THE

TRANSACTIONS

OF

THE LINNEAN SOCIETY

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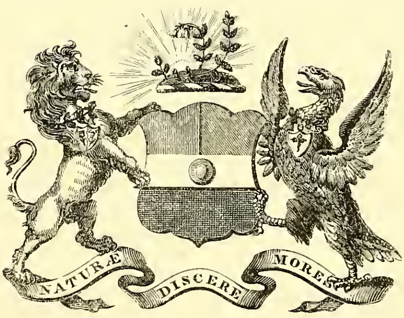

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ERRATA.

Page 41, line 4 from bottom, *for* 'origin' *read* 'organ.'

,, 101–6. In Messrs. Knight and Mitten's "Contributions to the Lichenographia of New Zealand," in all the measurements, *for* 'from' *and* 'to' *read* 'breadth' *and* 'length.'

,, 149, line 3 from top, *for* 'limbs' *read* 'body.'

In vol. xxii. p. 381–2, in Mr. Knight's paper "On the Bitentaculate Slug, &c. of New Zealand," the references to Plate LXVI. are wrong. Nos. 6, 7, 8, 11, 12, & 15 are dissections, &c. of the common Black Slug of the Northern Island.

ERRATA.

Page 41, line 4 from bottom, *for* origin *read* organ.
Page 149, line 3 from top, *for* limbs *read* body.

TRANSACTIONS

OF

THE LINNEAN SOCIETY.

I. *Synopsis* Crescentiacearum: *an Enumeration of all the* Crescentiaceous *Plants at present known. By* Berthold Seemann, *Esq., Ph.D., F.L.S.*

Read November 17th, 1859.

In 1853 I had the honour of laying before the Linnean Society a short paper on *Crescentiaceæ* (conf. Proceedings Linn. Soc. ii. p. 268), accompanied by a promise of a more elaborate treatise on the same subject. As it was absolutely necessary to pay visits to Vienna, Berlin, and Paris, in order to compare the herbaria of those places with the notes made on the London Collections, I find myself only now in a position to fulfil my promise. I have seen eleven species of *Crescentiaceæ* in a living state, five of them wild in their native countries; and have besides carefully examined the various herbaria, but regret that these materials are not so complete as could be wished. Of some species there are only single specimens preserved, and the fruit of most species is merely superficially known. The generic characters are therefore in some instances left incomplete, and the limits of a few species await further settlement.

That the Crescentiaceous plants, or rather the genera *Colea*, *Phyllarthron*, *Tanæcium*, *Parmentiera*, *Crescentia*, and *Kigelia* constitute a closely associated group of the *Personatæ*, needs, as a universally accepted fact, no demonstration,—the views of Jussieu, who regarded them as *Solanaceæ*, not having found any modern supporters. But it will be necessary to say a few words respecting the diversity of prevailing opinions as to the affinity and rank they hold in the natural system. It is still a matter of debate whether this group should be regarded in the light of a separate order, or merely as a suborder of either *Bignoniaceæ* or *Gesneraceæ*. Bojer (Hort. Maurit. p. 220) placed it with *Bignoniaceæ* (in which he was followed by Don, DeCandolle, Fenzl*, Miers, and others); Endlicher and Miquel with

* Fenzl associates three foreign elements with *Crescentiaceæ*: viz. *Spathodea*, and *Periblema*, both *Bignoniaceæ*; and *Bravaisia*, a true *Acanthacea* (= *Onchycanthus Cumingianus*, Nees).

Gesneraceæ. Gardner (Hook. Journ. ii. p. 424) erected it into a separate natural order, in which he was supported by Lindley (Veg. Kingdom, p. 673) and myself (Proc. Linn. Soc. ii. p. 268, and Bot. Herald, p. 181). *Crescentiaceæ* seem to me to stand between *Cyrtandreæ* and *Bignoniaceæ,* where they are placed by Lindley: they differ from *Cyrtandreæ* in the transverse position of their seed; from *Bignoniaceæ* in their indehiscent fruit and wingless seed. Respecting their claim to the rank of a separate natural order, it must be conceded that it depends entirely upon the subjective importance attached to certain characters upon which the various orders composing the great class *Personatæ* (*Bignoniales,* Lindl.) are founded. For instance, if *Orobancheæ,* in virtue of their spherical pollen, capsular fruit, parietal placentæ, anatropal ovule, and albuminous wingless seed, are held to be a separate order of plants, as is done in most systematic works, there is no option but to acknowledge the independence of the *Crescentiaceæ,* unless indeed the whole of the *Personatæ* are looked upon as *one* great natural order, and *Crescentiaceæ, Acanthaceæ, Bignoniaceæ, Scrophularineæ,* etc. as merely so many suborders or tribes. In the former case there would be 10 separate natural orders ranged under *Personatæ,* the differences of which often rest upon only a single *constant* character. This will be seen from the following sketch, which will also show that, if any of the distinctive characters pointed out be disregarded, several large groups fall together.

PERSONATÆ (*Bignoniales* et *Orobancheæ,* Lindl.).

§ I. *Placentæ parietales.*

Pedaliaceæ. Pollen . . . . Ovula anatropa. Drupa vel capsula. Semina erecta v. pendula, aptera, exalbuminosa.

Besleriaceæ. Pollen ellipticum. Ovula anatropa. Bacca. Semina pendula, aptera, albuminosa.

Gesneraceæ. Pollen ellipticum. Ovula anatropa. Capsula. Semina pendula, aptera, albuminosa.

Orobancheæ. Pollen sphæricum. Ovula anatropa. Capsula. Semina . . . . . aptera, albuminosa.

Didymocarpeæ. Pollen . . . . Ovula anatropa. Capsula. Semina pendula, plerumque aptera, albuminosa.

Cyrtandreæ. Pollen . . . . Ovula anatropa. Bacca. Semina pendula, aptera, exalbuminosa.

Crescentiaceæ. Pollen sphæricum. Ovula anatropa. Bacca. Semina transversa, aptera, exalbuminosa.

§ II. *Placentæ axillares.*

Bignoniaceæ. Pollen ellipticum. Capsula. Ovula anatropa. Semina transversa, alata, exalbuminosa.

Acanthaceæ. Pollen sphæricum. Ovula amphitropa v. campylotropa. Capsula. Semina erecta, aptera, exalbuminosa.

Scrophularineæ. Pollen ellipticum. Ovula anatropa v. amphitropa. Capsula*. Semina erecta, aptera, albuminosa.

§ III. *Placentæ centrales.*

Lentibulariæ. Pollen ellipticum. Ovula anatropa. Capsula. Semina . . . . aptera, exalbuminosa.

* Miers (Illustrations of South American Plants, i. App. p. 164) has incorporated all the baccate genera, formerly placed in *Scrophularineæ,* in his order *Atropaceæ,* standing between *Scrophularineæ* and *Solanaceæ.*

CRESCENTIACEÆ.

Crescentiaceæ, Gardn. in Hook. Journ. ii. p. 423 (1840); Lindl. Veg. Kingd. p. 673 (1846); Seem. in Proc. Linn. Soc. ii. p. 268 (1853), Bot. Herald, p. 181 (1854). *Bignoniacearum* et *Gesneracearum* tribus auct.

CHAR. ORDINIS EMEND.—*Arbores* vel *frutices* stantes vel interdum scandentes, sæpe glabræ, *ramis* plus minusve angulatis. *Folia* alterna, fasciculata, opposita v. verticillata, petiolata, nunc simplicia, sæpissime integerrima, nunc composita (trifoliolata vel imparipinnata). *Stipulæ* nullæ, vel interdum e gemmis axillaribus foliis primariis spuriæ. *Flores* hermaphroditi, subregulares vel irregulares, terminales vel axillares, vel sæpissime ex trunco aut basi ramorum orti, solitarii, racemosi vel paniculati. *Calyx* liber, gamophyllus, persistens vel deciduus, 5-merus, spathaceus vel bipartitus. *Corolla* hypogyna, gamopetala, subcampanulata, infundibuliformis vel hypocraterimorpha, limbo 5-lobo, subæquali vel subbilabiato, lobis per æstivationem duplicato-plicatis vel subplicato-imbricatis. *Stamina* 4, didynama, cum rudimento quinti, corollæ tubo inserta, ejusdem laciniis alterna, exserta vel inclusa. *Filamenta* simplicia. *Antheræ* biloculares (abortu uniloculares), loculis discretis. *Pollen* sphæricum. *Discus hypogynus* glandulosus, obsolete lobatus, ovarii basin cingens. *Ovarium* liberum, 1-loculare; *ovula* anatropa, indefinita. *Stylus* terminalis, simplex. *Stigma* bilobum vel bilamellatum. *Fructus* baccatus, 1-locularis, vel spurie 2-4- pluri-locularis. *Semina* plurima, aptera, transversa. *Albumen* nullum. *Embryo* rectus vel curvatus. *Radicula* umbilico proxima, brevis, crassa. *Cotyledones* plano-convexæ.

Obs. This definition excludes *Periblema*, DeCand. Prod. ix. p. 242 (*Boutonia*, De Cand.), a Madagascar genus having a bilocular ovary, and two ovules in each cell. Its fruit is unknown. It will therefore be much better placed among the genuine *Bignoniaceæ*,—its definite number of ovules showing it to possess some affinity with *Platycarpum*, H. et B., and *Henriquezia*, Spruce (Linn. Trans. xxii. p. 296).

Geographical Distribution.

The *Crescentiaceæ* are inhabitants of the tropical and subtropical regions of both hemispheres, ranging from 30° S. to 30° N. latitude. They occur in the greatest number in Madagascar, Mauritius, the Seychelles and other islands of Eastern Africa. In America they are represented by 10 species, the most northern of which (*Crescentia Cujete*, Linn.) is found in Key West, Florida. In Asia only two species have as yet been discovered, one of them (*Colea Mauritiana*, Boj.) having been collected in Timor, and also in Mauritius and Madagascar, the other (*C. tripinnata*, Seem.) in Cochin-china. No representative of the order has hitherto been met with either in Europe, or the continent of Australia. Numerically we may state that Africa produces 16, America 10, and Asia 2 members of this group of plants. Considerable additions may, however, still be expected from the islands of Eastern Africa, and necessitate a careful revision of the genuine *Bignoniaceæ* and allied orders. Four species are extensively cultivated in the tropics, viz. *Crescentia Cujete*, Linn. and *C. alata*, H. B. K. (both for the sake of their hard-shelled fruit), *Colea Telfairiæ*, Boj. (on account of its edible, agreeable-flavoured fruit), and *Kigelia pinnata*, DeCand. Probably the great geographical range which *Crescentia Cujete*, Linn. and *Kigelia pinnata*, DeCand. enjoy (the former in America, the latter in Africa), is in a great measure owing to their having accompanied man in his wanderings, been planted where new homes were established, and become gradually naturalized, and to all appearance wild, in the localities where we now meet with them.

Properties and Uses.

All *Crescentiaceæ* may be termed ornamental plants, the fine foliage, elegant flowers, and curious fruit of which have already procured for their order a fair representation in our gardens. We cultivate (1859) *Colea floribunda*, Boj.; two species of *Phyllarthron* (*P. Bojerianum*, DeCand. and *P. Comorense*, DeCand.=*P. Poivreanum*, DeCand.); *Tanæcium parasiticum*, Swartz; all the known species of *Crescentia*, and *Kigelia pinnata*, DeCand. *Parmentiera cereifera*, Seem. was in 1845 at Kew, but has since been lost. Several *Crescentiaceæ* furnish excellent timber; and considerable praise is given in this respect to the *Kigelia pinnata*, DeCand., of which canoes, posts and pillars, etc. are made[1], and which, not only as an umbraculiferous, but also as a sacred tree, is held in high esteem in Africa. Kotschy, speaking of the kingdom of Nubia, says: "On moonlight nights the negroes celebrate their religious festivals under this tree and the *Boswellia serrata*, Roxb. As soon as the moon rises, they form circles under the oldest trees, and begin to dance, sing, and beat large drums, whilst the women supply them with the slightly intoxicating merisa (beer made of *Sorghum*). These festivals are repeated every month, and extend over several nights, during which time pitchers filled with merisa are placed around the trunks, and some of the same beverage poured on the roots of the trees. As symbols of special veneration, high poles made of *Kigelia*-wood are erected before the houses of the great chiefs[2]." The genus *Crescentia* has a fruit with a hard woody shell, which in *Crescentia Cujete*, Linn. (=*C. cuneifolia*, Gardn.), the Calabash-tree of the British colonists, is so large and durable, that it admits of being converted into pails, bottles, pans, cups, sieves, ladles, spoons, and various other household articles[3]. In Panama I have seen milk-pans made of it, measuring thirteen inches across; and Humboldt mentioned to me that during his travels in America, Bonpland and he commonly used one of these vessels as their wash-hand basin. Even the shell of *Crescentia alata*, H. B. K., the *Tecomate* of the Mexicans, though much smaller than that of *Crescentia Cujete*, Linn. is used in Mazatlan and other parts of Mexico as a drinking-cup[4]. The shell, or rather rind, of *Kigelia pinnata*, DeCand., after having been hardened by drying, serves as frames for drums in Africa[5]; and it is not unlikely that the account given by the missionary Knoblecher, of the shell of a fruit found on the White Nile[6] and devoted to the same purpose, refers to it. The fruit of the Palo de velas, the famous Candle-tree of the Isthmus of Panama (*Parmentiera cereifera*, Seem.), has an apple-like smell, and fattens cattle[7], whilst that of the Quauhilote (*Parmentiera edulis*, DeCand.=*Crescentia aculeata*, H. B. K.), resembling a cucumber in shape, is eaten by the Mexicans[8]. The berry of *Tanæcium lilacinum*, Seem. (=*Besleria*? *violacea* et *B.*? *cærulea*, Aubl.) is also edible[9]; and the subacid pulp of the fruit of *Crescentia Cujete*, Linn. affords food to the negroes[10]. Tussac believed that the fruit of *Crescentia cucurbitina*, Linn., a common sea-side shrub of tropical America, contained a deadly poison, and hence he

[1] Oswald, Mem. in Mus. Kew; H. Barth in Bonpl. iv. p. 292.
[2] Kotschy in Bonpl. iv. p. 304.
[3] Seemann, Bot. Herald, p. 183.
[4] Seemann in Hooker's Journ. and Kew Misc. vi. p. 276.
[5] Barth in lit. ad auct.
[6] Kotschy in Bonpl. iv. p. 304.
[7] Seemann, Bot. Herald, p. 183.
[8] DeCandolle, Prodromus, ix. p. 244; Lindley, Veg. Kingd. p. 674.
[9] Seemann, Bot. Herald, p. 182.
[10] Lindley, Veg. Kingd. p. 674.

thought it necessary to warn against it by changing the specific name of the plant into that of *Crescentia lethifera.* "I know myself," he says, "that some English soldiers in garrison at the Merebalis, who, having found the fruit possessed a cucumber-like taste, boiled and ate it, were seized with dreadful colic, and nearly all perished[11]". As this is the only instance of poisonous properties recorded of this order, the statement must be received with caution; possibly some fruits of the Manchineel-tree, which generally grows in company with *Crescentia cucurbitina*, Linn., may have been mixed with those alluded to, and caused the accident. *Colea Telfairiæ*, Boj. is extensively cultivated in Madagascar on account of its fleshy fruit, which has an agreeable flavour, and is highly esteemed as an esculent[12]. *Phyllarthron Bojerianum*, DeCand. also yields an edible fruit[13]. The natives of Guiana extract a violet colour from the fruit of "Emossé bereoy" (*Tanæcium lilacinum*, Seem.), with which they dye their cotton cloth, their bark and straw furniture[14]. The juice of the fruit of the common Calabash-tree dyes silk black[15]. The fruit of the "Coco de Mono" of Topo, Venezuela (*Crescentia cucurbitina*, Linn.), diffuses, when ripe, an agreeable odour, which attracts monkeys, birds, and other animals partial to the fruit[16]. The medicinal properties of some species are in repute among the natives of various countries, though they have not yet been recognized in our pharmacopœias. The Philippine Islanders consider a decoction of the leaves of *Crescentia alata*, H. B. K. (= *C. trifolia*, Blanco) an effectual remedy for hæmoptysis[17]. The pulp of the fruit of the same species, boiled with sugar, is administered internally by the Mexicans in complaints of the chest (consumption?)[18], and half a drachm of the root of *Parmentiera edulis*, DeCand., to one pound of water, is considered by them as a remedy for dropsy[19]. Purgative properties reside in the pulp of *Kigelia pinnata*, DeCand., of which the Africans avail themselves[20]; they are also found in the juice of *Crescentia Cujete*, Linn., obtained in Panama by incision of the fruit[21]. The pulp of the fruit of the last-named tree is also used internally in Mexico in inflammatory and bilious diseases[22], and employed, like that of *Tanæcium albiflorum*, DeCand.[23], in various countries as poultices. With the fruit of *Kigelia pinnata*, DeCand. cut in halves, and slightly roasted, the nations of North-eastern Africa rub their skin, as a cure for rheumatic and syphilitic complaints[24]. Its aphrodisiacal properties are also confirmed by A. Richard[25].

Classification.

I have divided *Crescentiaceæ* into two tribes, the one having a regular, the other an irregular calyx. I retain for them DeCandolle's names (*Tanæcieæ* and *Crescentieæ*) and their typical genera, but reject his characters and remove *Parmentiera* from *Tanæcieæ* to *Crescentieæ*, and *Tripinnaria* from *Crescentieæ* to *Tanæcieæ*. No new genera are created; but two (*Schlegelia* and *Tripinnaria*) suppressed, they having proved

[11] Tussac, Fl. des Antilles, iv. p. 51.
[12] Hooker, Bot. Mag. (1830) t. 2976.
[13] Bojer, Mem. in Herb. Vindob.
[14] Aublet, Guiana, ii. p. 631.
[15] Seemann, Bot. Herald, p. 183.
[16] W. Birschell, Mem. in Herb. Hook.; Bonpl. v. p. 44.
[17] M. Blanco, Fl. de Filipinas, p. 490 (1st edit.).
[18] Seemann in Hook. Journ. and Kew Misc. vi. p. 276.
[19] Heller, Reisen in Mexiko, p. 414.
[20] Eduard Vogel, Mem. in Herb. Hook.; Bonplandia, v. p. 44.
[21] Seemann, Bot. Herald, p. 183.
[22] Heller, Reisen in Mexiko, p. 414.
[23] Lindley, Veg. Kingd. p. 674; Heller, Reisen in Mexiko, p. 414.
[24] Kotschy in Bonplandia, iv. p. 304.
[25] A. Richard, Flora Abyssinica, ii. p. 60.

identical with *Tanæcium* and *Colea*; whilst *Periblema*, DeCand., on account of its bilocular ovary and definite number of ovules, is altogether excluded from the order.

Diagnosis Generum.

Tribus I.—TANÆCIEÆ. Calyx persistens, regularis, 5-merus.

1. *Colea,* Boj. Calyx obsolete 5-dentatus vel 5-partitus, ecostatus. Fructus carnosus, cylindraceus, spurie 2-locularis. Folia opposita vel verticillata, imparipinnata. Africâ et Asiâ tropicâ.

2. *Phyllarthron,* DeCand. Calyx 5-dentatus, 5-angulato-costatus. Fructus carnosus, cylindraceus, spurie plurilocularis. Folia verticillata vel sparsa, lomentacea. Africâ tropicâ.

3. *Tanæcium,* Swartz. Calyx obsolete 5-dentatus, ecostatus. Fructus carnosus, oblongus vel globosus, 1- vel spurie 2-locularis. Folia opposita, simplicia vel trifoliolata. Americâ tropicâ.

Tribus II.—CRESCENTIEÆ. Calyx deciduus, irregularis (spathaceus vel bipartitus).

4. *Parmentiera,* DeCand. Calyx spathaceus. Fructus carnosus, cylindraceus, epulposus. Folia opposita, trifoliolata vel simplicia. Americâ tropicâ.

5. *Crescentia,* Linn. Calyx bilabiatus, lobis integerrimis. Fructus lignosus, rotundatus vel oblongus, pulposus. Folia sparsa vel fasciculata, simplicia vel trifoliolata. Americâ tropicâ.

6. *Kigelia,* DeCand. Calyx bilabiatus, lobis irregulariter fissis. Fructus corticatus, ellipsoides seu cylindraceus. Folia opposita, imparipinnata. Africâ tropicâ.

Tribus I.—TANÆCIEÆ. Seem. in Proc. Linn. Soc. ii. p. 269 (1853); Bot. Herald, p. 182 (1854).—*Calyx* persistens, regularis, 5-merus.

1. COLEA, Bojer.

Calyx persistens, subcampanulatus, obsolete 5-dentatus, vel 5-partitus. *Corolla* infundibuliformis, tubo oblongo supra paulum ampliato, limbo 5-fido subæquali, lobis rotundatis patentibus. *Stamina* 4, didynama, cum rudimento quinti; *antheræ* bi- (vel abortu uni-) loculares, loculis discretis. *Discus glandulosus* obsolete 5-lobus, ovarii basin cingens. *Stylus* elongatus; *stigma* bilamellatum. *Ovarium* uniloculare, multiovulatum, placentis parietalibus. *Ovula* anatropa. *Bacca* oblonga cylindraceave, styli-apiculata, spurie 2-locularis. *Semina* exalbuminosa, imbricata, irregulariter ovata, crassiuscula. *Cotyledones* plano-convexæ apice emarginatæ; *radicula* brevissima.

Frutices, arbusculæ vel arbores *Africæ et Asiæ tropicæ,* sæpius glabræ, foliis verticillatis vel oppositis, imparipinnatis (abortu simplicibus), foliolis integerrimis, floribus racemosis vel paniculatis, terminalibus vel ex trunco ramisque ortis, flavidis, roseis vel albidis.

Colea, Boj. Hort. Maurit. p. 220 (1837); Endl. Gen. Plant. Suppl. i. n. 4171/2 (1840); DeCand. Prodr. ix. p. 240 (1845).

Bignoniæ sp., auct.

Tripinna, Lour. Fl. Cochin. (ed. Ulyssip.), p. 391 (1790).

Tripinnaria, Pers. Ench. ii. p. 173 (1807); Endl. Gen. Pl. n. 4173 (1836–40).

Tripinna tripinnata, Lour. (=*Tripinnaria Cochinchinensis,* Pers.), has always been numbered among the doubtful genera; and unfortunately there are no specimens of it among Loureiro's plants preserved at Paris and London. But I do think that in all essential points it agrees with *Colea,* and may appropriately take its place near *Colea Telfairiæ,* Boj., with which it corresponds in its arboreous habit, terminal panicles, and undulated lobes of the corolla. Loureiro does not state in his description whether his plant has opposite leaves; but if the systematic position now assigned to it be correct, there is reason to believe that, like all other *Coleas* with terminal flowers, the leaves are opposite. Having thus united the genera *Colea* and *Tripinna,* the necessity of adopting the oldest name (*Tripinna*) would seem forced upon me; but in yielding to this I should be obliged to disturb a whole series of well-established names; and that I cannot bring myself to do as long as no specimens of Loureiro's doubtful plant have been examined. There is another reason which prompts me to pause. The habit of all *Coleas* with opposite leaves and terminal flowers is very different from that of the *Coleas* with verticillate leaves and flowers growing out of the old wood, rendering it probable that these differences may be accompanied by important generic distinctions, which, when the flowers and fruit of all the species shall have become better known, may justify a breaking up of *Colea* into at least two distinct genera. Loureiro's *Tripinna* might then be restored, and the name of *Colea* be restricted to *Colea Mauritiana* and its allies. Even now it will aid us in the classification, if we divide the genus sectionally into *Coleæ genuinæ* and *Tripinna*. I have added four new species, three of which were discovered by recent travellers, whilst one (*C. Bojeri*) had been misplaced under *Bignonia*. This will in some measure compensate for the reduction of species it has been necessary to make. *Colea ramiflora*, DeCand. and *C. obtusifolia*, DeCand. have been united with *C. Mauritiana*, Boj., there being no specific distinction between them. *C. floribunda*, Boj., like all *Coleas* established by Bojer, proves a good species, of which *C. cauliflora*, DeCand. and *C.? Commersonii* are undoubtedly synonyms. *C. purpurascens*, Seem. seems a very distinct species: I must, however, own that I entertain doubts whether it may not fall, together with *C. Bojeri* (*Bignonia Bojeri*, DeCand.), of which I have seen no specimens, and which is but imperfectly described. *C. Seychellarum*, Seem. and *C. hispidissima*, Seem. are founded upon very distinctive characters, and will probably stand. *C. tetragona*, DeCand. is also a good species, the branches of which are, however, apt to have more than four sides. *C. decora* is perhaps the most variable species, the leaves being simple, trifoliated, and imparipinnate, whilst the flowers (normally placed in simple racemes) are often quite isolated on a bracteate rachis. Owing to this extreme variation, the species has seldom been recognized, and a host of synonyms has been the consequence. *Colea nitida*, DeCand., *C. Chapelieri*, DeCand., *Bignonia racemosa*, Lam., and *B. compressa*, Lam., are the names under which it appears in our systematic works. *C. Telfairiæ*, Boj. and *C. involucrata*, Boj. are also good species, to the latter of which *Bignonia bracteosa*, DeCand. must be added as a synonym.

§ I. *Folia verticillata. Flores e trunco ramisque orti* (Coleæ genuinæ).

1. Colea floribunda; arbuscula; ramis obtuse angulatis glabris, foliis 4–5-no-verticillatis 5–8-jugis cum impari, foliolis petiolulatis elliptico-oblongis vel oblongo-lanceolatis acuminatis, utrinque glabris, racemis e caule ramisque ortis, calyce glabro, corolla (lutea) extus velutino-scabrida, intus villosa, staminibus ovario stylo fructuque elongato cylindraceo subtoruloso glabris. (v. v. cult. et sp. s.)

Colea floribunda, Bojer, Hort. Maurit. p. 220 (1837); Lindl. Bot. Reg. 1841, t. 19; DeCand. Prodr. ix. p. 241, n. 3 (1845).

Colea? Commersonii, DeCand. Prodr. ix. p. 242, n. 11 (1845).

Colea cauliflora, DeCand. Prodr. ix. p. 241, n. 3 (1845).

Bignonia cauliflora, Sieb. Fl. Maurit. exsic. ii. n. 284.

Nomen vernaculum Madagascariense: "*Rei-rei.*"

Geogr. Distr. Common throughout Madagascar (*Commerson*! in Herb. Par., et Juss.! *Bojer*!); Mauritius (*Sieber*! in Herb. Vindob.).

This is the only species of *Colea* as yet cultivated in our gardens. It is better known than all the others; and we are therefore enabled to settle its synonymy with tolerable accuracy. I have seen, at Paris, Commerson's specimens upon which DeCandolle founded his *Colea*? *Commersonii*, and consider them to be in every respect identical with *C. floribunda*. Why DeCandolle placed *C. Commersonii* among the species with terminal flowers is difficult to say, since some of the specimens prove that the racemes grow out of the old wood. Sieber's n. 284 from Mauritius, upon which DeCandolle founded his *C. cauliflora*, I have examined in the Vienna Herbarium, and I find that it cannot be specifically separated from *C. floribunda*.

2. Colea Seychellarum; arbuscula; ramis angulatis glabris, foliis 3- 4-nove verticillatis 4–5-jugis cum impari, foliolis petiolulatis obovato-oblongis obtusis, basi attenuatis, coriaceis utrinque glabris, racemis elongatis e caule ramisque ortis, calyce glabro, corolla extus glabra, intus villoso-pubescente, ovario styloque glabro, fructu . . . . (v. sp. s.)

Colea Seychellarum, Seem. MSS. in Herb. Paris.
Geogr. Distr. Isle of Mahé (*Bernier*!, n. 38).

This new species has the habit of *Colea floribunda*, Boj. It is, according to Bernier, from 20–25 feet high. Leaves 1–1½ foot long; leaflets 4–5 inches long and 1½–2 inches broad. Racemes often 8 inches, and corolla about 1 inch long. At once distinguished from *C. floribunda* by its very long racemes and its (outside) glabrous corolla.

3. Colea purpurascens; . . . . , ramis angulatis pubescentibus, foliis 3–7-no verticillatis 7–10-jugis cum impari, foliolis petiolulatis ovato-oblongis longe acuminatis basi attenuatis, petiolis, petiolulis nervisque inferioribus purpurascentibus, racemis abbreviatis e caule ramisque ortis, calyce glabro, corolla extus velutino-scabrida, stylo superne villoso, fructu . . . . (v. sp. s.)

Colea purpurascens, Seem. MSS. in Herb. Paris.
Geogr. Distr. Ste. Marie de Madagascar (*Boivin*!); Nossi-be (*Boivin*!).

Has the habit of *Colea floribunda*, but differs in the pubescent branches, and pseudostipules, the purplish tinge of the petioles, petiolules, and veins of the under side of the leaflets, as well as in its villose style. It flowers, according to Boivin, from November to January.

4. Colea discolor; fruticosa; ramis (angulatis?) apice hirsutis; foliis (verticillatis?) 7-jugis cum impari, foliolis brevi-petiolulatis oblongo-lanceolatis obtuse acuminatis subtus purpureis, racemis e caule ramisque ortis, calyce . . . , corolla . . . , ovario . . . , stylo . . . , fructu . . .

Colea discolor, Seem. MSS.
Bignonia discolor, Boj. in lit. ad DeCand. 1833, non Rich.
Bignonia Bojeri, DeCand. Prodr. ix. p. 165 (1845).
Geogr. Distr. Madagascar, on Mount Antoungoun, prov. of Emirna (*Bojer*, teste *DeCand.*).

I have not seen specimens of this species; and those seen by DeCandolle were without flowers and fruit. My reasons for placing it among the genuine *Coleas* were twofold:—Because no true *Bignonia* has imparipinnate leaves with quite entire leaflets, nor flowers growing out of the old wood, as those of *Colea discolor*, according to Bojer, do: these three characters combined are only met with in *Colea*, and in no other Bignoniaceous or Crescentiaceous genus. As an additional reason, I may plead the close resemblance this species must bear to *Colea purpurascens*, rendering a specific distinction difficult. Both have hairy branches, leaves with 7 pairs, and leaflets more or less purplish underneath. Should a larger number of specimens come to hand, it may be found that there is no specific distinction between *Colea purpurascens* and *C. discolor*.

5. Colea hispidissima; fruticosa?, ramis subteretibus glabris, foliis oppositis (v. verticillatis?) 4–5-jugis cum impari, foliolis longe petiolulatis obovato-oblongis breviter acuminatis, racemis abbreviatis e caule ramisque ortis, calyce corollaque extus pilis ferrugineis hispidissimis, corolla (albida?) intus ovario styloque hispidis, staminibus glabris, fructu . . . . (v. sp. s.)

Colea hispidissima, Seem. MSS.

Geogr. Distr. Ste. Marie, Madagascar (*Boivin*! n. 1820 in Herb. Par.).

Differs from all known *Coleas* by its very hispid calyx and corolla. The leaves are probably, in the older branches, verticillate, as in all the other species of this group of the genus.

6. Colea Mauritiana; arborea; ramis angulatis glabris, foliis 3–4-nove verticillatis 2–3-jugis cum impari, foliolis subsessilibus obovato-cuneatis obtusis vel acuminatis coriaceis, racemis e caule ramisque ortis, calyce glabro, corolla (rosea) glabra vel tenuissime puberula, staminibus ovario styloque glabris, fructu oblongo acuminato verrucoso glabro (flavescente), seminibus ovali-oblongis. (v. sp. s.)

Colea Mauritiana, Bojer, Hort. Maurit. p. 220 (1837); DeCand. Prodr. ix. p. 241, n. 1 (1845).

Colea ramiflora, DeCand. Prodr. ix. p. 241 (1845).

Bignonia Colei, Boj. MSS.; Hook. Bot. Mag. t. 2817 (1828).

Bignonia ramiflora, Decaisne, Nouv. Ann. Mus. Par. iii. p. 381.

Colea obtusifolia, DeCand. Prodr. ix. p. 241 (1845).

Geogr. Distr. Madagascar (*Chapelier*! *Petit-Thouars*! *Commerson*!); Mauritius (*Bojer*!); Timor (*Herb. Par.*).

A tree, according to Bojer's MSS. in the Viennese Herbarium, and having *Colea tetragona* for its nearest ally. The leaflets of Bojer's specimen from Mauritius are quite obtuse.

7. Colea tetragona; fruticosa; ramis acute 4–7-gonis, glabris, foliis 4–7-nove verticillatis 5–9-jugis cum impari, foliolis brevi petiolulatis oblongis obtusis basi inæqualibus subcuneatis coriaceis, racemis e caule ramisque ortis abbreviatis, calyce glabro, corolla (rosea) extus puberula, ovario . . ., fructu . . . (v. sp. s.)

Colea? tetragona, DeCand. Prodr. ix. p. 242 (1845).

Geogr. Distr. Madagascar (*Petit-Thouars*! *Perville*! n. 234).

According to Perville, who found this species at St. Marie, in the N.E. of Madagascar, it is a shrub 12–15 feet high, with rose-coloured flowers. The specific name "*tetragona*" does not apply well to this plant, since better specimens than those at DeCandolle's disposal show that the normal number of the leaves, and the consequent edges of the branches, is seven, and that only weak specimens have square branches. The hard, acute, persistent scales occasionally met with in this species, and regarded by Bojer as stipules, appear to me (as supposed by DeCandolle) to be abortive leaves, somewhat analogous to the scales on the trunk of *Cycas*.

§ II. *Folia opposita. Flores axillares vel terminales.* (Tripinna, *Lour.*)

8. COLEA DECORA; fruticosa, glabra, ramis compressis, foliis oppositis 5-jugis cum impari, trifoliolatis vel imo simplicibus, foliolis petiolulatis obovato-oblongis obtusis vel acuminatis, basi subcuneatis, coriaceis, supra nitidis, petiolo angustissime marginato, racemis terminalibus vel axillaribus bracteatis, bracteis obovatis acutis vel obtusis basi cuneatis, pedunculis acute tetragonis, pedicellis solitariis vel 4-no verticillatis, calyce glabro, corolla (alba) staminibusque puberulis, ovario styloque glabris, fructu . . . (v. sp. s.)

Colea decora, Bojer, Hort. Maurit. p. 220 (1837); DeCand. Prodr. ix. p. 241. n. 8. (1845).
Colea? Chapelieri, DeCand. Prodr. ix. p. 242 (1845).
Colea? nitida, DeCand. Prodr. ix. p. 242 (1845).
Bignonia compressa, Lam. Dict. i. p. 424 (1783).
Bignonia racemosa, Lam. Dict. i. p. 424 (1783); DeCand. Prodr. ix. p. 166. n. 139 (1845).
Geogr. Distr. Madagascar (*Bojer*! *Goudot*! *Commerson*! *Chapelier*! *Petit-Thouars*! *Boivin*!). Goudot collected it near Tamatave, and Boivin at Ste. Marie.

Easily distinguished from *Colea tetragona*, its nearest ally, by its opposite, never verticillate leaves, and from all other Coleas by its racemes clothed with foliaceous bracts. By its bracts it approaches *Colea involucrata*, Boj. It is necessary to add, that Bojer distributed specimens of *Colea floribunda*, Boj. under the name of *Bignonia decora*, which has given rise to some confusion, leading in some herbaria to the error of attaching the name of *Colea decora* to the wrong plant.

9. COLEA INVOLUCRATA; fruticosa; ramis teretibus glabris, foliis oppositis 3–6-jugis cum impari, foliolis petiolulatis ellipticis obtuse acuminatis, basi cuneatis, supra nitidis, racemis abbreviatis (subcymosis) longe pedunculatis, 3–5-floris, bracteis 4 late obovatis vel suborbiculatis cinctis, calyce glabro, dentibus obtusis, corolla (rubro-aurantia, margine flavo-aurantio) limbo patente obtuse 5-lobo, extus intusque glabra, staminibus ovario styloque glabris, fructu . . . . . (v. sp. s.)

Colea involucrata, Bojer, Hort. Maurit. p. 221 (1837); DeCand. Prodr. ix. p. 242 (1845).
Bignonia bracteosa, DeCand. Prodr. ix. p. 165 (1845).
Nomen vernaculum: "*Sifin-souki-mena-felan*," teste Bojer.
Geogr. Distr. Madagascar (*Bojer*! in Herb. Par. et Hook.).

The fruit of this species, though unknown to both DeCandolle and myself, was probably seen by Bojer, and induced him to place the plant with his genus *Colea*, in which

DeCandolle followed him; but, probably by some oversight, the celebrated author of the 'Prodromus' enumerated it a second time in his great work as *Bignonia bracteosa*, with which genus (if the fruit be fleshy) it can have nothing to do. The imparipinnate leaves with quite entire leaflets are also a feature not met with in any genuine species of Bignonia.

10. COLEA TELFAIRIÆ; arborea; ramis subcompressis, minutissime pubescentibus viscosis; foliis oppositis 6–9-jugis cum impari, foliolis ovato-oblongis acuminatis lucidis, paniculis terminalibus laxis, calycis dentibus puberulis longiusculis acutis, corolla (rosea, tubo ad faucem flavo fasciato) extus minute puberula, intus subglabra, lobis crenatis, staminibus ovario styloque glabris, fructu longius cylindraceo acuminato carnoso sublævi. (v. sp. s.)

Colea Telfairiæ, Bojer, Hort. Maurit. p. 220 (1837); DeCand. Prodr. ix. p. 242. n. 10. (1845).

Bignonia Telfairiæ, Boj. MSS., in Hook. Bot. Mag. t. 2976 exclud. fig. 2 (1830).

Geogr. Distr. Province of Emirna, Madagascar (Bojer!), where it is also cultivated on account of its edible fruit.

Nomen vernaculum Madagascariense: teste Bojer, "*Vouën-Kici-Kicika.*"

11. COLEA TRIPINNATA; arborea; ramis patentibus, foliis (oppositis?) 3-jugis cum impari, foliolis (petiolulatis?) ovatis acuminatis glabris, paniculis terminalibus, calyce cyathiformi 5-crenato, corolla (luteo-rubra) subcampanulata, laciniis ovatis undulatis villosis, ovario subrotundo styloque . . . ., fructu ovato, seminibus oblongis compressis.

Colea tripinnata, Seem. in Bonplandia, iv. p. 128 (1856); Hook. Journ. of Bot. and Kew Misc. ix. p. 84 (1857).

Tripinna tripinnata, Lour. Fl. Cochinch. (ed. Ulyssipol.) p. 391 (1790).

Tripinnaria Asiatica, Sprengl. Syst. ii. p. 842 (1822).

Tripinnaria Cochinchinensis, Pers. Ench. ii. p. 173 (1807); DeCand. Prodr. ix. p. 248 (1845).

Tanæcium tripinna, Raeusch, ex Steudl. Nomen. Bot. p. 712 (1841).

Nomen vernaculum Cochinchinense: "*A Cây Dĕn.*"

Geogr. Distr. Cochinchina (teste *Loureiro*).

As there are no specimens of this plant in Europe to supply the deficiencies of Loureiro's character, it may not be superfluous to add here all that the 'Flora Cochinchinensis' contains about it:—"*Cal. Perianthium* cyathiforme, 5-crenatum, persistens. *Cor.* monopetala, subcampanulata, patens; tubo calycem superante, limbo 5-fido; laciniis ovatis undulatis, villosis, summa majore. *Stam. Filamenta* 4 (quorum duo longiora) corollæ subæqualia. *Antheræ* bicornes, incumbentes. *Pist. Germen* subrotundum. *Stylus* æqualis staminibus. *Stigma* acutum, bifidum. *Peric. Bacca* ovata, carnosa, 1-locularis, polysperma. *Sem.* oblonga, compressa, pauca*. Nom. *Tripinnam* vocavi a foliis tripinnatis.—*Tripinna tripinnata*; foliis 3-pinnatis, foliolis ovatis acuminatis; racemis terminalibus. Hab. *Arbor* magna, ramis patentibus. *Folia* tripinnata † cum impari

* "pauca" is probably a misprint for "*parva*," as just before the berry is termed "POLYspermous" by Loureiro, and as the seeds of all Coleas are small.—B. S.

† The term "tripinnata" here employed I take to mean "3-juga."—B. S.

majore, *foliolis* ovatis acuminatis, integerrimis, glabris. *Flos* luteo-ruber, corymbis racemosis terminalibus. Habitat in sylvis montanis, Cochinchinæ."

2. Phyllarthron, DeCand.

Calyx persistens, 5-angulatus, 5-dentatus. *Corolla* infundibuliformis, tubo oblongo supra paulum ampliato, limbo 5-fido subæquali, lobis rotundatis patentibus. *Stamina* 4, didynama, cum rudimento quinti; *antheræ* biloculares, loculis discretis. *Discus glandulosus* obsolete 5-lobus, ovarii basin cingens. *Stylus* elongatus, stigma bilamellatum. *Ovarium* uniloculare, multiovulatum, placentis parietalibus. *Ovula* anatropa. *Bacca* cylindracea, spurie plurilocularis. *Semina* exalbuminosa, subrotunda.

Arbores vel frutices ex insulis *Africæ australis* ortæ, ramis dichotomis compressis vel angulatis, foliis oppositis verticillatis vel sparsis, lomentaceis (nempe petiolo articulato articulis 2–5 late foliaceis), foliolis nullis (v. in sp. dubio paucis), racemis terminalibus vel axillaribus paucifloris, floribus roseis, fructibus flavis.

Phyllarthron, DeCand. Prodr. ix. p. 243; Endl. Gen. Plant. Suppl. ii. p. 65. n. 4171/4.
Arthrophyllum, Bojer, Hort. Maurit. p. 221; DeCand. Rev. Bign. p. 18, non Blum.
Bignoniæ sp., auct.

The number of species here enumerated is the same as that of DeCandolle's 'Prodromus,' one of DeCandolle's species (*Ph. Poivreanum,* DeCand.) having been suppressed, and a new one (*Ph. Bernerianum,* Seem.) added. *Ph. Thouarsianum,* DeCand. will probably have to be excluded from this genus, its habit being entirely different from that of the genuine Phyllarthrons.

1. Phyllarthron Noronhianum; fruticosa, ramis angulatis, sæpe trigonis, foliis 3–4-nove verticillatis vel sparsis, petiolis articulatis, articulis 2–3 ample foliaceo-marginatis late obovatis basi cuneatis, supra lucidis subtus eveniis vel venis impressis, coriaceis, foliolis nullis, racemis terminalibus, pedunculis compressis, calyce cylindraceo 5-nervio obtuse 5-dentato, corolla ...., staminibus ...., ovario styloque ...., fructu .... (v. sp. s.)

Phyllarthron Noronhianum, DeCand. Prodr. ix. p. 243. n. 1 (1845).
Bignonia articulata, Desf. in Poiv. Suppl. i. p. 636?
Geogr. Distr. Madagascar (*Boivin*! *Petit-Thouars*! *Poivre*! in Herb. Par.).

2. Phyllarthron Bojerianum; arborea; ramis ancipitibus petiolisque junioribus viscosis; foliis oppositis, petiolis articulatis, articulis 2 late marginatis, inferiore obovato-cuneato, super. elliptico, utroque pinnatim venoso, foliolis nullis; racemis terminalibus subcorymboso-trichotomis, pedunculis compressis, calyce ovato-campanulato enervio subtruncato obtuse 5-dentato, corolla (rosea) extus pulverulento-velutina, lobis 5 latis obtusissimis, staminibus ....., ovario styloque glabris, fructu ..... (v. sp. s. et cult.)

Phyllarthron Bojerianum, DeCand. Prodr. ix. p. 243. n. 3 (1845); Hook. Bot. Mag. t. 4173 (1845); Van Houtte, Fl. des Ser. ii. t. 7 (Mars 1846).
Arthrophyllum Madagascariense, Boj. Hort. Maur. p. 221 excl. syn. (1837).
Nomen vernaculum Madagascariense: "*Zahane,*" teste Bojer.
Geogr. Distr. Madagascar (*Bojer*! *Boivin*!). Cultivated in Europe, having been introduced about 1840.

"Arbor excelsa," teste Bojer. Easily distinguished from the allied species by its viscous compressed branches and opposite leaves, as well as by its arboreous habit. Fruit edible, according to Bojer. Branches dichotomous. Racemes simple. Bracts opposite, ovate, acute. Corolla with five blunt, wavy segments. Glandular disc 5-toothed. Flowers in August. According to information kindly furnished by Mr. Duncan in Mauritius, the fruit of this and the following species is whitish, and as long as a little finger.

3. Phyllarthron Comorense; fruticosa; ramis acute 3–4-gonis; foliis 3–4-no verticillatis vel oppositis, petiolis articulatis, articulis 3–5 longe cuneatis, superne obcordato-emarginatis, lateraliter præter nervum medium parce venosis, foliolis nullis, racemis abbreviatis paucifloris, pedunculis teretiusculis, calyce tubuloso 5-nervio acute 5-dentato lepidoto-punctulato puberulo, corolla (rosea) extus puberula, intus . . . ., staminibus . . . ., ovario styloque . . . ., fructu "Capsici formam æmulante." (v. sp. s. et v. cult.).

Phyllarthron Comorense, DeCand. Prodr. ix. p. 224 (1845).
Phyllarthron Poivreanum, DeCand. Prodr. ix. p. 243 (1845).
Phyllarthron Bojerianum, var.? *β elongatum,* DeCand. Prodr. ix. p. 244 (1845).
Arthrophyllum Comorense, Bojer, Hort. Maurit. p. 221 (1837).
Nomen vernaculum: "*Taumounann,*" teste DeCand.
Geogr. Distr. Madagascar (*Poivre*! *Boivin*!); Comoro Isles (*Bojer*! *Boivin*! *Grey*!). Cultivated in Europe.

This species, according to Boivin "a shrub 6 feet high," has the longest leaves of the whole genus, some of them measuring 12–14 inches, and having petioles normally composed of five joints. The width of these joints is very variable, and imparts a different look to different specimens. Hence the many synonyms of this comparatively new plant. *P. Poivreanum,* DeCand. is one of the broad-jointed forms, but not specifically different from the genuine *P. Comorense. P. Bojerianum,* var.? *elongatum,* DeCand. is the same; for the "beard" sometimes observable at the junction of the petioles is simply a fungus that establishes itself upon some specimens.

4. Phyllarthron Bernierianum; fruticosa, ramis compressis glabris, foliis oppositis petiolis articulatis, articulis 2–5 anguste linearibus apice obcordato-emarginatis, nervis subparallelis, foliolis nullis, racemis terminalibus vel axillaribus usque ad 12-floris, pedunculis compressis, pedicellis oppositis, calyce glabro acute 5-dentato, corolla (rosea) extus pulverulento-velutina, staminibus . . . ., ovario styloque . . . ., fructu . . . (v. sp. s.)

Phyllarthron Bernierianum, Seem. in Bonplandia, vii. p. 224 (1859).
Geogr. Distr. Madagascar (*Bernier*! coll. ii. n. 215); Ambongo (*Perville*!); Diego Suarez (*Bernier*!).

According to Bernier, a shrub 6 feet high, with rose-coloured flowers. Leaves narrower than any other known species of *Phyllarthron,* 2″ broad, and from 4–5 inches long.

Species dubia.

5. Phyllarthron? Thouarsianum; fruticosa, ramis subteretibus foliisque nascentibus lepidotis demum glabris, foliis (siccitate utrinque cupreis) alternis, petiolo articulato, articulis 2 oblongo-cuneatis æqualibus, foliolis abrupte bijugis lanceolatis utrinque attenuatis alisque petioli pinnatim venosis, racemis . . . ., fructu . . . (v. sp. s.)

Phyllarthron Thouarsianum, DeCand. Prodr. ix. p. 244 (1845).
Geogr. Distr. Madagascar (*Petit-Thouars*! in Herb. Juss. et Par.).

There is no evidence to show that this plant is a genuine species of *Phyllarthron*, or even a *Crescentiacea*, as neither the flowers nor the fruit of it are known. "Folia abrupte pinnata" only occur once among *Crescentiaceæ*, and in that instance (*Kigelia pinnata*, DeCand.) by abortion. Amongst the genuine *Bignoniaceæ* such leaves are known in only one imperfectly described species, *Bignonia bijuga*, Vahl, which, like *Ph. Thouarsianum*, is a native of Madagascar, and may possibly prove identical with it.

3. Tanæcium, Swartz.

Calyx persistens, globoso-cylindraceus, obsolete 5-dentatus. *Corolla* tubulosa, infundibuliformis, limbo 5-fido subæquali, lobis tubo brevioribus, 2 superioribus erectis approximatis paulum minoribus, inferioribus patentibus. *Stamina* 4, didynama, cum rudimento quinti; *antheræ* 2-loculares, loculis divergentibus. *Discus glandulosus* ovarii basin cingens. *Stylus* elongatus; *stigma* bilamellatum. *Ovarium* uniloculare, multiovulatum, *placentis* parietalibus. *Bacca* oblonga vel globosa, cortice fragiliter corticosa, 1- vel spurie 2-locularis. *Semina* plurima, compressa aut angulata, in pulpa nidulantia; *albumen* nullum.

Frutices *Americæ tropicæ* scandentes, sæpe radicantes; foliis oppositis petiolatis simplicibus integerrimis, trifoliolatis vel germinatis cum cirrho intermedio; foliolis petiolulatis integerrimis; floribus racemosis vel paniculatis axillaribus et terminalibus bracteatis bracteolatisque, corollis albis, coccineis, roseis, violaceis vel lilacinis; baccis ferrugineis vel nigris.

Tanæcium, Swartz, Prodr. ii. p. 9; Fl. Ind. Occ. ii. p. 1049; Endl. Gen. Plant. n. 4172; DeCand. Prodr. ix. p. 245; Seem. in Bonpl. iv. p. 126, et in Hook. Journ. and Kew Misc. ix. p. 82.
Schlegelia, Miquel in Bot. Zeit. ii. p. 788.
Besleriæ sp., Aubl.
Citharexylon sp., Linn.

Amongst the various species from time to time referred to this genus, there are three which must be excluded. *Tanæcium? paniculatum*, Sieb. is a *Bignoniacea* proper (*Arrabidæa paniculata*, Seem.*); *Tanæcium pinnatum*, Willd. is identical with *Kigelia pinnata*, DeCand.; and *T. tripinna*, Raeusch, a synonym of *Colea tripinnata*, Seem. Having added two new ones (*T. crucigerum*, Seem. and *T. lilacinum*, Seem.), the genus now consists of four well-defined species, which arrange themselves into two very natural groups, —the one having non-rooting branches, compound ecoriaceous leaves, and white pubescent corollas; the other rooting branches, simple coriaceous leaves, and glabrous corollas of a scarlet, pink, or more or less bluish tint. The former is represented by *T. crucigerum* and *albiflorum*, the latter by *T. parasiticum* and *lilacinum*. *T. crucigerum* is the old *Bignonia crucigera* of Linnæus, well figured in Burmann's edition of Plumier's work; *T. albiflorum*, DeCand. is the *T. Jaroba* of Swartz, the alteration of its name having become neces-

* *Arrabidæa paniculata*, Seem. MSS. (*Tanæcium? paniculatum*, Sieb.! Flor. Martinic. n. 81; DeCand. Prodr. ix. p. 245: 1845)! ramis teretibus glabris, foliis oppositis petiolatis 3-foliolatis, foliolo medio ovali maximo, lateralibus minimis, junioribus velutinis adultis glabris, paniculis axillaribus laxe trichotomis, pedunculis ramulisque compressis, minutissime puberulis, calyce cupuliformi, breviter 5-dentato, æquali, corolla apice pulverulento-velutina; fructus . . . . (v. sp. s. in Herb. Vindob.) Martinica (Sieb.! Fl. Martin. n. 81).

sary, as the "*Jaroba*" of Marcgrav, from which the older specific name was borrowed, is not, as Swartz supposed, a synonym of this plant, but, judging from the indifferent description and the rude woodcut, a *Cucurbitacea**. *T. parasiticum* is a very characteristic species (the only one hitherto introduced in our gardens), which has fortunately no conflicting synonymy. *T. lilacinum* was originally founded by me, upon Miquel's *Schlegelia lilacina*, adding as synonyms *Schlegelia elongata* of the same author, and the doubtful *Besleria* ? *violacea* and *B.* ? *cærulea* of Aublet, original specimens of which are preserved at the British Museum. Recently I discovered that the plant described by Linnæus in his 'Plantæ Surinamenses' as *Citharexylon cinereum* (five specimens of which are preserved under that name in Linnæus's own Herbarium) must also be referred to this species. Sir J. E. Smith had already noticed, in a memorandum to the Linnean specimens, that they could not belong to the *Citharexylon cinereum* of the 'Systema,' which was taken up, it would seem, from Jacquin's, Plumier's, and Pluckenet's figures, and is a terrestrial tree inhabiting the West Indies, to which the brief character ("*parasiticum, scandens*") of the 'Plant. Surinam.' cannot possibly apply.

§ I. *Caules ramique eradicantes; folia trifoliolata vel conjugato-bifoliolata cum cirrho intermedio; foliola ecoriacea. Corolla pubescens, alba.*

1. TANÆCIUM CRUCIGERUM; ramis punctatis, foliis trifoliolatis vel conjugato-bifoliolatis cum cirrho intermedio (abortu unifoliolatis), foliolis ovatis acuminatis, supra glabris, subtus pubescenti-velutinis, racemis axillaribus terminalibusque 5–8-floris, bracteis ovato-lanceolatis, bracteolis subulatis, corolla (alba) longe tubulosa pubescente, bacca oblonga†. (v. sp. s.)

Tanæcium crucigerum, Seem. in Bonpl. iv. p. 127, et in Hook. Journ. and Kew Misc. ix. p. 83.
Bignonia crucigera, Linn. spec. 869 (excl. syn. omnib. except. Plum.); DeCand. Prodr. ix. p. 152.
Bignonia foliis conjugatis cirrhosis ternatis, Plum., ed. Burm. fasc. iii. p. 48, t. 58 (exclud. syn. omnib. except. Linn.).
Geogr. Distr. Dominica (*Imray*!); St. Vincent (*Guilding*!).

There are no specimens of this plant preserved in Linnæus's herbarium; and Linnæus seems to have taken it up solely from Plumier's figures.

2. TANÆCIUM ALBIFLORUM; ramis epunctatis, foliis trifoliolatis vel conjugato-bifoliolatis cum cirrho intermedio, foliolis ovato-oblongis acuminatis utrinque glabris, racemis axillaribus 3–5-floris, bracteis ...., bracteolis subulatis, corolla (alba) longissima tubulosa pubescente, bacca oblonga maxima glabra. (v. sp. s.)

* The description in Marcg. Hist. Reg. Nat. Brasil. lib. i. p. 25, runs as follows:—"*Jaroba* Brasiliensibus dicta, *Casaca amargosa* Lusitanis.—Altissimas arbores hæc planta ascendit, caule lento, tereti, qui hinc inde in longis pediculis tria folia opposita habet Phaseoli modo, sunt autem plane similia foliis Mucuna. Fructus autem similis fructui Cuete, sed ut plurimum minor, eadem pulpa, iisdem seminibus, ejusdem quoque usus."—*Marcgr. Hist. Reg. Nat. Brasil.* lib. i. p. 25. The figure represents a climbing stem, with alternate, tripartite or trifoliolated leaves, and obovate, dotted fruits.

† "Fructus optime repræsentat capsulam vulgi, quam tabaco replent, secumque portant, uti notatur in 'Hort. Cliff.,'" Plum., ed. Burm. fasc. iii. p. 48.

Tanæcium albiflorum, DeCand. Prodr. ix. p. 245; Seem. in Bonpl. iv. p. 127, et in Hook. Journ. et Kew Misc. ix. p. 83.

Tanæcium Jaroba, Swartz. Fl. Ind. Occ. ii. p. 1050, t. 20. fig. 1 (exclud. syn. Marcgr. et ideo nomine).

Cucurbitifera, Sloane, Hist. ii. p. 173; Browne, Jamaica, p. 266. n. 6.

Geogr. Distr. Jamaica (*Robins*! *Distan*! *Wright*! *Swartz*!); British Guiana (*Schomburgk*! n. 829); woods near Crato, prov. Ceara, Brazil (*Gardner*! n. 1765).

§ II. *Caules ramique radicantes, folia simplicia coriacea. Corolla glabra, lilacina, violacea, cærulescens, rosea vel coccinea.* (Schlegelia, *Miq.*!)

3. Tanæcium parasiticum; foliis ovato-oblongis acuminatis utrinque glabris, racemis axillaribus 2–12-floris, corolla (coccinea) glabra, tubo abbreviato, bacca globosa, glabra (ferruginea), seminibus angulato-oblongis parvis. (v. sp. s. et v. cult.)

Tanæcium parasiticum, Swartz, Fl. Ind. Occ. ii. p. 1053, t. 20. f. 2; DeCand. Prodr. ix. p. 245; Seem. in Bonpl. iv. p. 127; et in Hook. Journ. and Kew Misc. ix. p. 83.

Crescentia, Browne, Jamaica, p. 266. n. 5.

Geogr. Distr. Woods of Jamaica (*Swartz*! *Purdie*! *Alexander*!); Cuba (*Ch. Wright,* n. 434); near San Gabriel da Cachoeira, Rio Negro, Brazil (*Spruce*! n. 2243). Cultivated at the Royal Botanic Gardens, Kew.

4. Tanæcium lilacinum; foliis ovatis ovato-ellipticis vel lanceolato-oblongis utrinque glabris, paniculis terminalibus multifloris, bracteis ovato-oblongis acuminatis, bracteolis lineari-lanceolatis striatis pedunculisque puberulis, corolla (lilacina, rosea vel violacea) glabra, tubo abbreviato, bacca ovali glabra (nigra). (v. sp. v. et sp. s.)

Tanæcium lilacinum, Seem. Bot. Herald, p. 182, Bonpl. iv. p. 128, et Hook. Journ. and Kew Misc. ix. p. 84.

Schlegelia lilacina, Miq. in Bot. Zeit. ii. (1844) p. 788, Stirp. Surinam. p. 116 cum icon.; DeCand. Prodr. ix. p. 564.

Schlegelia elongata, Miq. in Linnæa, xxii. p. 73, Stirpes Surinam. p. 128.

Besleria? violacea, Aubl. Guian. ii. p. 630, t. 254; DeCand. Prodr. vii. p. 539.

Besleria? cærulea, Aubl. Guian. ii. p. 631; DeCand. Prodr. vii. p. 539.

Citharexylon cinereum, ("*parasiticum, scandens*") Linn. Plant. Surinam. p. 11. n. 92 (non Syst., non Spec. Plant.) et in Herb. prop.

Nomen vernaculum Guianense: "*Emossé bereoy,*" teste Aublet.

Geogr. Distr. Darien (*Seemann*!); Surinam (*Hostmann*! n. 553 in Herb. Paris.; Herb. Linn. prop.; Focke et Kegel, teste Miquel); French Guiana (Aublet! in Mus. Brit.).

Authors do not quite agree respecting the colour of the corolla. In the specimens I collected in Darien it was lilac, some might call it pink. Aublet had specimens with blue, and some with violet corollas. I regard these discrepancies as indicating so many slight varieties.

Species exclusæ.

Tanæcium? paniculatum, Sieb. = *Arrabidæa paniculata,* Seem.
Tanæcium pinnatum, Willd. = *Kigelia pinnata,* DeCand.
Tanæcium tripinna, Raeusch = *Colea tripinnata,* Seem.

Tribus II.—CRESCENTIEÆ. Seem. in Proc. Linn. Soc. ii. p. 269 (1853); Bot. Herald, p. 182 (1854).—Calyx deciduus, irregularis (spathaceus vel bipartitus).

4. PARMENTIERA, DeCand.

Calyx deciduus, spathaceus, longitudinaliter fissus. *Corolla* subcampanulata, tubo lato brevi, fauce hiante, limbo distincto 5-lobo, lobis subæqualibus patentibus. *Stamina* 4, didynama, cum rudimento quinti. *Antheræ* 2-loculares, loculis divergentibus. *Discus glandulosus* ovarii basin cingens. *Stylus* elongatus; *stigma* bilamellatum, lamellis integerrimis. *Ovarium* 1-loculare, multiovulatum. *Fructus* carnosus, indehiscens, teres, tuberculatus vel lævis, spurie 2–4-locularis, epulposus. *Semina* plurima, parva, cordata vel subrotunda. *Albumen* nullum.

Arbores *Americæ tropicæ*, ramis aculeatis vel inermibus, foliis oppositis, simplicibus vel trifoliolatis, pedunculis unifloris subcongestis ex trunco aut basi ramorum et ramulorum ortis, corollis albidis vel virescentibus, fructibus flavis.

Parmentiera, DeCand. Revis. Bignon. p. 19; Prodr. ix. p. 244. Endl. Gen. Plant. Suppl. i. p. 1409, n. 4171. 1. Seem. in Hook. Journ. and Kew Misc. vi. p. 272.

Crescentiæ spec. auct.

DeCandolle (Prodr. ix. p. 244) has enumerated only one species of *Parmentiera* (*P. edulis*, DeCand.); and I have added two more (*P. cereifera*, Seem. and *P. aculeata*, Seem.). Of the latter two, only one (*P. cereifera*, Seem.) holds good, *P. aculeata*, Seem. having proved identical with *P. edulis*; so that the genus consists at present of two species, both very distinct from each other. *P. edulis*, DeCand. has thorns, occasionally simple leaves, and a tuberculate fruit; whilst *P. cereifera*, Seem., the famous Candle-tree of the Isthmus of Panama, is unarmed, has always compound leaves and a smooth fruit. As synonyms of *P. edulis*, DeCand., must also be regarded *Crescentia aculeata*, H. B. K., *C. edulis*, Desv., and *C. musæcarpa*, Zaldivar.

1. PARMENTIERA CEREIFERA; ramis inermibus, foliis omnibus trifoliolatis, foliolis ovato-ellipticis vel obovato-oblongis utrinque acuminatis serratis vel integerrimis, petiolo alato, corollæ (albidæ) lobis emarginatis, fructu tereti bisulcato lævi glaberrimo. (v. sp. v. et cult.)

Parmentiera cereifera, Seem. iii. p. 302; Bot. Herald, p. 182, t. 32; Hook. Journ. and Kew Misc. vi. p. 273.

Nomen vernaculum Panamense: "*Palo de velas*" (*i.e.* Arbor cereifera), teste Seemann.

Geogr. Distr. Central parts of the province of Panama, near the villages of Cruces, Gorgona, and San Juan (*Seemann*!). Formerly (in 1846) cultivated at Kew.

This singular production was first described by me in Hooker's 'Journal of Botany and Kew Miscellany,' vol. iii. p. 302, where I said: "This tree is confined to the valley of the Chagres, Isthmus of Panama, where it forms entire forests. In entering them, a person might almost fancy himself transported into a chandler's shop. From all the stems and lower branches hang long cylindrical fruits of a yellow colour and a wax-like appearance, so much resembling a candle as to have given rise to the popular appellation of Palo de Velas, or Candle-tree. The fruit is generally from two to three, but not unfrequently four feet long, and an inch in diameter. The tree itself is about 24 feet high, with opposite, trifoliated leaves, and large white blossoms, which appear throughout the year, but in greatest abundance during the rainy season. The fruit serves for food to numerous herds of cattle. Bullocks especially, if fed with Guinea grass, Batatilla (*Ipomœa brachypoda*, Bth.=*I. variabilis*, Chois.), and the fruit of this tree, soon get fat. It is generally admitted, however, that their meat partakes in some degree of the peculiar apple-like smell of the fruit; but that is by no means disagreeable, and easily got rid of if, for a few days previous to the killing of the animal, the food is changed. As the principal harvest is at a season when all herbaceous vegetation is dried up, the cultivation of this tree in tropical countries is especially to be recommended: a few acres of it at each farm would effectually prevent that want of fodder always severely felt after the periodical rains have ceased."

2. Parmentiera edulis; ramis aculeatis, aculeis sub foliis insertis, foliis aliis simplicibus ovato-oblongis vel cuneato-lanceolatis, aliis trifoliolatis, foliolis ovato-oblongis utrinque attenuatis integerrimis, petiolo superne anguste alato vel nudo, corollæ (virescentis) lobis undulato-crispis, fructu angulato tuberculato. (v. sp. s.)

Parmentiera edulis, De Cand. Rev. Bignon. p. 19; Prodr. ix. p. 244. Seem. in Hook. Journ. and Kew Misc. vi. p. 273.

Parmentiera aculeata, Seem. in Bot. Herald, p. 183.

Crescentia aculeata, Humb. Bonpl. et Kunth, Nov. Gen. Amer. iii. p. 158; DeCand. Prodr. ix. p. 247.

Crescentia edulis, Desv. Journ. Bot. iv. p. 112; DeCand. Prodr. ix. p. 246; Moç. Fl. Mex. ined. fide DC.

Crescentia musæcarpa, Zaldivar, Fl. Mex. ined. nov.; Heller, Reisen in Mexiko, p. 414.

Quauxhichotl seu *arbor Cucumeris moschati*, Hernandez, Mex. p. 90.

Nomina vernacula Mexicana: "*Quauxhichotl*," "*Quaunuxilotl*," "*Quaxilote*" et "*Cuajilote*," teste DeCand. et Heller.

Geogr. Distr. Mexico (*Schiede*! n. 1207, *Coulter*!). According to *Hernandez*, it is found in Yauhetepec; according to *Desvaux*, in Guaxaca; according to *Humboldt* and *Bonpland*, in Campeche, at Gonacatepic; and according to *Coulter*, at Zinapan.

5. Crescentia, Linn.

Calyx deciduus, bilabiatus, lobis integerrimis. *Corolla* subcampanulata, tubo elongato, fauce magna ventricosa, limbo inæqualiter 5-fido vel crenato aut fimbriato-laciniato. *Stamina* 4, cum rudimento quinti. *Antheræ* biloculares, loculis divergentibus. *Discus glandulosus* ovarii basin cingens. *Stylus* elongatus; *stigma* bilamellatum. *Ovarium* 1-loculare, multiovulatum. *Fructus* globosus, ovatus vel ellipsoideus, cortice lignoso, spurie 2-locularis, intus pulposus. *Semina* plurima. *Albumen* nullum. *Embryo* magnus.

Arbores vel frutices arborescentes in *America tropica* indigenæ, in *Asia et Africa* cultæ, foliis alternis solitariis vel fasciculatis, simplicibus vel trifoliolatis, pedunculis e trunco ramisve ortis, corollis rubentibus, virescentibus, vel virescentibus purpureo et flavo variegatis, fructibus virescentibus vel flavescentibus.

Crescentia, Linn. Gen. n. 772; Endl. Gen. Plant. n. 417; DeCand. Prodr. ix. p. 246 excl. sp.; Seem. in Hook. Journ. and Kew Misc. vi. p. 273.

Cujete, Plum. Gen. t. 16.

Crescentia Cujete, Linn., the species upon which the genus *Crescentia* was founded, is distinguished from its congeners by its fasciculate leaves, *all* of which are simple, and its fruit, the shell of which is so hard that it can be broken only by the application of an axe or some other sharp instrument. To this species *C. cuneifolia*, Gardn. must be added as a synonym, as the latter is in no way distinct from the former, some of the specimens in

Linnæus's own herbarium having leaves the under side of which is slightly pubescent, as those of *C. cuneifolia*, Gardn. are; and the difference in the fruit amounts to nothing: the spots are generally observable in young fruits, and disappear in the old ones. *C. acuminata*, H. B. K., which (misled by the term "*fragile*," applied to its fruit by DeCandolle, a term not contained in the original description of H. B. K.) I suggested (Bot. Herald, p. 183), might belong to *C. cucurbitina*, is, according to an authentic specimen preserved in the Berlin Herbarium, also identical with *C. Cujete*, Linn. *C. angustifolia* of Willdenow's Herbarium is another synonym. The second *Crescentia* which I consider a good species is *C. cucurbitina*, Linn., which Linnæus published in his 'Mantissa,' and which he probably never saw, as there is no specimen of it in his herbarium; he described it, most likely, as he has done in several other instances, from Plumier's figures. This species is distinguished by its simple isolated leaves, and the shell of its fruit, which is so fragile that it may be crushed in the hand like an egg. *C. latifolia*, Linn. has justly been regarded as a synonym of this species; and to this I have added *C. obovata*, Benth., *C. lethifera*, Tussac, *C. toxicaria*, Tussac, and *C. palustris*, Forsyth Herb. The description of *C. ovata* of Burmann's 'Flora Indica,' p. 132, short as it is (" C. foliis ovatis integerrimis, apice acuminatis; folia in hac specie perfecte ovata nec attenuata, ut in *Crescentia Cujete*, L."), agrees perfectly well with this, and no other species. The third species of *Crescentia* holding good is *C. macrophylla*, Seem., allied to, but quite distinct from *C. cucurbitina*. It is cultivated in some gardens under the names of *C. regia* and *Ferdinandusa superba*; and its geographical range seems to be limited to a portion of Mexico. The fourth species of *Crescentia*, the validity of which I am ready to acknowledge, is *C. alata*, H. B. K., the Tecomate of the Mexicans. That species is characterized by having a hard-shelled fruit and fasciculate leaves, the central leaf of its fascicles being trifoliolated. As a synonym of it I regard *C. trifolia*, M. Blanco, the description of the latter in the 'Flora de Filipinas' agreeing word for word with *C. alata*, H. B. K., and its Mexican origin having been traced by Blanco, the author of that 'Flora,' who says: "Tal vez habran venido de America; . . . . llaman in Nueva España '*Tecomate*.'" These are the only four genuine species of *Crescentia*. *C. aculeata*, H. B. K. and *C. edulis*, Moz. are merely synonyms of *Parmentiera edulis*, DeCand.; *C. edulis*, Desv. the simple-leaved form of the same species. *C. jasminoides*, Lam. belongs to *Gardenia clusiæfolia*, Jacq.; and *C. pinnata*, Jacq. to *Kigelia pinnata*, DeCand.

§ I. *Folia alterna, solitaria. Corolla virescens.*

1. CRESCENTIA CUCURBITINA; arborescens, foliis alternis solitariis omnibus simplicibus lanceolato-ovatis vel obovatis breviter acuminatis, fructibus globosis ovatis vel ellipticis, cortice fragili. (v. sp. v. et cult.)

Crescentia cucurbitina, Linn. Mant. p. 250; DeCand. Prodr. ix. p. 246; Seem. in Hook. Journ. and Kew Misc. vi. p. 274; Swartz, Obs. p. 234; Plum. et Burm. t. 109. fig. sup.; Pluck. Alm. t. 171. fig. 2.

Crescentia latifolia, Lam. Dict. i. p. 558.

Crescentia obovata, Benth. Bot. Sulph. p. 130, t. 46; Wlprs. Rep. vi. p. 517.

Crescentia ovata, Burm. Fl. Ind. p. 132; DeCand. Prodr. ix. p. 247.

Crescentia lethifera, Tussac, Fl. des Antil. iv. p. 50, t. 17; Wlprs. Rep. vi. p. 517.

Crescentia toxicaria, Tussac, Fl. des Antil. iv. t. 17.

Crescentia palustris, Forsyth Herb.

Nomina vernacula: in Isthmo Panamensi, teste Seemann, "*Calabaza de playa*;" in Venezuela, teste Birschel, "*Coco de mono*" dicitur.

Geogr. Distr. Jamaica (*Swartz*! in Herb. Willd. n. 11486, *W. Wright*! *Purdie*! *Distin*!); St. Vincent (*Anderson*!); Cuba (*Ed. Otto*!); St. Thomas (*Moritz*! *C. Ehrenberg*!); Chagres (*Fendler*, n. 120); San Juan (*Moritz*!); Topo, Venezuela (*Birschel*!); St. Domingo (teste *Tussac*); Pacific shores of the Isthmus of Panama (*Seemann*!); Island of Gorgona (*Barclay*!). Commonly growing close to the sea, with *Hibiscus tiliaceus* and *Hippomane Mancinella*, Linn.

A shrub about 15 feet high.

2. CRESCENTIA MACROPHYLLA; arborea; glaberrima, foliis alternis solitariis omnibus simplicibus obovato-lanceolatis breviter acuminatis, basin versus longe cuneatis, nervo (medio) utrinque acuto, petiolis basi valde incrassatis, corolla (virescente) subcampanulata, tubo elongato curvato ventricoso, limbo subregulari fimbriato-laciniato, lamellis stigmatis fimbriatis, fructu elliptico utrinque rostrato cortice lignoso duro. (v. sp. s. et v. cult.)

Crescentia macrophylla, Seem. in Hook. Journ. and Kew Misc. vi. p. 274; Bot. Mag. t. 4822.

Crescentia regia, Hort.

Ferdinanda superba, Hort. Germ.

Geogr. Distr. Teapa, Tabasco (*Linden*, n. 1608). Cultivated in Europe.

The largest plants cultivated are about 12 feet high. Young branches and petioles purplish. Largest leaves 2–2½ feet long, and from 2–6 inches broad. Peduncles 1½ inch long. Calyx and corolla furnished with glandular dots. Style and stamens as long as the tube of the corolla. Ovary unilocular. Fruit not unlike that of *Martynia proboscidea*; the specimens ripened at Kew 6–8 inches long, and in the thickest part about 1 inch in diameter. The limb of the corolla probably varies like that of *C. cucurbitina*, which is sometimes distinctly five-lobed, sometimes crenato-dentate or fimbriated. The leaves resemble in *shape* those of *C. Cujete*, but their size is very much larger than that of any of its congeners.

§ II. *Folia fasciculata. Corolla rubescens vel virescens purpureo et flavo variegata.*

3. CRESCENTIA CUJETE; arborea, foliis fasciculatis ex axilla 5, omnibus simplicibus lanceolato-obovatis breviter acuminatis basin versus longe cuneatis, supra glabris nitidis, subtus puberulis glabrisve, fructibus plerumque globosis vel globoso-oblongis, cortice lignoso duro. (v. sp. v. et cult.)

Crescentia Cujete, Linn. Spec. 872; DeCand. Prodr. ix. p. 246; Seem. in Hook. Journ. and Kew Misc. vi. p. 275; Swartz, Obs. p. 234; Lam. Dict. i. p. 557; Jacq. Amer. p. 175, t. 111; Hook. Bot. Mag. t. 3430; Vell. Fl. Flum. vi. t. 103; Plum. et Burm. t. 109. fig. infer.; Com. Hort. i. t. 71; Tussac, Fl. des Ant. ii. 80, t. 19.

Crescentia cuneifolia, Gardn. in Hook. Journ. of Bot. ii. p. 422; DeCand. Prodr. ix. p. 246.

Crescentia acuminata, H. B. K. Nov. Gen. Amer. iii. p. 157; DeCand. Prodr. ix. p. 246.

Crescentia angustifolia, Willd. Herb. n. 11485.

Nomina vernacula: in Cuba, teste E. Otto, "*Guido*;" in Colon. Brit. Indiæ Occident., "*Calabash-tree*;" in America Hispana, teste Humboldt, Bonpland et Seemann, "*Tutumo*," "*Turtumo*," "*Palo de Turtuma*," "*Palo de Tutuma*" vel "*Calabazo*" vocatur.

Geogr. Distr. Jamaica (*P. Browne*! in Herb. Linn. propr., *W. Wright*!); Cuba (*Humboldt* et *Bonpland*! *Ed. Otto*!); Santa Lucia (Herb. Mus. Brit.!); St. Thomas (*C. Ehrenberg*!); Guiana (*Aublet*!); Guatemala (*Friedrichsthal*! n. 1186); Surinam (*Splitzgerber*!); Brazil (*Blanchet*!); Isthmus of Panama (*Seemann*!); Cumana (Herb. Mus. Par.!); Puerto Caballo (*Karsten*!); Cartago de Quindiu (*Boussingault*!); Peru (*Dombey*!); Key West, Florida (*Blodgett* in Herb. Torrey!). Cultivated throughout the Tropics and in European gardens.

A tree about 30 feet high, generally crowded with *Orchideæ*, Ferns, *Bromeliaceæ*, and other epiphytical plants. Fruits generally attaining the size of 32-pounder cannon-balls.

4. Crescentia alata; arborea; foliis fasciculatis ex axilla 3, medio longe petiolato trifoliolato, lateralibus simplicibus minoribus similibus, petiolo foliorum foliolatorum late alato, fructibus globosis, cortice ligno duro. (v. sp. v. et cult.)

Crescentia alata, H. B. K. Nov. Gen. Amer. iii. p. 158; DeCand. Prodr. ix. p. 247; Seem. in Hook. Journ. and Kew Misc. vi. p. 275; Seem. Parad. Vindobonens. ii. t. 87.

Crescentia trifolia, Blanco, Fl. Filipin. p. 489; DeCand. Prodr. ix. p. 247.

Nomina vernacula: in Mexico, teste Heller et Seemann, "*Guantecomate*," "*Tecomate*" vel "*Quiro*;" in ins. Philip., teste Blanco, "*Hoja cruz*" appellatur.

Geogr. Distr. Common on the western coast of Mexico, from Acapulco to Mazatlan (*Humboldt and Bonpland*! *Gregg*! n. 944; *Seemann*!); Itztoluca (*Ehrenberg*!); Central America (*Herm. Wendland*!). Cultivated in Veraguas (*Seemann*!), Mariana Islands (*Gaudichaud*! in Herb. Berol.), Manilla (*Perrottet*! in Herb. Par.), and in European gardens, having been introduced by me in 1850 to Kew.

The size of the fruit is that of a large orange.

Species exclusæ.

C. aculeata, H. B. K. = *Parmentiera edulis*, DeCand.

C. edulis, Desv., Moz. = *Parmentiera edulis*, DeCand.

C. jasminoides, Lam. = *Gardenia clusiæfolia*, Jacq.

C. pinnata, Jacq. = *Kigelia pinnata*, DeCand.

6. Kigelia, DeCand.

Flos resupinatus. *Calyx* deciduus, tubuloso-campanulatus, bilabiatus, labiis irregulariter fissis et hinc calycem spurie 5-fidum constituentibus. *Corollæ* tubo brevi, fauce lata campanulata, limbo subæqualiter 5-lobo, lobis ovatis acuminatis. *Stamina* 4, didynama, cum quinto sterili. *Antheræ* biloculares, loculis basi longe discretis. *Discus glandulosus* ovarii basin cingens. *Stylus* staminum fere longitudine; *stigma* bilamellatum. *Ovarium* uniloculare, multiovulatum, glabrum, placentis parietalibus. *Bacca* elongato-ellipsoidea seu cylindracea, 2- 4-plove latitudine longior, cortice corticato, intus pulposa, spurie 2-locularis. *Semina* in pulpa nidulantia, subrotunda vel ovoidea, testa fuscescente. *Albumen* nullum. *Cotyledones* (fide DC.) rotundatæ, externe longitudinaliter plicatæ segregatæ.

Arbor *Africæ tropicæ*, ramis divergentibus, cortice albido, foliis oppositis imparipinnatis, foliolis (5–11) ellipticis vel ovato-ellipticis, non raro inæqualibus, terminali obovato, integerrimis vel subrepando-dentatis, coriaceis, utrinque glaberrimis, paniculis longissime pedunculatis, pendentibus e trunco seu ramis vetustis ortis, corollis amplis atro-rubris extus pallidioribus, baccis (2 ped. et ultra long., 5-8 unc. lat.) pendulis, albidis.

Kigelia, Revis. Bignon. p. 18; DeCand. Prodr. ix. p. 247; Endl. Gen. Plant. Suppl. i. p. 1409. n. 4137; Seem. in Hook. Journ. and Kew Misc. vi. p. 276.

Bignoniæ, *Tecomæ*, *Crescentiæ*, *Tanæcii* et *Tripinnariæ* spec. auct.

Sotor, Fenzl, Vortrag über eine Crescent.-Gattung, p. 1.

DeCandolle (Prodr. ix. p. 247) enumerates only one species of *Kigelia*, viz. *K. pinnata*, DeCand. adding as synonyms *Crescentia pinnata*, Jacq., *Tanæcium pinnatum*, Willd., and *Tripinnaria Africana*, Spreng.,—an arrangement in which I fully concur. Decaisne has, since the publication of the ninth volume of the 'Prodromus,' described as a second species *K. Æthiopica* (DeLessert, Icon. 39, t. 93 A et B), and Bentham (Hook. Niger Flora, p. 463) subsequently a third, *K. Africana*, uniting with the latter the old *Bignonia Africana* of Lamarck, which DeCandolle enumerates amongst his doubtful *Bignonias*. A comparison of the various descriptions and specimens of these three supposed species has convinced me that all are one and the same species, the original *K. pinnata*, upon which the genus was founded, and which has for nearly a century been an inmate of our gardens. *K. Abyssinica*, A. Rich., the genus *Sotor*, established by Fenzl upon Kotschy's specimens (n. 403), and *Tecoma Africana*, Don, are also synonyms of *Kigelia pinnata*.

1. Kigelia pinnata. (v. sp. s. et v. cult.)

Kigelia pinnata, DeCand. Prodr. ix. p. 247; Seem. in Hook. Journ. and Kew Misc. vi. p. 277.
Bignonia Africana, Lam. Dict. i. p. 424.
Kigelia Æthiopica, Dcne. in DeLessert, Nov. Selec. v. p. 39. A et B; Wlprs. Rep. vi. p. 517.
Kigelia Africana, Benth. in Hook. Niger Flora, p. 463; Wlprs. Ann. iii. p. 93.
Kigelia Abyssinica, A. Rich. Tent. Fl. Abyss. ii. p. 60, t. 75; Wlprs. Ann. iii. p. 93.
Sotor, Fenzl, Vortrag über eine Crescentiaceen-Gattung, p. 1.
Crescentia pinnata, Jacq. Coll. iii. p. 203, t. 18. icon floris.
Tanæcium pinnatum, Willd. Spec. iii. p. 312.
Tecoma Africana, G. Don, Gen. Syst. iv. p. 224.

Nomina vernacula: in Abyssinia, teste Richard, "*Meder Deur*;" in Nubia, teste Kotschy, "*Sotor*;" in Mozambico, teste DeCandolle, "*Kigelikeia*;" et in Africa australi, ad ripas fluminis Zongha, teste Oswald, "*Maropotla*" dicitur.

Geogr. Distr. Nubia (*Kotschy*! n. 403); White Nile (*Sabatier*!); Abyssinia (*Quartin Dillon*! *Petit*! in Herb. Par.); Mozambique (teste *DeCandolle*); Bornu (*Ed. Vogel*!); Port Natal (*Garden*!); Senegal (*Don, Adanson*! in Herb. Juss.); Cape Coast Castle (*Th. Vogel*!); River Zongha, lat. 26° S. (*Oswald*!); and at the Great Lake of South Africa (according to specimens at Kew). Cultivated in European gardens.

II. *On the Distribution of the* Tracheæ *in Insects.*

By John Lubbock, *Esq., F.R.S., F.L.S., &c.*

Read January 19th, 1860.

Dean Swift, in the 'Tale of a Tub,' asserts that in the world generally, and in animals in particular, the outside is generally more beautiful than the inside. "Last week," he says, "I saw a woman flayed; and you will hardly believe how much it altered her person for the worse." The Dean, however, does Nature an injustice. We constantly find the most lovely things where we should least expect to meet with them. Many insects are very beautiful externally; but there is nothing, I think, more pleasing to the eye than some parts of their internal anatomy; and no one, I am sure, can see the tracheæ branching over the different organs, like trees of shining quicksilver, without being both astonished and gratified.

Although Lyonet, Straus-Dürckheim, and many other entomologists have described and figured the arrangement of the larger tracheal branches, no one has yet studied the distribution of the finer branchlets. This is, no doubt, mainly owing to the fact that, more or less quickly after death, fluid penetrates into them, and that they then become very difficult to distinguish from the surrounding tissues. It is indeed true that there are a few scattered observations on this subject; but no one has yet compared together the finer tracheæ attached to the different organs of various insects, or attempted to arrive at the laws regulating their distribution,—to determine, for instance, whether the type is the same throughout each insect, or different in the various organs, and to compare with one another insects of various families and orders.

I ought perhaps to apologise for presenting to the Linnean Society a memoir so imperfect; but if the marvellous number of insects be remembered, and if it be borne in mind that each one contains at least from fifteen to twenty different organs to be examined separately, it will be evident that no one man could hope to exhaust the subject.

Having, therefore, to deal with a subject so vast in itself, I have confined myself strictly to it. Without intending to express any opinion of my own as to their homologies and functions, I allude to the various organs by the names under which they generally pass, even when the generally received opinion seems to me doubtful or incorrect.

I wish, however, to say a few words respecting the homologies of the intestine of *Pentatoma*. It seems to be pretty generally admitted that in this group of Hemiptera, the biliary vessels, either directly or through the "vésicule biliaire" of Léon Dufour, pour their contents into the rectum, below the ileum. Léon Dufour*, indeed, while

* Mém. des Savants Etrangers, vol. iv. p. 153.

admitting that this is apparently the case, seems to think that it must be an illusion, and that there cannot really be any such communication.

There is however, I believe, no other group of insects known in which the biliary vessels open elsewhere than at the anterior end of the ileum (excepting perhaps the Homoptera); and we find in certain Hemiptera that the posterior part of the stomach is much elongated, and that the Malpighian vessels open at the end of it. I am therefore inclined to believe that in *Pentatoma*, *Scutellera*, &c., the so-called "cordons valvulaires" represent the posterior part of the stomach, and that if the chamber into which the Malpighian vessels fall is really the "colon," we may infer that the ileum is not developed.

In examining any given organ or membrane, it is of course necessary to have before one a surface sufficiently large to give a good idea of the type of distribution, in order to feel sure that the arrangement of the tracheæ which is seen is really characteristic of the organ. I have therefore chosen the largest insects I could obtain, because in them we see the same type of distribution repeated over and over again in the field of view; and I have also compared different specimens together.

The mode of branching is in many respects comparable to that of trees. As we find, for instance, no two oaks exactly alike in their mode of branching, while yet the species possesses a well-marked type of its own, so in the tracheæ, though no two branchlets divide in exactly the same manner, still they possess a well-marked character. And though in numerous insects many organs are alike in this respect, there are others in which any fragment of an organ could at once be recognized if it were large enough to show the mode of branching of the tracheæ.

In the different species of one genus we generally find the tracheæ very similar. In comparing together, however, insects belonging to different families of the same order, this is by no means the case. In the ovarian tracheæ, for instance, *Musca* (Pl. III. fig. 2) much resembles *Bombus*; while *Tipula* (Pl. III. figs. 4 & 5) and *Tenthredo* are quite different from either, but resemble one another. A third genus of Hymenoptera, *Ophion* (Pl. III. fig. 7), again, is dissimilar from either *Bombus* or *Tenthredo*, and agrees very nearly with *Acheta* (Pl. III. fig. 12), which, for its part, differs entirely from *Locusta*. It would seem, therefore, that the distribution of the finer tracheæ cannot have any bearing on the question of ordinal, or even of family affinities.

In some cases tracheæ, which at first sight are very dissimilar, present in reality no difference. Thus, in Pl. III, the figures 4 & 5 represent the tracheæ on the ovary of *Tipula*: in fig. 5, the tracheæ are represented as they appear when expanded by the egg; while on the parts of the tube which lie between the eggs, and are much narrower, they resemble fig. 4. It may probably be stated, as a general rule, that the waved course of many tracheæ is a provision to allow for the expansion and movements of the organ to which they are attached.

There seems to be some special tendency in the ovarian tracheæ to arrange themselves in tufts, perhaps because in this way they are better able to adapt themselves to the alterations which occur in the diameter of the egg-tubes during the rapid growth and passage of the eggs. In *Necrophorus*, *Locusta*, *Chrysopa*, *Tipula*, &c., the ovaries present more decided tufts of tubules than most of the other organs; and in *Musca* and

Bombus, where tufts are present in most of the organs, the tubules are particularly numerous on the ovary. On the other hand, this rule is not without numerous exceptions—as, for instance, *Ophion* (Pl. III. fig. 7), *Acheta* (Pl. III. fig. 12), *Aphrophora* (Pl. III. fig. 1); and it would perhaps not be safe to generalize on the subject.

In every insect which I have examined, the ganglia were well supplied with tracheæ, and the type was very uniform, showing, I think, that the minute structure of these organs is very similar, not only in different parts of the nervous column, but also in different insects.

As regards the commissures, the case is quite the reverse: not only does the distribution of the tracheæ differ much in different groups, but in some, as, for instance, in the Neuroptera and Lepidoptera, they are, at least in the perfect insects, almost entirely absent. This difference probably arises from the difference in the respective properties and functions of the ganglia and commissures. It is an interesting fact, that while in butterflies and moths I have generally found the commissures free from tracheæ, in the larvæ they are richly supplied. Is this to be accounted for by supposing that the relative functions and structures of the different parts belonging to the nervous system are not so completely differentiated in the larva as they afterwards become in the perfect insect?

The presence of tracheæ on the commissures is not, however, always a sign of low development, since they are present in many Coleoptera.

Both the larva and perfect insect of *Acheta* have tracheæ on the thoracic, but hardly any on the abdominal commissures. The presence of a few tracheæ cannot, however, be of any great functional importance, since in insects with double commissures I have more than once seen instances in which one only was so provided.

Dr. Williams*, in a paper on the respiration of insects, enunciates very confidently the following propositions, which he considers to be true without any exception, and which he has since reiterated† :—

1st. That the larger tracheæ never anastomose; that "in the *spiral* tracheæ no plexiform union of the branches ever anywhere occurs."

2ndly. "That the 'spiralled' or larger tracheæ are mere conduits, like arteries or veins, and have nothing to do with, take no part in, the ultimate act of respiration."

3rdly. "That the peripheric or extreme distribution of the tracheal system is conformable in plan to that of a blood-vascular system; that is, the capillary or membranous tracheæ are always placed intermediately between larger trunks, the branches of which they serve to connect,—standing to the larger trunks in the same relation as the capillaries of a blood-vascular system do to arteries and veins."

4thly. "That the tracheæ can be discovered in no single instance to end in cæcal terminations—always in mutual inosculations."

I might have passed over the first assertion as a mere momentary slip of the memory if it were not repeated more than once in 1854, and again reaffirmed in 1856. Several of the figures given by Straus-Dürckheim, Léon Dufour, and other writers, show inosculations of the tracheæ; and there is hardly a single insect in which they do not

* Annals and Mag. of Nat. Hist. 1854, vol. xiii. p. 194. † Ib. 1856, vol. xvii. p. 347.

occur in certain organs. It will be sufficient here to mention the dorsal tracheæ in certain Coleopterous larvæ; the ganglia, anterior part of the stomach, oviduct, and heart of *Bombus;* the crop and ganglia of *Carabus*; the cæca and stomach of *Acheta*; the stomach of *Tenthredo*, *Athalia*, and *Libellula*.

These instances, and many others which might be given, show that inosculations of the larger tracheæ, so far from never occurring, are, on the contrary, by no means uncommon.

The second principle enunciated by Dr. Williams, viz. that the spiral tracheæ are mere conduit pipes and have nothing to do with the act of respiration, is less easily disproved, though I believe quite as erroneous as the preceding. Of course I do not mean to deny that the absorption of air is probably more rapid at the thin ends of the tracheæ, where the spiral is absent or rudimentary and the tracheal walls thinner. Still upon this Dr. Williams probably relies, since he scarcely gives any reason for the statement.

On the ovary of *Aphrophora* a few large tracheæ are given to the posterior end, and there divide into about 200 branches. These branches (Pl. III. fig. 1) run the whole length of the egg-tubes, a distance of $\frac{1}{10}$th of an inch, without giving off a single branchlet. They are $\frac{1}{6000}$th of an inch in diameter at the base, and gradually taper until they become excessively fine. At the base the spiral filament is very distinct; gradually it becomes less and less so, but it does not cease suddenly, and it can be traced for a considerable distance up the branch. If, therefore, Dr. Williams's view were correct, no respiration could take place in the ovary, except at its anterior end.

Moreover, while I readily admit that in all probability very little respiration can take place through the spiral filament itself, still it must be remembered that the coils of the spiral leave between them a considerable space, which is occupied by a delicate membrane. Why Dr. Williams should suppose that no interchange of gases can take place through this membrane, I know not; and until some reason is given, I shall think myself justified in concluding that the spiralled tracheæ are not mere conduit pipes, and that, although respiration may proceed more rapidly at the fine extremities of the branchlets, still it is not confined to these parts, but is carried on also in the larger vessels. It is true (as Dr. Williams was, I believe, the first to observe) that in some cases the spiral rib ends suddenly; this is generally the case where a trachea gives off at one point several small tubules, as for instance in Pl. I. fig. 8; but the sudden change does not occur in all insects, which led me for some time to think that there must be some error in Dr. Williams's observations.

We now come to Dr. Williams's third proposition, that the capillary or membranous tracheæ are always placed intermediately between larger trunks, standing to them in the same relation as the capillaries of a blood-vascular system do to arteries and veins.

I must confess that I am unable in any way to confirm this statement. I have never seen the minute tubules gradually collect into efferent branches, nor have I been able to find any evidence that there are two sorts of large branches—one afferent, and the other efferent—as there ought to be according to Dr. Williams's hypothesis. In the blood-vascular system we have arteries, capillaries, and veins; in the aeriferous system of insects we have only air-tubes, becoming, as a general rule, gradually smaller and smaller as they proceed further from their origin.

In most cases also, each trachea supplies a definite area, which receives no branchlets from any other source; and it seems evident therefore that in these cases the air must pass to and fro in the same channel.

Dr. Williams's fourth assertion seems to me as little tenable as any of the three preceding. I do not, of course, deny that in some organs the tubules may inosculate, or, in other words, that the tracheæ may end in loops; but certainly this does not seem to me to be universally or even generally the case. Referring again to the tracheæ belonging to the ovary of *Aphrophora*, we see that each branch tapers from $\frac{1}{6000}$th down to $\frac{1}{20000}$th of an inch without giving off a single branchlet. Does, then, the fine end run into the similar termination of some similar branch, and thus form an elongated ellipse? if so, we should have expected to find the calibre nearly equal throughout; but the ends were so excessively delicate that any such inosculation could be of little importance.

A glance at the tracheæ of the Malpighian vessels in *Æschna* seems to me to be almost equally conclusive, as the tracheæ there run nearly half an inch, becoming very fine, and yet sometimes only give out a single branchlet. I readily admit that these long blind tubes seem at first sight but little fitted to ensure a constant supply of fresh air to the organs along their whole course: on the other hand, it must be remembered that the interchange of gases is very rapid; and as we do not find among the larger tracheæ any separate afferent and efferent branches, we ought not hastily to conclude that they must certainly exist among the branchlets.

It occurred to me, in reflecting upon this subject, that the removal of the carbonic acid from the tracheæ, and the continual supply of oxygen, were probably effected in consequence of the diffusion of gases. Prof. Huxley also suggested to me that in fact the same is the case in man and the higher animals generally. Upon mentioning this to Prof. Graham, he referred me to his paper in the 'Philosophical Magazine' for 1833, where he has expressed the very same opinion.

As his suggestions appear to have been almost, if not altogether, overlooked by physiologists, I may perhaps be permitted to quote a few of his remarks. He says, "I may be allowed to mention an application of the law of diffusion in explanation of the mechanism of respiration. The cavity into which air enters during respiration consists, first, of a large tube, the windpipe; secondly, of smaller tubes, into which the windpipe diverges; and thirdly, of a series of still smaller tubes, diverging from the last, themselves ramifying to an indeterminate extent, till at last the tubes cease to be of sensible magnitude, but are believed to terminate in shut sacs. The capacity of the whole cavity cannot easily be determined; but we may estimate it at 300 cubic inches. In a natural expiration, about 20 cubic inches or $\frac{1}{15}$th of the contents are thrown out, from the application of a general pressure to the whole; but it is evident that these 20 cubic inches will be the 20 cubic inches nearest the outlet, or the contents of the larger tubes. The contents of the second-sized tubes will advance at the same time into the largest tubes, but no further, and will recede again into their original depositories on the next inspiration, which will fill the larger tubes with fresh air, which identical quantity will again be expelled in the next expiration.

"This illustration is perhaps too strongly stated; but it is evident, that, in ordinary respiration, the slight mechanical compression will have little or no effect in emptying the most distant tubes, or the ultimate air-cells, of their contents. The bulk of the air, also, is not altered during respiration, although, for a quantity of oxygen, carbonic acid gas is substituted. This substitution, which is the great end of respiration, undoubtedly takes place most abundantly in the minute and distant air-cells, which present the largest surface to the blood; and the carbonic acid there produced must be moved along the smaller tubes by the diffusion-process (which we know to be extremely energetic and also inevitable), till it is thrown into the larger tubes, from which it can be expelled by the ordinary action of respiration. But the action of diffusion is always twofold: at the same time that carbonic acid is being carried outward from the air-cells, oxygen is carried inward in exchange; and thus the necessary circulation is kept up throughout the whole lungs.

"There can be no doubt that much of this quantity occupies constantly and permanently the most minute tubes and air-cells; for it can scarcely be withdrawn by means of the air pump. Now the question has arisen, how these ultimate tubes and air-cells are so powerfully inflated; for they are not distended by the action of muscular fibre, of which they are known to be destitute. This state of distension must be highly useful by exposing surface; and the law of diffusion enables us to account for it. The heavy carbonic acid which these minute cells may contain, is not merely exchanged for oxygen, but for a larger volume of oxygen, in the proportion of the diffusion-volumes of carbonic acid and oxygen; namely, 81 carbonic acid are replaced by 95 oxygen. The resistance to passage through the most minute tubes is overcome by the diffusion-action, as in the case of the pores of the stucco plug; and there follows a tendency to accumulation on the side originally occupied by the carbonic acid. This accumulation is limited by the increased facility with which the air-vessels can empty themselves mechanically of a portion of their contents, from their distended state.

"In the law of diffusion of gases, we have, therefore, a singular provision for the full and permanent inflation of the ultimate air-cells of the lungs. But it is in the respiration of insects that the operation of this law will be most distinctly perceived. The minute air-tubes accompanying the blood-vessels to every organ, and like them ramifying till they cease to be visible under the most powerful microscope, are kept distended during the most lively movements of the little animals, and the necessary gaseous circulation maintained wholly, we may presume, by the agency of diffusion."

Certainly, however, in many insects the respiratory movements are as well-marked as in any of the higher animals; and even in Caterpillars and other insects* where they are absent, still the interchange of gases must be assisted by the ordinary movements of the body. Yet Prof. Graham is, no doubt, quite correct in denying the existence of any actual current of air in the smaller tracheæ; and that under these circumstances the supply of oxygen should be sufficient shows well how rapidly and forcibly the diffusion of gases takes place †; but I am still doubtful whether the superior quantity of oxygen

* *Ranatra* has no respiratory movements. In this genus, according to Newport, the whole respiration is effected through the caudal tube. It has, however, three pairs of spiracles on the under side of the abdomen; and each spiracle receives a moderate-sized trachea.

† The membrane of the spiracle well represents the plaster plug used by Prof. Graham in his experiments.

which enters, over the carbonic acid which escapes, is in all cases so necessary to expand the tracheæ as Dr. Graham suggests, because I have found the small branchlets in a larva of *Musca* still full of air after it had been drowned by immersion for some hours in water.

On putting some larvæ of *Melolontha* into water, I was surprised to see a considerable formation of bubbles on the skin, especially at a point below each spiracle, while no bubble ever appeared from the spiracles themselves. If, however, the water is first boiled, then no bubbles are produced, and the larvæ very soon, say in about a quarter of an hour, become motionless, though, if pricked, they still contract a little. Their flesh is then quite soft and flabby, while generally it is tolerably firm to the touch. I expected to have found the tracheæ free from air, or nearly so; but this was not the case. Like other insects, these larvæ readily recover from their suffocation when they are taken out of the water.

The larvæ of flies are also naked fleshy grubs; and I expected them to behave in a similar manner; this, however, is by no means the case. They live much longer in water. When they are placed in it, no bubbles form on their skin; nor does it seem to make any difference to them whether the water is boiled or not: I put four into some boiled water, and the same number into water which had not been boiled; and at the end of forty-four hours they still moved a little, gently turning their heads from one side to the other. These facts seem to me to prove that the larvæ of *Melolontha* breathe partly by means of their skin, and that those of *Musca* do not.

Yet these opposite states of the skin may be necessary for these larvæ, living as they do under such different circumstances *.

This result was quite unexpected by me; yet it throws much light on the intermediate stages which, upon the principle of natural selection, must have existed between ordinary larvæ, respiring principally through spiracles, and those which, like the larvæ of *Botys*, of Dragonflies, Ephemeræ, &c., breathe by means of foliaceous expansions of the skin.

In most insects the air will be found, after death, filling the fine ends of the tracheæ. In some cases, however, as in many parts of *Carabus*, *Melolontha*, *Acheta*, *Hipparchia*, &c., the smaller branchlets are generally, even very soon after death, filled with fluid, and can therefore scarcely be distinguished, or they even become quite invisible. This happens very frequently in Lepidoptera, Coleoptera, and Orthoptera; but I have not noticed it so often in Hymenoptera, Diptera, or Neuroptera. It is not, however, constant in the first three orders; and in *Necrophorus*, for example, the very fine tubules may be beautifully seen. The larvæ, at least of Coleoptera and Lepidoptera, do not in this respect resemble the perfect insect; but in *Acheta* all the three forms are alike.

* M. Lyonet, writing before the observations of Dr. Graham had thrown so much light upon the subject, and misled principally by the absence of special respiratory movements in many insects, doubted whether the tracheæ were organs of respiration, and suggested that one at least of their uses might be "de concourir avec les nerfs, à la contraction des muscles, pour opérer les mouvements," though I confess that I do not quite understand in what way the tracheæ were to cooperate with the nerves. In support of this view, he mentions that if the spiracles are closed by oil, or if the insect is kept under water, after a while it loses all power of movement. This experiment, however, hardly justifies the conclusion which M. Lyonet deduces from it; and it seems to me that the larvæ lose their power of movement in the same way as M. Lyonet himself would, had he been treated in a similar manner.

It might at first be supposed that the points at which the air ceases are really the ends of the tracheæ, and that where they can be traced further they are merely solid threads. In some cases, however, the air disappears slowly from the fine tubules; and a case of this is represented in Pl. III. fig. 8. Fig. 8 represents a small tracheal branchlet ramifying over two egg-tubes of *Hipparchia Janira*, examined as soon as possible (perhaps a quarter of an hour) after the death of the insect. Fifteen minutes later, the air had disappeared from the fine ends, and no more could be seen than is represented in figs. 8′ & 8″. In another quarter of an hour, still more of the tracheæ had disappeared, and only the stump as it were, F, remained. In this instance all the other tracheæ on the organ ended in the same abrupt manner; but it is evident, from the preceding and many other similar observations, that the apparent ends are by no means the real terminations of the tracheæ.

This absorption or repulsion of the air from the finer tubules depends evidently, in a great measure, on the nature of the wall of the tracheæ and of the surrounding tissue, because it proceeds with different rapidity in different parts of the same insect, so that while, for instance, in *Carabus* I never found air in the finer tubules on the Malpighian vessels, on the ovaries the air may be seen for a short time after death; and in the ganglion, even after some hours, all the fine tubules still contain air.

I am unable to offer any decided opinion whether this disappearance of the air from the finer tubules is owing to its absorption by the tissues, or whether the surrounding fluid forces its way through the delicate membrane of the tracheæ. Probably, however, the latter is the case; because, if the air were simply absorbed by the surrounding tissue, a fresh quantity would, I suppose, continually be supplied by the larger tracheæ.

Moreover I never found that the manner of death made much difference in the condition of the tracheæ, whereas, if the disappearance of the air were caused by vital action of the surrounding tissue, this would hardly have been the case.

It is difficult, however, to understand why the small tracheæ fill themselves with fluid so much quicker in some insects, and in some organs, than in others. Probably, however, this is owing to some differences in the tracheal wall, which, though always permitting the absorption of air by the tissues, may be more easily permeable by fluid in some parts than in others.

The surrounding fluid must probably have the same tendency to expel the air from the finer branchlets during life as after death; so that, whilst the insect remains alive, some counteracting agency must be at work. In those insects which show no respiratory movements, Prof. Graham's suggestion, above alluded to, seems to offer the best explanation.

I have not yet paid much attention to the metamorphoses of the tracheæ during the change from the larva into the imago. The process seems, however, to be very curious; and I hope ere long to be able to devote some time to the investigation of it.

In a Lepidopterous pupa, I found, in various parts of the body, knotted spiral tracheæ invested by a common membrane, as figured by Semper*. How these knots are formed I know not.

The structure of the tracheæ has generally been described as consisting of an external

* Zeitschrift für Wiss. Zool. pl. xv. fig. 10.

and an internal membrane, enclosing between them a spiral filament. Marcel de Serres and Straus-Dürckheim deny the existence of the spiral thread in the air-vesicles, which, however, is affirmed by Suckow and Sprengel. The truth seems to be that it is certainly present in some cases, while in others it is either imperfectly developed or altogether absent. In some instances the chitinous thickening has a zigzag appearance, which Leydig also has observed.

Leydig* also appears to me to have given the best description of the structure of the tracheæ. He considers that the outer "peritoneal tunic" is a "connective-tissue, transparent, and generally colourless membrane, formed by the union of the same cells which form the fatty tissue, and with which also they remain in intimate connexion."

This description seems to me quite correct; and any one may test its accuracy by examining the fatty tissue of a caterpillar, where he will see that the external membrane here and there leaves the trachea and encloses around it a considerable space, which is occupied by the fat globules. In other words, the external membrane of the trachea is continuous with that of the fatty tissue; the trachea possesses therefore an external membrane only so long as its course is between the masses of fatty tissue, and loses it as soon as it enters one of the masses.

Burmeister† describes this membrane as structureless; but it undoutedly consists of a union of cells, whose walls can generally be perceived without much difficulty. The nuclei also are generally visible.

Among the older writers, Sprengel appears to have had the most correct idea of the so-called spiral filament. He considers it merely as a local spiral thickening of the inner membrane,—in which view he has been followed by Burmeister and Leydig. Burmeister, however, like DeGeer, Lyonet, Bonnet, Straus-Dürckheim, Newport, and others, describes a third, inner membrane, which, like Sprengel and Leydig, I have been unable to see.

Pl. II. fig. 13 represents a fragment, which shows clearly the membrane uniting the spires of the "thread." It is, however, possible that the spirally thickened portion of the inner membrane may sometimes detach itself more or less completely from the membrane by which it is formed. Some of those naturalists who have convinced themselves of the presence of an inner membrane lining the spiral thread, appear to have arrived at this conclusion mainly on account of the inner membrane of the tracheæ being shed at each change of skin; the spiral structure, however, is shed at the same time. I have not yet been able to investigate the mode in which this exuviation takes place so carefully as I could wish; but the fact does not justify the conclusion which has been deduced from it. In the cast skin of a larva of *Dasychira pudibunda*, and in a pupa-case of *Deilephila galii*, I convinced myself that the spiral filament is cast at the time of moulting.

Nervous System.—Ganglia.—(Pl. I. figs. 1, 3, 4, 5 & 6.)

Throughout the Insecta the tracheæ of the nervous system and of the muscles vary less than those of almost any other part of the body, from which it may probably be

* Lehb. d. Histologie, p. 386.

† Handbook of Entomology, Shuckard's Transl. p. 171.

inferred that their ultimate structure also varies less than that of other parts. The ganglia are always well and often very richly supplied with tracheæ, differing in this respect from the commissures and nerves, which in many insects (as mentioned below) are entirely free from them. The tubules, excepting sometimes those which are distributed to the surface, are straight or gently curved, but not waved. They generally rise singly from the branchlets, as in Pl. I. fig. 1; but sometimes, even in the same insect, we find tufts, as in Pl. I. fig. 3.

The abdominal ganglia in *Bombus terrestris* and *B. lapidarius*, are covered over with a network of tracheæ. The meshes vary much in size, from $\frac{1}{300}$ inch in length and $\frac{1}{700}$ inch in breadth to less than $\frac{1}{20}$th of that size. The tracheæ forming the network are of considerable breadth, averaging perhaps $\frac{1}{2500}$ inch. The short commissure between the posterior and penultimate ganglia has as rich a network of air-vessels as the ganglia themselves.

These latter are penetrated by numerous branches which end in tufts (Pl. I. fig. 3) of from five, or even six, down to two or three. The tubules branch two or three times, and resemble a fishing-rod in their general proportions and curvature, running in a gentle sweep often for $\frac{1}{100}$ inch, with a thickness at the base of only $\frac{1}{15000}$ inch.

The ganglionic tracheæ of *Panorpa*, *Libellula*, *Carabus*, and *Aphrophora* are like those of *Bombus*; and so are the tracheal tubules of *Vespa*, *Tenthredo*, *Athalia spinarum*, *Ichneumon* (probably) *extensorius*, *Ophion*, *Chrysopa*, *Tipula*, *Campæa margaritaria*, *Callimorpha jacobææ*, *Pterophorus*, and the larva of *Euplexia lucipara*; but I am not sure whether the branches end in tufts. In none of them is there a network enclosing the ganglia, as in *Bombus*.

In the larva of *Lampyris*, *Amphimalla*, *Acheta* (both larva and imago), *Locusta*, and *Gryllus*, the tubules are larger and longer, but otherwise very similar. The branches, however, do not end in tufts.

In *Forficula* the tracheæ resemble those of *Acheta*, but are smaller.

In *Necrophorus humator*, *N. vespillo*, *Scarabæus*, and *Musca*, in *Hipparchia Janira*, *Pieris napi*, *Noctua gamma*, the larva of *Lasiocampa rubi*, of *Mamestra brassicæ*, of *Gonepteryx rhamni*; the tracheæ sometimes end like the preceding, and sometimes in tufts, a large branchlet ceasing suddenly and giving off from four to seven or more tubules. These latter divide and re-divide again, sometimes breaking into little secondary tufts.

In the larva of *Musca* the mode of branching is quite unlike that of the imago, being simple and not in tufts.

In *Hydrous piceus* the tracheæ are in tufts; but the tubules rising from them are nearly of uniform size, so that there are no secondary tufts.

In *Eristalis* the tracheæ of the ganglia break into tufts like those prevalent throughout the body. Upon the surface they are waved and resemble those of the commissures; but in the interior of the ganglion they seem to be straighter.

In *Pentatoma* large wide tracheæ go to the ganglia, and give off short thick branches. These again give off still shorter branchlets, which end in tufts consisting each of a few straight tubules (Pl. I. fig. 5).

Interganglionic Commissures. (Pl. I. figs. 2 & 7.)

It might have been expected that the tracheæ on these organs would have resembled those on the ganglia, and at any rate that tracheæ would either have been present or absent in all insects. Both suppositions, however, would have been wrong. The tubules in the ganglia are usually straight, while those on the commissures are generally waved, besides differing in other respects. Again, in *Pentatoma* and all the Lepidopterous larvæ which I have examined, the commissures are very richly supplied; in *Bombus*, the Diptera, and some Coleoptera, they are less numerous; while in some Coleoptera, the Orthoptera, Lepidoptera, and Neuroptera, the tracheæ are either rare or altogether absent. This at least holds good as far as my observations go; but the statement will no doubt be modified by further investigations.

Between two of the thoracic ganglia in the larva of *Acheta* I found one of the commissures pretty well supplied with tracheæ, while the other was quite free from them. Indeed generally throughout insects the tracheæ on the two nervous columns are not arranged in exactly the same manner.

In *Scarabæus, Necrophorus vespillo,* and *N. humator*, the tracheæ on the commissures and on many nerves were in tufts resembling those of the ganglion, except that they are altogether smaller, that the tubules branch oftener, and that they are more waved.

In *Cerambyx moschatus* also the commissures were well supplied with tracheæ. In *Hydrophilus piceus* the tracheæ were like those of *Necrophorus*, but in some cases I observed branchlets which did not form tufts. The tubules were numerous and very delicate indeed. In *Musca* and *Eristalis* the tracheæ were in tufts, very much like those on the ganglia, but with straighter tubules. The nerves, however, were almost entirely free from tracheæ. In *Tipula* the tracheæ were numerous. In the larva of *Lucanus* the commissures were well supplied, but in *Carabus*, the larva of *Lampyris*, and in *Forficula*, both they and the nerves were almost entirely free from tracheæ. In *Acheta, Locusta,* and *Gryllus* also, the abdominal commissures had only here and there a single trachea, which seemed as it were to have strayed out of a neighbouring ganglion. In these cases I have not examined a sufficient number of specimens to prove that these single tracheæ are inconstant, but I have little doubt that this is the case. The thoracic commissures of *Acheta*, and also of its larva, were provided with decidedly more numerous tracheæ, which are a little waved and give out single branchlets which again divide once or twice.

In *Noctua* the tracheæ are like those of *Acheta*, but rather more numerous, two or three generally running nearly to the middle of the commissure. They are seldom, if ever, branched, and are almost straight. On those of *Campæa margaritaria, Pieris napi, Hipparchia janira, Callimorpha jacobææ,* and *Pterophorus*, I found no tracheæ. On the contrary, in the larvæ of *Euplexia lucipara* and *Gonepteryx rhamni* they were well supplied; and in the larvæ of *Lasiocampa rubi* and *Mamestra* they were very numerous both on the commissures and nerves. On the commissures of *Bombus muscorum* they are numerous, waved, and generally in tufts consisting of a few branched tubules, sometimes even of only two. On those of *Athalia spinarum, Tenthredo, Ichneumon* (probably) *extensorius,* and another small black species, I found none. On those of *Ophion* there were hardly any. The few that I could see were almost straight and branched at intervals. In *Vespa* there was only here and there a little tuft.

On the commissures of *Chrysopa, Panorpa,* and *Libellula,* I found no tracheæ, and on those of *Aphrophora* only one here and there. In *Pentatoma juniperina* and *P. baccarum,* on the contrary, both the commissures and the nerves were well supplied with waved tracheæ, whose mode of branching needs no special remark.

On the nerves of Insects generally I found fewer tracheæ than on the commissures, and in most species many even of the larger nerves were without any. Whether this difference in different nerves be constant in each species, I am unable to say.

Œsophagus. (Pl. I. figs. 8 & 14.)

The œsophagus is generally very poorly, if at all, supplied with tracheæ; indeed even when they are present they are attached to the muscular bands with which the organ is provided, rather than to the organ itself.

In *Pentatoma, Panorpa,* the larva of *Lampyris, Noctua gamma, Limnephilus vitratus, Aphrophora spumaria, Ichneumon, Ophion luteum, Vespa communis, Tenthredo viridis, Gryllus viridissimus, Tipula,* and the larva of *Mamestra,* it appeared to have no tracheæ.

In *Musca* there is a ring round the pharynx very richly supplied with tracheæ. On the upper part of the œsophagus the tracheæ are in tufts, with waved or straight tubules; on the posterior half there are a few longitudinal tracheæ; starting from the front end and running backwards, they give off waved, transverse, branchlets at intervals, and belong to the œsophageal muscles rather than to the organ itself.

In *Libellula* the œsophagus is narrow in front and swollen behind. The anterior narrow part has no tracheæ; the posterior portion is supplied as in *Musca,* only that the branches rise behind instead of in front. In *Necrophorus vespillo* the type is almost the same. In *Cerambyx moschatus* the tracheæ had more numerous transverse branchlets, but only their bases were visible. In *Lucanus cervus* and *Amphimalla solstitialis* they were similar, but with fewer branchlets; the ends were invisible. In *Carabus* the tracheæ are as in *Forficula* and *Musca.* In the larva of *Lucanus* the tracheæ resembled those of the rest of the intestinal canal, while the larva of *Lampyris* seemed to have none. In *Bombus* they are few, waved, and simply branched. In the Orthoptera generally, the œsophagus is much swollen behind.

In *Forficula* the type is the same as in *Musca,* but the lateral branchlets are larger and more branched. In *Acheta domestica* it is accompanied by two enormous tracheæ, which are wide at each end and narrow in the middle. They give off large transverse branches, which are irregularly branched, somewhat like a system of rivers; and the ends are finely and beautifully waved. *Locusta* is also well provided with tracheæ, but the ends had become invisible. In the larva of *Acheta* the mode of termination of the tracheæ, so far as it was seen, resembled that of the imago.

In *Eristalis* the tracheæ are unlike those of *Musca*; most of them are in tufts (Pl. I. fig. 8), but are straighter and more delicate than those on the stomach. Here and there the character of tufts is almost lost, and they branch simply.

Salivary Glands.

In the larva of *Euplexia lucipara* and of one of the *Mamestræ* the salivary glands have few branchlets, which are simple and without numerous tubules. The duct was generally free from tracheæ.

In *Chrysopa* the mode of branching is similar, but the tubules are not quite so long. In *Bombus lucorum* the tracheæ on the thoracic glands were in tufts. In *Pentatoma* the tracheæ are very nearly like those of the stomach, but with perhaps rather fewer tubules. *Eristalis* has four salivary glands; two are cylindrical with circular bosses, the other two resemble in shape the ordinary long salivary glands of caterpillars. On all four the tracheæ are in tufts as on the œsophagus, and the tubules are greatly curved, but in each tuft there are very few, and even sometimes the branching scarcely seems to be in tufts at all.

In the larva of *Musca* the branching is simple, and not in tufts. It is much like the figure in Pl. IV. fig. 8.

Cæca. (Pl. I. figs. 10 & 11.)

The cæca of *Acheta* are two thick pulpy organs, one on each side of the stomach. They have some large vascular tracheæ, which divide several times and then run into the corresponding branches on the other side of the organ, as in Pl. I. fig. 10. The branchlets have a very rigid appearance, as they are broad at their origin, and taper very quickly. In the larva the tracheæ are nearly similar, but more elongated.

The character of the tracheæ is nearly the same in *Gryllus* as in *Acheta*, but the inosculations are less conspicuous, and the branchlets are rather more elongated.

In *Chrysopa* the cæcum is cylindrical, but tapering to the free end. It is divided by twelve constrictions into well-marked bosses. Large tracheæ run up the organ from its base and give off transverse branches, one of which is represented in Pl. I. fig. 12. Each boss has also a branch or more, which give off from their outer side long straight tubules (Pl. I. fig. 11). I counted 328 of these long tubules in one half of one boss, so that the total number must be very large; and as each one is about $\frac{1}{70}$th of an inch in length, the total length of the whole must be considerable.

In the long tubes attached to the front end of the stomach in the larva of *Musca*, the mode of branching is simple, and offers no great peculiarity.

Sucking Stomach. (Pl. I. fig. 9.)

In *Bombus terrestris*, *Vespa vulgaris*, *Ophion*, *Tenthredo luteus*, *Ichneumon*, *Campæa margaritaria*, *Pieris brassicæ*, *Tipula*, and *Noctua gamma*, this organ has no tracheæ.

In *Musca*, on the contrary, it is well supplied with tracheæ in pretty little systems. The tracheæ branch simply, and the tubules have a tendency to run a little way along the parent stem, and then curve out from it in a beautiful manner. In the larva of *Musca* it appeared to be free from tracheæ.

In *Eristalis* it is poorly supplied, but the tracheæ are of the same type as those on the stomach. The duct also is supplied in a similar manner.

Crop. (Pl. I. fig. 13.)

The walls of the crop are generally strengthened by a thick chitinous layer which prevents the fine ends of the tracheæ from being well seen. It is also generally surrounded by muscular tissue. In *Acheta domestica* it is provided with twelve longitudinal tracheæ in six pairs which are joined at the base, and send off transverse branchlets at regular intervals.

In *Carabus* there are about ten longitudinal tracheæ which send out some large branches at acute angles, and many cross-branchlets (Pl. I. fig. 13). At the posterior end the great longitudinal tracheæ are connected by a transverse vessel.

In the larva of *Lampyris* the tracheæ are as on the stomach.

In *Panorpa* they form a network, as in *Carabus*.

Stomach. (Pl. II. figs. 1 to 10.)

In *Bombus terrestris*, *B. lapidarius*, *B. muscorum*, and *B. hortorum*, the stomach is divided into two parts: along the anterior run several large longitudinal tracheæ which anastomose frequently, while on the posterior portion the tracheæ are mostly transverse. In *B. pratorum* this anterior part is shorter than in *B. terrestris*. The tracheæ give off branchlets which generally end in tufts (Pl. II. fig. 5), but the tubules themselves branch a good deal; so that often the character is almost lost, as in the right-hand tuft in the figure. Pl. II. fig. 11 represents some of the tracheæ of the larva of *B. muscorum*. The branchlets are longer than is the case in the perfect insect, and the tubules are longer, straighter, and fewer,—generally, indeed, only three in a tuft. In *Vespa* the tracheæ resembled those of *Bombus*. Often, however, instead of ending in tufts, the branchlets terminated as in Pl. II. fig. 10, the long tubules running up a muscle. *Ophion* (Pl. II. fig. 3) is characterized by very long branchlets (one-fortieth of an inch in length, without a division), which at last break up more or less dichotomously into numerous tubules. In *Tenthredo*, a genus belonging to the Ichneumonidæ, the type was much like that of *Ophion*, but altogether much smaller. The same is the case with *Cynips lignicola*. In *Athalia spinarum* and *Tenthredo*, as in *Bombus* and *Vespa*, the tracheæ anastomose frequently on the front part of the organ.

In *Ichneumon* the tubules are straight, or but little waved, long, few, and more or less at right angles with the branches from which they spring.

In the Cricket the stomach is divided into two distinct parts. The walls of the first (*f* of Léon Dufour's fig. 19*) seem to consist of large cells, round which the tracheæ run. They (Pl. II. fig. 9) are short and broad, and anastomose frequently.

On the posterior part (*h* of Léon Dufour's figure) are numerous dark glandular bodies. A great ribbon-like trachea runs along the organ and gives off transverse branches. On one side these branches much resemble trees (Pl. II. fig. 4), and the glandular bodies look like some enormous kind of fruit. On the other side of the main trachea, the mode of branching is similar, but the branches are more elongated.

* "Recherches Anat. et Phys. sur les *Orthoptères*, les *Hyménoptères*, et les *Névroptères*," 'Mém. d. Sav. Étrangers,' vol. vii.

In *Gryllus* also and *Forficula* the mode of branching has much similarity to that of a tree; but in neither did I trace the fine tubules. In the larva of *Acheta* the termination of the tracheæ, so far as it could be seen, resembled that of the perfect insect.

In *Melolontha*, *Scarabæus*, and *Lucanus* I met with the same difficulty. In the larva of *Lampyris* and in that of *Lucanus* the distribution was much the same (Pl. II. fig. 6). In *Necrophorus vespillo* and *N. humator* the branchlets are long, waved, not very numerous, and without any special peculiarity in the mode of branching, which is generally more or less dichotomous. The organ is provided with numerous white finger-like glands, on which the waved tubules had a beautiful appearance. Generally one or two run up each gland.

The distribution of the tracheæ in *Libellula* is very peculiar. Two large tracheæ run along the stomach and give off about eight large transverse branches on each side in pairs. These lateral branches again give off branchlets at right angles, and these again others at acute angles. These last often run into one another, and thus divide the organ into numerous elongated compartments.

In *Panorpa* about ten large tracheæ go to the stomach, on which they ramify in a radiating manner. There are also a few smaller systems, but by far the greatest number of tracheæ originate from these large branches.

The tracheæ of *Chrysopa* and of *Mamestra brassicæ* (larva) resembled those of *Tenthredo* and *Cynips*, but I did not notice such long unbranched tubes. Sometimes the tracheæ were here and there in tufts. Those of *Campæa margaritaria* were still more like those of *Tenthredo* and *Cynips*, while *Hipparchia* again agreed with *Chrysopa*.

In *Musca* and *Eristalis* the tracheæ are in very pretty tufts. The ends of the tubules often run into the spaces occupied by other systems, but they very seldom inosculate. Sometimes the systems are more elongated, so as almost to lose the appearance of tufts. When magnified about 100 times, the tracheæ have a beautiful appearance.

In the larva of *Musca* the stomach is well supplied, principally by transverse branches, which, however, do not end in tufts. On the anterior part especially they are very pretty.

In *Tipula* the tracheæ are but very loosely attached to the stomach, so that they may easily be torn off in the dissection. They are not in tufts like those of *Musca* and *Eristalis*, but resemble those on the ilium.

In *Aphrophora spumaria* the tracheæ are not very numerous, and consist of long waved branchlets, with few ramifications, much, in fact, like those of *Lampyris* and *Necrophorus*.

In *Pentatoma* the stomach is complicated. Pl. II. fig. 2 represents one of the tracheal branches magnified 60 times, and fig. 7 one of the lateral branchlets magnified 250 times, of the anterior part. The branchlets divide dichotomously, and also throw out numerous tubules from the side. The tubules often run close together for some distance. On the posterior sacculated part of the stomach are thick, broad tracheæ which send out large branches. These run principally between the sacculi, and appear to branch like those of the front part of the stomach. It is, however, difficult to follow them satisfactorily, on account of the folds. Finally, there is a broader, short chamber, into which the Malpighian vessels fall; and on this the tracheæ resemble those of the anterior division of the stomach. I have already given my reasons for considering all these organs as being together homologous with the stomach of other insects, though the great differences in structure certainly indicate differences of function.

On the front part of the stomach two or three fine tubules rise from the large tracheæ near the base of each system, and run with only one or two branches all along the main branch of the system. What makes these tubules particularly conspicuous is, that while they are nearly as delicate as the ordinary tubules, they are much longer, and as straight as the larger branches which they accompany.

On the round sac to which the Malpighian vessels are attached the tracheæ are much like those of the front part of the stomach.

The recurrent intestine of *Aphrophora spumaria* is not very richly supplied. The tracheæ (Pl. II. fig. 16) branch more or less dichotomously, and are waved at the ends.

Malpighian Vessels. (Pl. II. fig. 15; Pl. IV. fig. 11.)

In *Bombus terrestris* the tracheæ run along the Malpighian vessels, giving off short, broad branchlets at intervals. Each of these ends abruptly, and from the termination spring from five to ten tubules. These tubules branch generally two or three times at acute angles, and are about $\frac{1}{150}$ inch long. What, however, gives a very peculiar appearance to these tracheæ, is, that the tubules of each tuft, and the branches proceeding from them, though somewhat divergent, are more or less parallel to one another.

In *B. muscorum*, *B. lapidarius*, *B. hortorum*, *Vespa vulgaris*, *Anthophora acervorum* (Pl. II. fig. 15), the tracheæ are like those of *B. terrestris*.

In *Ophion luteum* long tracheæ run along the Malpighian vessels, and give off side-branches here and there, which form little systems. In *Tenthredo* they are as in *Ophion*, but in *Athalia spinarum* they seem to have hardly any tracheæ.

In *Acheta* (larva and imago), *Gryllus*, *Locusta*, and *Forficula*, a very long trachea runs along each Malpighian vessel, from one end to the other, giving off minute branchlets at intervals. The ends of these branchlets were always filled with fluid; and I was therefore unable to determine their mode of termination.

In *Libellula* (Pl. II. fig. 19) this character was carried to an extreme, and it was only here and there that a little branchlet could be seen proceeding from the main trachea.

In *Panorpa* the Malpighian vessels were so opake that the arrangement of the tracheæ could not be made out. In *Chrysopa* they seem to have no tracheæ. In *Aphrophora* the tracheæ were badly seen. They appeared to divide dichotomously into curved, but not waved branchlets.

In the larva of *Lampyris* they were long, waved, and either branched dichotomously, or gave off little branchlets at intervals, very much, in fact, as on the stomach and ilium. In *Necrophorus vespillo* and *N. humator* the branchlets were more numerous, so as to have almost the appearance of being in tufts. They are less wavy than in *Lampyris*. In *Carabus*, *Cerambyx moschatus*, *Amphimalla solstitialis*, *Melolontha vulgaris*, and *Lucanus cervus*, the ends of the tracheæ when examined were filled with fluid, and therefore could no longer be distinguished.

In *Pentatoma* the tracheæ are like those on the stomach.

In *Campæa margaritaria*, *Pieris napi*, and the larva of *Eupexia lucipara*, the ends became invisible so soon after death, that I was never able satisfactorily to see the finer branchlets. In the larva of *Mamestra* the tracheæ were long, slender, and with few branchlets, at obtuse angles.

In *Musca* and *Eristalis* they are in tufts, as is so generally the case with the tracheæ of these insects; while in the larva of *Musca* they are quite simple. A rather larger trachea runs along each Malpighian vessel in *Tipula*, and gives off little systems of branchlets at intervals (Pl. II. fig. 18).

In the larva of *Bombus muscorum* the tracheæ of the white urinary tubes resembled those of the stomach, but the branches generally ended in only two tubules.

Ilium. (Pl. II. figs. 11, 12 & 17.)

In *Bombus terrestris*, *B. muscorum*, *B. lapidarius*, and *B. hortorum* the walls of the ilium are composed of quadrangular cells, and the smaller branchlets of the tracheæ run round and between them, so that they divide the organ as it were into quadrangular spaces. This arrangement, however, I could not see well without the assistance of acetic acid. In *Vespa* the arrangement of the tracheæ is much like that on the stomach. The same is the case in *Ophion* also, though the very long branches were not so much developed, and the whole arrangement is on a smaller scale. At the front part of the organ in *Tenthredo* the tracheæ branch frequently, and finally end in tufts (Pl. II. fig. 17). At the posterior end, the tufts are less developed, or altogether absent. In parts of the organ the larger branches anastomose frequently. In *Athalia spinarum* the larger branches are like those of *Tenthredo*. The tufts have fewer tubules, and often the branchlets end without any tuft at all.

In *Ichneumon* the tracheæ resemble those of *Ophion*. In *Acheta* (imago and larva) the mode of distribution is much like that on the posterior end of the stomach, but at the lower end the tree-like branches are more elongated. In *Gryllus* also the branches are more elongated than on the stomach. In *Forficula auricularia* the branches run in a wavy course along the muscles, with short transverse branchlets.

In *Necrophorus vespillo* the ilium is very long, and covered with saccular bags. It has four longitudinal tracheæ, which send a branch to each sacculus.

In the larvæ of *Lampyris* and *Lucanus* the tracheæ are much like those of the stomach (Pl. II. fig. 6).

In *Panorpa*, on the contrary, they are very different, but I was unable to see them satisfactorily. In *Chrysopa* again they are similar, but the branchlets are fewer. *Limnephilus vitratus* has on the ilium several large tracheæ which throw out rather numerous tubules. These latter are rather long and slightly curved, but not waved. The number of them is larger than is generally found on this organ.

Campæa margaritaria seemed to have no tracheæ on this organ, nor on the cæcum; or at least they were so loosely attached, as, in the specimen examined, to have become separated from it.

On the long ilium in the larva of *Musca* the tracheæ branch very simply, and resemble those of the salivary glands. In *Eristalis* the tracheæ resembled those of the stomach; in *Musca* they were perhaps rather more like those of the colon. The arrangement in *Tipula* is quite different, not being in tufts. In *Aphrophora* (Pl. II. fig. 16) they are much like those of the recurrent intestine and the Malpighian vessels.

In the larva of *Bombus muscorum* the tracheæ resemble those of the stomach. The different systems cross one another a good deal. The tracheæ are stiff and wand-like, and end in small tufts of from two to four, long, straight, or gently curved tubules. These latter sometimes, though not often, branch dichotomously. In the larva of *Lampyris* the tracheæ on the duodenum were like those on the ilium.

Colon. (Pl. IV. figs. 1 to 7.)

In *Bombus terrestris*, *B. muscorum*, and *B. lapidarius*, the colon (Pl. IV. fig. 2) was but poorly supplied, and the tracheæ were long, with only a few branchlets.

In *Vespa* the wall of the colon is divided into six parts, which have a cellular appearance, and are united to one another by their membranes. These membranes have no tracheæ, but a large branch runs along each of the divisions, and gives off numerous side branchlets, a part of one of which is represented in Pl. IV. fig. 5.

In *Ophion luteum* the rectum contains a good many round glands? which, as usual, are well supplied with tracheæ. The mode of branching is much like that in *Chrysopa* (Pl. IV. fig. 4). In *Tenthredo* and *Athalia spinarum* the colon contains six elliptical shield-like glands, which, as usual, are more richly supplied than the rest of the organ. The mode of branching is much like that of *Ophion* and *Chrysopa*. In *Ichneumon* also the rectal glands and their tracheæ are as in *Tenthredo*. In *Acheta* the walls of the organ are divided into six compartments, each of which has a double series of tracheæ, two large branches distributing themselves from near the middle, one to the front part, the other behind. The figure (Pl. IV. fig. 6) which represents the front part of one division will give a more correct idea than any description could do. The colon of *Locusta* much resembles that of *Acheta*. The type is very nearly the same in *Gryllus*; but the lateral branchlets are fewer and longer. On the colon of the larva of *Acheta* the tracheæ resemble those of the imago.

In *Forficula auricularia* the colon contains six round shield-like glands in two alternate rows. In *Carabus* it is well supplied, and the larger branches anastomose a good deal. The muscles make it somewhat difficult to follow the ramifications of the finer branches; but they seemed to be like those on the egg-tubes. In *Cerambyx* the tracheæ seemed to resemble those on the stomach, as was also the case with the larvæ of *Lampyris* and *Lucanus*. In *Necrophorus vespillo* and *N. humator* they are almost as in *Bombus*; but the branchlets are longer. In *Libellula* there are six wide longitudinal bands, connected by a membrane without any tracheæ; each band has a large trachea, which gives off about six systems of branchlets. *Panorpa* has also six rectal glands, each with a system of tracheæ radiating from the centre. In *Limniephilus vitratus* there were at least twenty-five round glands, on which the distribution of the tracheæ was not unlike that of *Chrysopa*. *Chrysopa* has six round glands, as in *Tenthredo*, &c. The mode of tracheal distribution in the glands and surrounding membrane is represented in Pl. IV. fig. 4. In

Campæa margaritaria, *Hipparchia Janira*, *H. Tithonus*, *Pieris napi*, and *Noctua gamma*, there are many round glands, each with numerous tracheæ.

In *Eristalis* and *Musca* the tracheæ are as on the stomach, though in the latter the systems are particularly large. In both, there are several tongue-shaped glands with numerous tracheæ. In *Tipula* also are several similar glands. A large trachea enters the base of each, and there divides into four or five branches, of which about three continue nearly parallel, and give off branchlets from time to time, while the others diverge to supply the basal part of the gland. In *Pentatoma* the tracheæ resemble those of the stomach.

Male Generative Organs.—Testis. (Pl. III. figs. 13, 14, 16, 18 & 19.)

In *Bombus muscorum*, *B. terrestris*, and *B. pratorum*, the tracheæ generally divide dichotomously, but sometimes into three. The end tubules are very long,—a character which we often meet with in the testis. In *Acheta*, *Locusta*, and *Gryllus*, the air had always been removed from the fine ends, which therefore had become invisible. The branches were, however, long between the branchlets, and they tapered very little. In the pupa of *Acheta*, the tracheæ, so far as they could be seen, resembled those of the imago. In *Musca* the testis is a brown, sausage-shaped body, and the tracheæ end in small tufts (Pl. III. fig. 18). In *Eristalis* the organ is formed on a similar type. The tufts, however, though larger, are more open, and consist of fewer branchlets. In *Aphrophora* the tracheæ are almost like those of the ganglia. They end in long, gently curved tubules, which arise successively, and without forming tufts.

In the button-like testes of *Melolontha* long tracheæ run from the centre to the circumference. They divide three or four times dichotomously, and are very long. They, however, diverge but slightly, and are a good deal twisted on themselves. In *Amphimalla solstitialis* they are very similar. Pl. III. fig. 16 represents one of the least-complicated systems. In *Necrophorus mortuorum* and *N. vespillo* the tracheæ branch simply, small tubules rise from branches of considerable size, and the end tubules are straight and of great length. In *Carabus* the ends of the tracheæ had disappeared. In *Cerambyx moschatus* they were much like those of *Aphrophora spumaria*. In *Panorpa* the tracheæ were almost as in *Necrophorus*. Most of the ends had disappeared; and yet the fine tubules seemed to be very long, because they remained for a considerable distance without any great diminution of size. When one of the branchlets divided, the two tubules were each almost as thick as the branchlet from which they sprang. This character gives the tracheæ a peculiar appearance, which is very striking. In *Pentatoma* the testis is covered by broad, longitudinal, saccular tracheæ, which give off thick branches at the ends and sides.

Vas Deferens.

This origin is often without tracheæ. When they are present, they are often very like those on the testis, as for instance in *Bombus terrestris*, *B. muscorum*, *B. pratorum*, *Pentatoma prasina*, &c. In *Acheta* and *Locusta* it was thin, delicate, and apparently without tracheæ. In *Gryllus*, on the contrary, it is large and of a yellow colour. I did not observe the ends of the tracheæ; but the larger branches were like those of the testis. In *Musca, Aphrophora, Tipula, Forficula*, and *Panorpa* there seemed to be no tracheæ. In *Eristalis* the testes are almost sessile; and in *Necrophorus mortuorum* the vas deferens is too short to give a good view of the tracheæ.

Ductus ejaculatorius. (Pl. III. fig. 17.)

In *Bombus terrestris* and in *Panorpa* this organ has no tracheæ. In *Musca* the tracheæ are in tufts, as in so many other parts of the body. In *Necrophorus vespillo* and *Eristalis* they are like those on the testis. In *Pentatoma*, finally (Pl. III. fig. 17), the organ is pear-shaped, the vas deferens being attached to the swollen end. A number of branches start from the periphery, and soon give off several branchlets at acute angles. These branchlets run towards the posterior end, and go for almost half the length of the organ without dividing any more. They are generally straight; but some were in coils, which, however, may perhaps not be their natural position.

Epididymis. (Pl. III. fig. 20.)

Pl. III. fig. 20 represents the mode of distribution on the epididymis of *Bombus pratorum*.

Vesiculæ seminales.

In *Bombus terrestris, B. muscorum*, and *B. derhamellus*, the tracheæ are in tufts, the tubules often being branched again two or three times: the type is much like that on the heart; but each tuft occupies much more space. On the heart I always found the tubules waved, which is not the case in those of the vesiculæ seminales.

In *Necrophorus mortuorum* and *N. vespillo* they may be seen very well. They are large, and their manner of branching is more or less dichotomous.

In *Aphrophora spumaria* they are like those of the testis, and are therefore not very different from those of *Necrophorus*.

In *Panorpa* I did not see them well; but they seemed to be like those of *Necrophorus* and *Aphrophora*.

In *Musca* and *Eristalis* the tracheæ are in tufts, as is the case throughout these insects. In this organ the tufts are rather large.

Female Generative Organs.—Ovaries. (Pl. III. figs. 1 to 12.)

In *Bombus terrestris, B. muscorum, B. lapidarius, B. pratorum, B. hortorum*, and *Vespa*, the egg-tubes are covered by such an immense number of tracheæ, that at first sight they look almost like organs of respiration. The mode of distribution also is very different from that found in any other part of the body. In another specimen of *Vespa*, belonging perhaps to another species, the tubules were fewer, so as more to resemble those of *Tenthredo*.

The large tracheæ give off short stout branchlets at small intervals. These branchlets stop abruptly, and give off from their end a great number of fine tubules. These latter are so excessively numerous and so much twisted and interwoven together, that I was unable to trace any one to its end, or to determine whether they are branched or not.

From analogy with other tufted tracheæ, it is probable that the tubules are long, and that they branch occasionally. The impression, however, left on my mind after examining them carefully, was rather the reverse; but, as above stated, they lie so thickly together, that I cannot speak positively.

In *Tenthredo* the tracheæ were also in tufts, like Pl. III. fig. 4, which represents those of *Tipula*, consisting, however, only of from three to ten tubules. These latter branch several times. However, the tracheæ are far less numerous than in *Bombus*, and have altogether a very different aspect. In *Ophion luteum* (Pl. III. fig. 7) the contrast is still more striking. The tracheæ are few, inconspicuous, and have entirely lost the tufted character. They give off straight branchlets at acute angles; and the end tubules are long, slender, and straight. The branches do not keep each to a single egg-tube, but pass freely from one to another. In *Athalia spinarum* the tracheæ generally resembled those of *Tenthredo*, but they were not in such well-marked tufts. In a small species belonging to the Ichneumonidæ, the tracheæ resembled those of *Ophion*, but the branchlets were waved and twisted instead of straight.

In *Acheta* the tracheæ are much like those of *Ophion*, but on a larger scale. In *Gryllus* I did not get a good view of the tracheæ, and especially not of their terminations. They were more waved than in *Acheta*. In *Locusta* (Pl. III. fig. 6) they were quite different from those of *Acheta*, or, so far as I could see them, of *Gryllus*. The large branches give off short stout branchlets, almost as in *Bombus*, except that they are more waved. The branchlets end abruptly, and give off tufts of tubules, like those of *Tenthredo*. The tubules, however, are smaller in proportion to the branchlets, so as to afford a stronger contrast. Moreover they are less frequently branched. In *Forficula* (Pl. III. fig. 9) I did not see the fine ends. The tracheæ were simply branched; and the branchlets were long, much twisted, and of uniform diameter for considerable distances. In *Carabus* the tracheæ branch dichotomously towards their ends. The systems are rather large. Often two or three fine tubules spring from the side of the branchlets. In *Lucanus cervus* and *Amphimalla solstitialis* I was unable to see the fine tubules. In *Hydrophilus piceus*, *Necrophorus vespillo*, and *N. humator*, the tracheæ were generally in tufts, almost as in *Bombus*, but the tubules far less numerous. In these insects the tubules certainly divide. In *Chrysopa* (Pl. III. fig. 3) the tracheæ end in tufts. The tubules in each are few in number, straight, and divergent like a fan. They often give off one or two still smaller tubules. Except that they are in tufts, they much resemble those of *Ophion*. The tracheæ in *Panorpa*, *Limnephilus*, and I believe also in *Libellula*, resemble those of *Chrysopa*. In *Campæa margaritaria* they are in tufts, as in *Tenthredo*; but the tufts are not above a quarter as large as in that insect. In *Hipparchia* I was only once able to see the tubules. They are represented in Pl. III. fig. 8. Figs. 8′ and 8″ represent all that was visible after intervals of a quarter of an hour. In *Pieris brassicæ* also I was unable to see the finer branchlets. In *Tipula* the tracheæ were like those in Pl. III. figs. 4 & 5. Unlike as are these two figures, the mode of branching is in reality very similar, and would be seen if the tracheæ of fig. 4 were extended as they are on the larger egg-germs. In *Eristalis tenax* and a large species of *Musca* (Pl. III. fig. 2), the tracheæ were intermediate in character between those of *Necrophorus* and *Bombus*.

In a smaller species of *Musca*, however, the tubules in each tuft were less numerous. In *Dioctria flavipes* the tracheæ resembled those of *Tipula* and *Tenthredo*. In *Pentatoma* a single trachea runs up the terminal chamber of each ovary, and gives off branchlets from the side, as in Pl. III. fig. 11. The trachea ends simply. In *Aphrophora spumaria* (Pl. III. fig. 1) we meet with a type quite different from any of the preceding. Large tracheæ proceed to the posterior end of the egg-tubes, where they rapidly break up into branches about $\frac{1}{6000}$th of an inch in diameter. These branches run all up the egg-tube, and half-way along the connecting filament, gradually diminishing in size till they can be seen no longer. They are nearly one-sixth of an inch in length, and do not give off a single branchlet. On one side of an ovary I counted sixty of these branches; and there seemed to be as many on the other side.

In *Ranatra* there are five egg-tubes. One single very large trachea, about $\frac{1}{100}$th of an inch in diameter, passes to the upper end of the egg-tubes, where they reunite to form the common connecting filament, which was first described by Müller. Here the trachea divides into about fifteen large trunks, each of which is about $\frac{1}{500}$th of an inch in diameter. These trunks divide here and there dichotomously, and sometimes give off side branches; but the distribution of air takes place principally by means of small lateral branchlets, which give off numerous long twisted tubes, and sometimes end finally in a small tuft. This continues for about $\frac{1}{10}$th of an inch, when all the trunks except six have exhausted themselves,—each trunk ending in the same manner as one of the lateral branchlets; but at these ends the tubules seem longer and more waved, and are not in tufts.

The six trunks just mentioned pass along the egg-tubes for about $\frac{1}{10}$th of an inch, with a diameter, excluding the so-called outer membrane, of $\frac{3}{2000}$ths of an inch, in which space they do not give off a single branchlet. For about half of this distance the egg-tubes are supplied by the other trunks; but for $\frac{1}{10}$th of an inch after these have ceased, the egg-tubes are left free from tracheæ. For the last $\frac{1}{33}$rd of an inch, the egg-tubes, and after that the oviduct and egg-canal, are supplied by the above-mentioned six trunks, and the mode of branching is the same as at the upper end of the egg-tubes. No tracheæ are given to the generative organs from any other source. The tracheæ on the oviduct are less numerous than those on the egg-tubes, and on the egg-canal they are fewer than on the oviduct.

It is very seldom that we find a whole system of organs supplied, as in this case, exclusively by one great trunk; and it is evident that here the air must pass to and fro in the same vessel.

I was surprised to find *six* large trunks running along the *five* egg-tubes. The two ovaries agreed in this respect; but I have not had an opportunity of examining other specimens, and therefore cannot say whether the number of these trunks varies or not. These six trunks run so far without a branch, and the branchlets arising from the other main trunks are so small in proportion, that the tracheæ have much the same appearance at first sight as those of *Aphrophora*; in that genus, however, the main trachea is at the posterior end, while in *Ranatra* it is at the anterior end, so that it is a case of analogy, and not of homology.

At the end of October, when I examined this insect, there were no traces of egg-germs;

so that I am therefore unable to say what relation they would bear to that part of the egg-tube which is free from tracheæ.

Oviduct.

In *Bombus terrestris* and several other species, the tracheæ of the oviduct frequently anastomose, so as to form meshes. In each mesh is one branch, ending in a tuft. The branchlets composing the tuft are waved, and branch rather often.

In *B. muscorum* the large tracheæ do not anastomose so often as in the other species I have examined.

In *Vespa* they do not anastomose, and the branchlets often ended in tufts, with, however, only a few tubules.

In *Ophion* the oviduct is thrown into folds, and the tracheæ run transversely along them. They are not very unlike those on the ovary; but the branchlets are waved, which is probably necessary on account of the movements of the organ.

In *Tenthredo*, *Locusta*, and *Carabus*, likewise, the tracheæ resemble those on the egg-tubes.

In *Cynips* the tracheæ end in tufts, consisting, however, of but few tracheæ.

In *Ichneumon* and *Forficula* I found no tracheæ on the oviduct.

In *Necrophorus vespillo* and *N. humator* the tracheæ are in tufts as on the egg-tubes, but the tubules are far less numerous and more branched. They are a good deal hidden by the irregularities of the organ, and altogether look very unlike those on the egg-tubes.

In *Libellula* I did not get a very good view of the tracheæ; but they seemed to resemble those of the ovary.

The same is the case in *Panorpa*; but I did not see the tracheæ well in this insect.

In *Eristalis* the tracheæ are, as usual, in large tufts. In *Musca* and *Tipula* also the oviduct is very short, but I saw on it several of the usual tufts.

In *Aphrophora*, on the contrary, they are quite unlike those of the ovary, being much smaller and more delicate. They are, however, long and without very many branchlets.

In *Pentatoma* the tracheæ resemble those on the stomach.

Egg-canal. (Pl. III. fig. 15.)

In *Bombus* the tracheæ do not inosculate as on the oviduct. The distribution of the smaller brachlets, however, is similar; but the tufts are fewer, more elongated, and the tubules also less numerous. In *Vespa* they are nearly the same. In *Ichneumon* it seemed to be free from tracheæ.

In *Gryllus*, *Locusta*, *Carabus*, and *Necrophorus*, the egg-canal is very short.

In *Panorpa* it seemed to have very few tracheæ. In *Eristalis* and *Musca* the tracheæ were in the usual tufts.

In *Aphrophora* and *Pentatoma* they are like those of the oviduct.

Supplementary Glands attached to the Reproductive Organs.

I have already stated that in this paper my attention is confined to the distribution of the respiratory organs. In the names applied to other parts, therefore, I have followed simply the best authorities, without wishing thereby to express any decided opinion of my own as to their functions or homologies.

In *Bombus* we find two sorts of appendages to the reproductive organs. One is the poison-gland, and consists of two long secreting tubes falling into an oval reservoir. On the tubes the tracheæ are in tufts, but are very unlike those on the Malpighian vessels, though the tubes themselves are very like them. On the reservoir the mode of branching is simple and successive. The tubules are straight, or at least gently curved.

Between the ovaries of *Aphrophora spumaria* lies a membranous bag with tracheæ much like those of the ganglia in *Acheta*. In one specimen, however, they were waved.

On the spermatheca of *Bombus muscorum* tracheæ were few, and the mode of branching simple.

In *Hydrophilus piceus* there are certain ramified glands with swollen ends. On these glands the tracheæ resemble those of the stomach.

Heart. (Pl. I. figs. 15, 16 & 17.)

In *Bombus terrestris, muscorum* (Pl. I. fig. 15.), *lapidarius, pratorum*, and *hortorum, Vespa vulgaris*, and *Apis mellifica*, the larger tracheæ branch freely along the margins of this organ, and anastomose frequently with one another and with the neighbouring systems, besides sending branches which run into those of the opposite side. The branches also give out short branchlets, which do not divide nor diminish in size, but terminate suddenly and give off from their end several smaller branchlets, which, again, divide more than once, so as to end in very fine, more or less waved tubules. The branchlets into which a branch divides are often of very unequal size.

This character is, however, not common to all the Hymenoptera; for in *Ophion luteum* and in one of the Ichneumonidæ, though they had in most parts been torn off, yet in one or two places where they remained they divided into more or less waved tubules, by simple successive branching.

This is also the case in *Limnephilus vitratus*, where, however, the tubules were larger; moreover they were much obscured by the surrounding fat.

For the same reason it was difficult to see them well in *Aphrophora*, where, however (Pl. I. fig. 17.), after dividing several times, and generally dichotomously, they appeared to end in a tuft of long and apparently simple tubules.

In the specimens of *Acheta* and *Gryllus viridissimus* which I examined, I was unable to make out the arrangement of the tracheæ; and in *Locusta* I was scarcely more fortunate, but they seemed to end in tufts, almost as in *Aphrophora*.

In *Pentatoma* the distribution was almost the same as on the oviduct, but generally with fewer tubules. They were sometimes waved, sometimes nearly straight.

In *Necrophorus* they branched simply and were straight, or rather with gentle curves. After adding acetic acid, many of them were thrown into waves.

In *Lucanus cervus* they were in folds, long, and with few branches, but all the ends had disappeared, as was also the case in *Carabus* and in *Noctua gamma*.

In *Eristalis*, *Musca* (Pl. I. fig. 16), and *Tipula*, the tracheæ are in small tufts consisting of from three to six tubules. These latter give off smaller ones from their sides.

Fatty Tissue. (Pl. IV. figs. 8, 9 & 10.)

In *Tenthredo* the fatty tissue consists principally of large round cells. The tracheæ are peculiarly straight and stiff-looking; they branch occasionally, and finally end in small tufts of from two to six tubules. In *Vespa* the tracheæ resemble those of *Tenthredo*. In *Bombus muscorum* the branches of the tracheæ have the same straight, even character, and often run for some distance without branching. They end in tufts of straight tubules, which are generally not very numerous and do not branch often.

In *Hydrophilus piceus* also the tracheæ are in tufts.

In the larvæ of *Lampyris* and *Lucanus*, and in *Scarabæus*, the fatty tissue consists of round masses, on which I did not ascertain the mode of distribution of the tracheæ.

In *Forficula* the fatty tissue is in large flakes, here and there running into one another. The tracheæ are long and rather thin in proportion. They branch seldom, and generally at obtuse angles. When the flake is broad, the trachea given to it generally emits several branchlets. When it is narrow and ribbon-like, a small branch generally runs along it, and divides only at long intervals.

In the larva of *Lasiocampa rubi* and of *Mamestra brassicæ*, in *Aphrophora spumaria*, in *Tipula*, and in *Acheta domestica*, the tracheæ are nearly as in *Forficula*, and they break up gradually into a few, long, straight tubules. In *Pentatoma* the tissue consists of thimble-shaped lobules, connected by their bases. A trachea enters each, and breaks up gradually as in Pl. IV. fig. 9. In *Cynips lignicola* (Pl. IV. fig. 10) the arrangement is very peculiar. The tracheæ are shaped like rolling-pins, and scarcely taper at all, being, even at their ends, $\frac{1}{1000}$th of an inch in breadth. From their ends and sides spring numerous fine tubules, about $\frac{1}{10000}$th of an inch in diameter, and as much as, or even more than, $\frac{1}{20}$th of an inch in length. The tubules scarcely ever branch, though in one or two cases I saw a dichotomous division.

Muscles. (Pl. IV. figs. 12 to 18.)

On the muscles of the abdomen in *Bombus* and *Vespa* thus end in tufts.

The thoracic muscles of these two genera have a number of large, parallel, saccular, transverse tracheæ, separated by intervals scarcely greater than their own width. They end suddenly in a number of very short, thick branchlets (Pl. IV. fig. 14); and the saccular branches give off similar little systems from their sides. In *Ophion* the system is similar, though the branchlets are more elongated.

In *Bombus* also the tracheæ of the thoracic muscles are similar; but I could follow the terminal tubules rather further. The thickness of the muscle, however, prevents them from being seen well.

In *Panorpa* (Pl. IV. fig. 12) the tracheæ on the abdominal muscles are straight, and the tubules expand like the rays of a fan. On the muscles of the thorax the tracheæ are sometimes waved; but the mode of branching may be best understood by referring to Pl. IV. fig. 18. In *Athalia spinarum* the tracheæ often end in tufts. The branchlets run across the muscles, and divide like a fan, but rather irregularly. Often the side branchlets diverge at first, and then curve round so as to become subparallel. Sometimes, on the other hand, a side branchlet forms a separate system at right angles, or nearly so, to the first.

On the thoracic muscles of *Chrysopa* the branches end in small fan-like tufts of tubules.

In the larva of *Lasiocampa rubi* the tracheæ are numerous, simply branched, and much waved. In the larva of *Mamestra brassicæ* they are very similar, but straighter.

In *Hipparchia Janira*, *Pieris brassicæ*, and *Amphimalla solstitialis*, the tracheæ break up into straight tubules, which diverge from one another.

In *Eristalis* the thoracic muscles consist of broad ribbon-like tracheæ, which lie parallel, and near to one another, across the muscles. They end in finger-like prolongations, from the end of each of which rises a small tuft of tubules, which are apparently very short. In *Musca* the tracheæ were very similar. In *Tipula* the tubules were longer than in *Musca* or *Eristalis*. In *Necrophorus* the saccular tracheæ resemble those of *Eristalis*; but the tubules are longer.

In the Cricket they resemble those of *Panorpa* (Pl. IV. fig. 18). Some parts more resemble Pl. IV. fig. 12. *Locusta* and *Gryllus* did not apparently differ from *Acheta*.

In the larva of *Acheta* the tracheæ in some parts resemble those of the imago. In parts I found long ribbon-like tracheæ, somewhat as in *Eristalis*; only they are longer, narrower, and further apart. The tubules also which arise from them are long and only branched here and there.

Aphrophora has tracheæ of the usual type. In *Pentatoma* the parallel saccular tracheæ are narrower than in *Eristalis*, being only about $\frac{1}{7000}$th of an inch in diameter. The terminal tubules also seemed longer; but I did not get a very good view of them.

Conclusion.

It would of course be rash to attempt to lay down general laws based on the examination of the few species which as yet I have been able to compare together; but so far as they go, my observations appear to point to the following conclusions.

First, that the same type of distribution regularly occurs in the homologous parts of different specimens belonging to the same species.

Secondly, that the same almost always holds good of homologous parts in different species belonging to the same genus.

Thirdly, that though the general type of distribution is the same in different specimens of the same species, yet the individual tracheæ differ very much,—just, in fact, as we find the general mode of branching is the same in different specimens of the Oak or Birch, though in no two oaks or birches are the various branches and twigs exactly alike.

Fourthly, that while in some insects, as for instance in *Pentatoma*, the tracheæ in many of the different organs have a different type of distribution, in others, as in *Eristalis*, one type is found in most of the different organs. Even in this case, however, the tufts (Pl. I. fig. 16) which end the branchlets, are very different in size in the different parts. A small organ has, as a general rule, more systems of tubules in a given space than a large one; but the relative proportions are, of course, not exact. Moreover, even in this case, some organs (as, for instance, the muscles) are very unlike the remainder.

Fifthly, while in the larva of Orthoptera the tracheæ very closely resemble those of the imago, in those larvæ which undergo a perfect metamorphosis (as, for instance, in those of Coleoptera, Lepidoptera, and Hymenoptera) the tracheæ are very unlike those of the perfect insect.

Sixthly, in these latter larvæ the same type of tracheal distribution appears to be more widely distributed in the different organs. Thus, while in the imago of *Bombus* the tracheæ on the stomach, ilium, and Malpighian vessels are all three very different from one another, the tracheæ on the corresponding organs of the larva of *B. muscorum* are very similar to one another, and as in Pl. II. fig. 11. Again, in the larva of *Lucanus* the œsophagus, stomach, ilium, and colon, and in that of *Lampyris* the stomach, ilium, colon, and Malpighian vessels, had tracheæ respectively like one another.

Seventhly, that in some cases the tracheæ of the larvæ seem to agree in species where those of the perfect insect are different; so that, comparing this with the preceding rule, it would seem that the larval tracheæ are in both respects less differentiated, and more in accordance with the original type than those of perfect insects.

DESCRIPTION OF THE PLATES.

Plate I.

Fig. 1. Tracheæ from ganglion of *Acheta*, × 125.
Fig. 2. Tracheæ from commissure of *Carabus*, × 125.
Fig. 3. Tracheæ from ganglion of *Bombus*, × 125.
Fig. 4. Tracheæ from commissure of *Acheta*, × 125.
Fig. 5. Tracheæ from ganglion of *Pentatoma*, × 125.
Fig. 6. Tracheæ from ganglion of *Carabus*, × 125.
Fig. 7. Tracheæ from commissure of *Lasiocampa*, × 125.
Fig. 8. Tracheæ from œsophagus of *Eristalis*, × 125.
Fig. 9. Tracheæ from sucking-stomach of *Musca*, × 125.
Fig. 10. Tracheæ from cæcum of *Acheta*, × 30.
Fig. 11. Tracheæ from cæcum of *Chrysopa*, × 125.
Fig. 12. Tracheæ from cæcum of *Chrysopa*, × 125.
Fig. 13. Tracheæ from crop of *Carabus*, × 30.
Fig. 14. Tracheæ from œsophagus of *Musca*, × 125.
Fig. 15. Tracheæ from heart of *Bombus*, × 125.
Fig. 16. Tracheæ from heart of *Musca*, × 125.
Fig. 17. Tracheæ from heart of *Aphrophora*, × 125.

Plate II.

Fig. 1. Tracheæ from the stomach of *Musca*, × 125.
Fig. 2. A few of the larger tracheæ from the stomach of *Pentatoma*, omitting the finer branches, × 30.
Fig. 3. Tracheæ from the stomach of *Ophion*, × 125.
Fig. 4. Tracheæ from the stomach of *Acheta*, × 60.
Fig. 5. Tracheæ from the stomach of *Bombus*, × 125.
Fig. 6. Tracheæ from the stomach of *Bombus*, × 125.
Fig. 7. One of the lateral branches from the above figure of *Pentatoma*, showing the fine branchlets, × 125.
Fig. 8. Tracheæ from the stomach of *Mamestra*, × 30.
Fig. 9. Tracheæ from the stomach of *Acheta*, × 30.
Fig. 10. Tracheæ from the stomach of *Vespa*, × 125.
Fig. 11. Tracheæ from the ilium of the larva of *Bombus*, × 125.
Fig. 12. Tracheæ from the ilium of *Tipula*, × 125.
Fig. 13. Small part of the inner membrane of a trachea, showing the spirally thickened rib, *a a a*, × 125.
Fig. 14. Tracheæ of salivary gland of *Pentatoma*, × 125.
Fig. 15. Tracheæ of Malpighian vessel of *Anthophora*, × 125.
Fig. 16. Tracheæ of recurrent intestine of *Aphrophora*, × 30.

Fig. 17. Tracheæ of ilium of *Tenthredo*, ×125.
Fig. 18. Tracheæ of Malpighian vessel of *Tipula*, ×125.
Fig. 19. Tracheæ of Malpighian vessel of *Libellula*, ×30.

Plate III.

Fig. 1. Tracheæ from ovary of *Aphrophora*, ×30.
Fig. 2. Tracheæ from ovary of *Musca*, ×125.
Fig. 3. Tracheæ from ovary of *Chrysopa*, ×50.
Fig. 4. Tracheæ from ovary of *Tipula*, ×125.
Fig. 5. Tracheæ from ovary of *Tipula*, ×125.
Fig. 6. Tracheæ from ovary of *Locusta*, ×125.
Fig. 7. Tracheæ from ovary of *Ophion*, ×30.
Fig. 8. Tracheæ from ovary of *Hipparchia*, ×125.
Fig. 9. Tracheæ from ovary of *Forficula*, ×125.
Fig. 10. Tracheæ from ovary of *Necrophorus*, ×125.
Fig. 11. Tracheæ from ovary of *Pentatoma*, ×30.
Fig. 12. Tracheæ from ovary of *Acheta*, ×30.
Fig. 13. Tracheæ from testis of *Necrophorus*, ×125.
Fig. 14. Tracheæ from testis of *Bombus*, ×125.
Fig. 15. Tracheæ from egg-canal of *Bombus*, ×125.
Fig. 16. Tracheæ from testis of *Melolontha*, ×125.
Fig. 17. Tracheæ from ductus ejaculatorius of *Pentatoma*, ×125.
Fig. 18. Tracheæ from testis of *Musca*, ×125.
Fig. 19. Tracheæ from testis of *Eristalis*, ×125.
Fig. 20. Tracheæ from epididymis of *Bombus*, ×125.
Fig. 21. Tracheæ on a Malpighian vessel of *Libellula*.

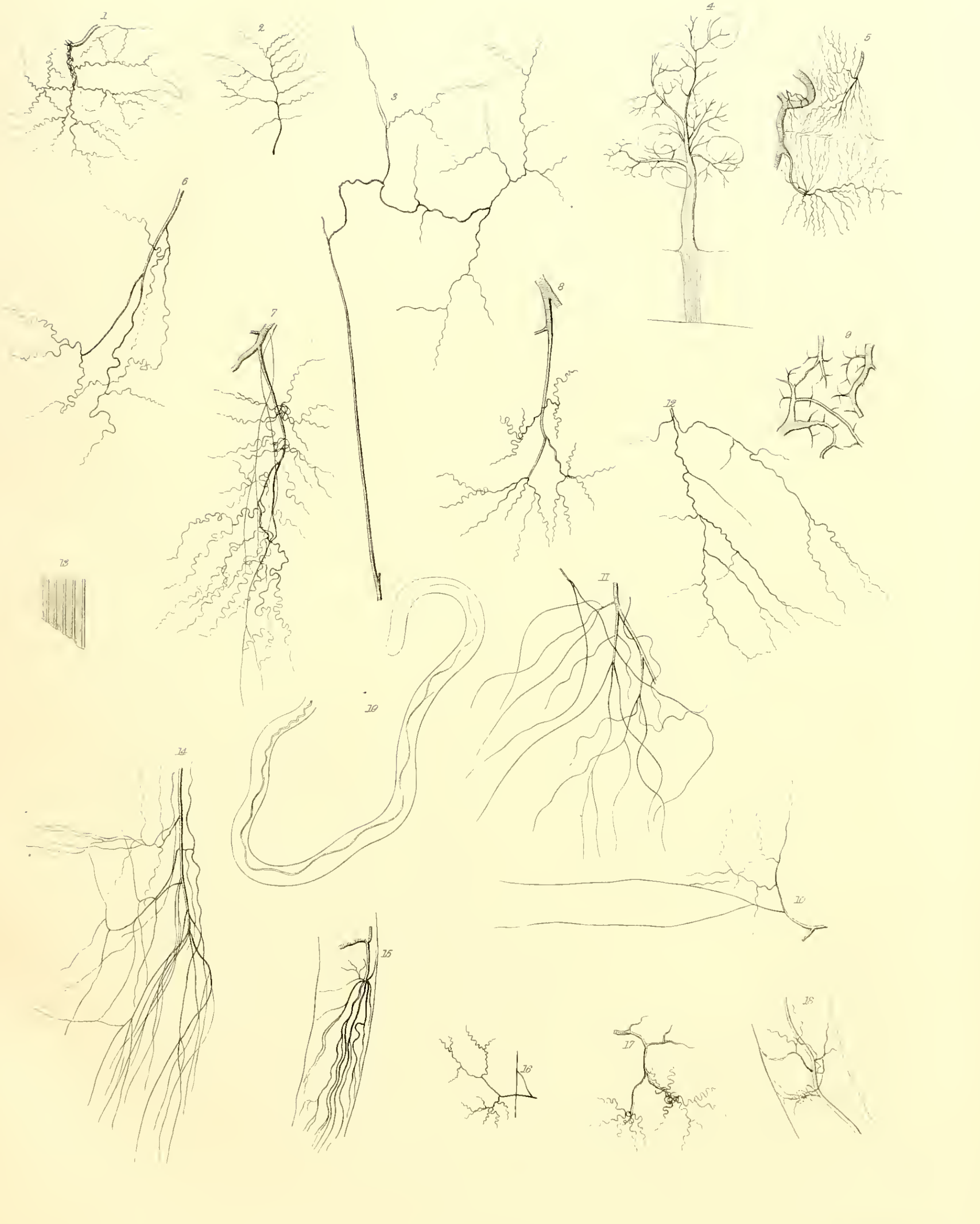
Plate IV.

Fig. 1. Tracheæ from the rectum of *Musca*, ×125.
Fig. 2. Tracheæ from the rectum of *Bombus*, ×125.
Fig. 3. Tracheæ from the rectum of *Pentatoma*, ×125.
Fig. 4. Tracheæ from the rectum of *Chrysopa*, ×125.
Fig. 5. Tracheæ from the rectum of *Vespa*, ×125.
Fig. 6. Tracheæ from the rectum of *Acheta*, ×30.
Fig. 7. Tracheæ from the rectum of *Forficula*, × 30.
Fig. 8. Tracheæ from the fatty tissue of the larva of *Mamestra*, ×125.
Fig. 9. Tracheæ from the fatty tissue of *Pentatoma*, ×125.
Fig. 10. Tracheæ from the fatty tissue of *Cynips lignicola*, ×30.
Fig. 11. Tracheæ from the Malpighian vessel of *Musca*, ×125.
Fig. 12. Tracheæ from the thoracic muscles of *Panorpa*, ×125.
Fig. 13. Tracheæ from the thoracic muscles of the larva of *Acheta*, ×125.
Fig. 14. Tracheæ from the thoracic muscles of *Vespa*, ×125.
Fig. 15. Tracheæ from the abdominal muscles of the larva of *Mamestra*, ×125.
Fig. 16. Tracheæ from the thoracic muscles of *Eristalis*, ×125.
Fig. 17. Tracheæ from the muscles of the larva of *Lasiocampa*, ×125.
Fig. 18. Tracheæ from the thoracic muscles of *Panorpa*, ×125.

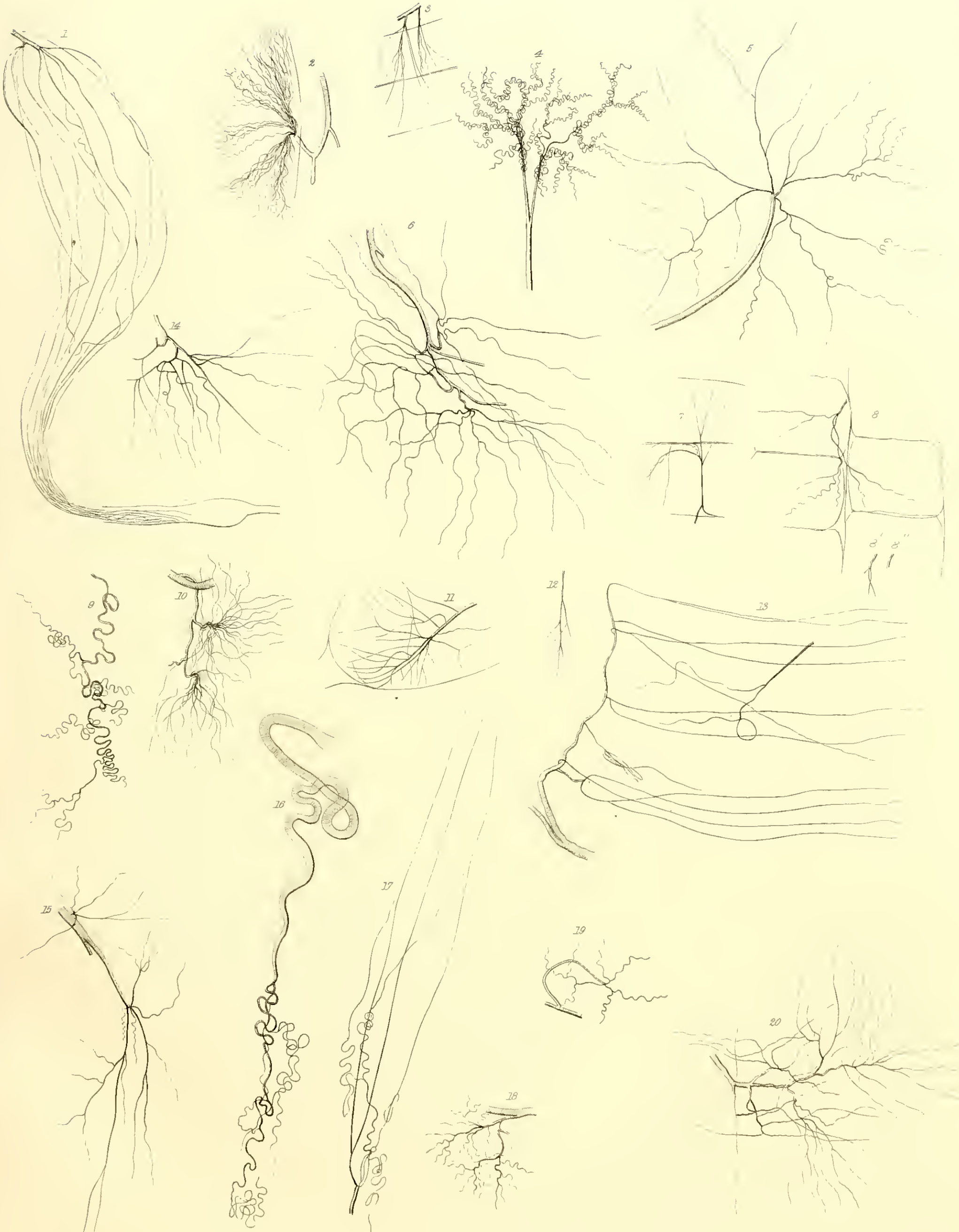
*** It has been found impossible to make the ends of the tracheæ as delicate as they ought to be in proportion.

J. Lubbock, del.

G. Jarman sc

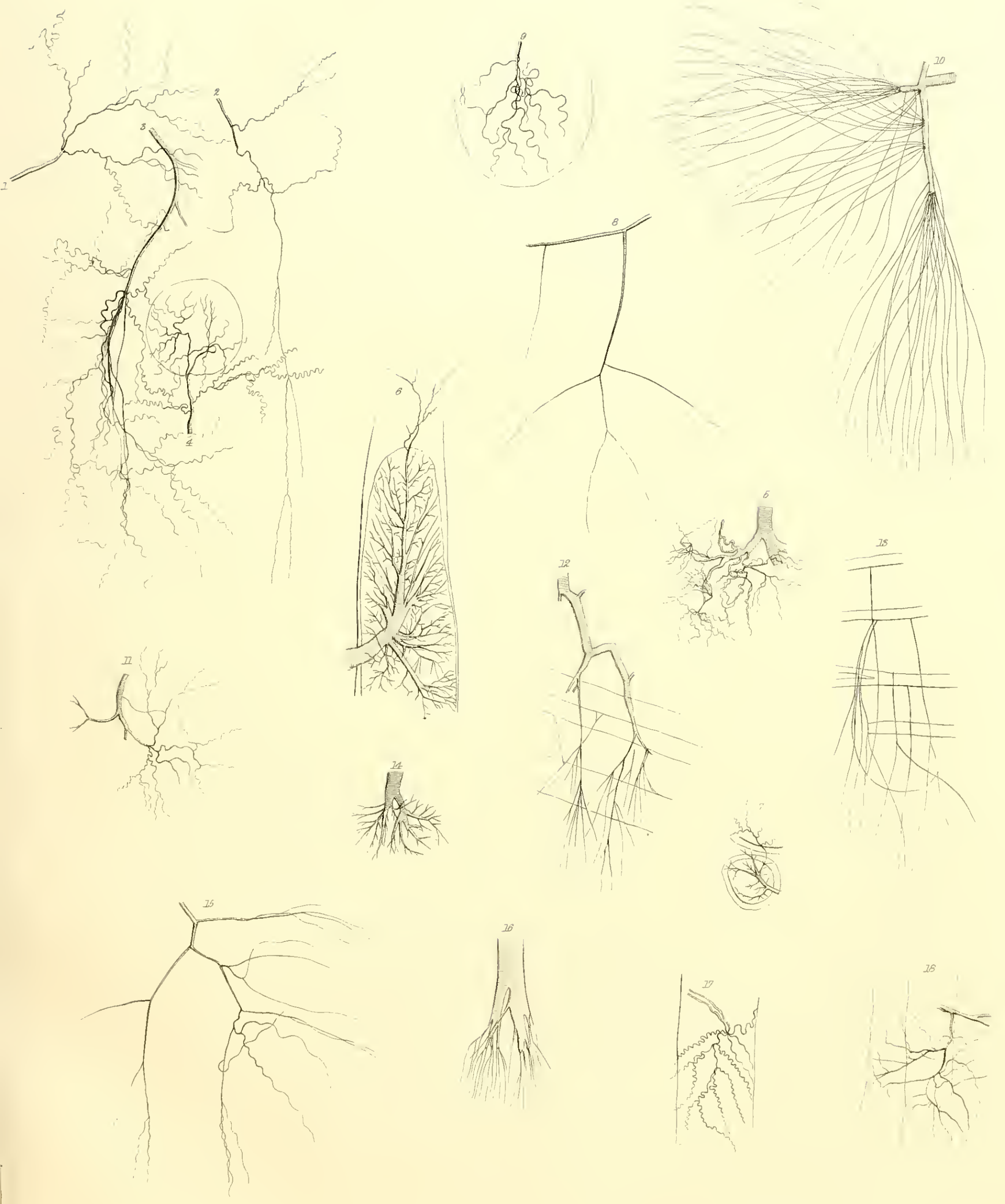


Lubbock. del.



T. Lubbock, del.

G. Jarman sc.



J. Lubbock, del.

G. Jarman, sc.

III. *On some new species of* Musci *and* Hepaticæ *in the Herbarium of* Sir W. J. Hooker, *collected in tropical Africa, chiefly by the late* Dr. Vogel *and* Mr. Barter. *By* William Mitten, *A.L.S.*

Read March 15th and June 21st, 1860.

Leptotrichum, Hampe.

L. nitidulum. Dioicum, gracillimum, humile; foliis erecto-patentibus e basi latiore sensim angustatis lanceolatis obtusiusculis integerrimis, nervo ubique a pagina distincto percurrente, cellulis basi infima majoribus oblongis inde angustis mollibus; perichætialibus obtusioribus; theca in pedunculo trilineari gracillimo luteo erecta, late ovali, ore parvo, operculo subrecte subulato, peristomio dentibus parvis rubris rugulosis solidis, annulo lato composito trigono; planta mascula ramis brevibus floribus gemmiformibus terminatis.—*L. exiguo* simile.

Hab. On the earth. River Niger (*Barter*).

More slender than *L. exiguum* = *Wiessia exigua*, Schw. = *Dicranum xanthodon*, Hook., inhabiting the West Indies and South America, and with more shining pale-green leaves.

Tab. V. fig. 1. 1. Plant (of the natural size); 2. a leaf, 3. the capsule, 4. the same after the fall of the operculum, 5. a portion of the peristome, and 6. a fragment of the annulus seen transversely (all magnified).

Stereodon, Bridel; Mitten, Musc. Ind. Orient. in Linn. Journ. Bot. Suppl. vol. i. p. 92.

S. Barteri, Mitten. Monoicus; foliis imbricatis late ovatis brevi-apiculatis concavis, margine (sicco) recurvo integerrimo, nervis binis brevissimis, cellulis alaribus pluribus quadratis viridibus, superioribus elongatis angustis; perichætio magno; foliis e basi ovata convoluta lanceolatis, internis erectis, paraphysibus exsertis; theca in pedunculo brevi luteo perichætium paululo superante ovali, peristomio dentibus——? —Habitu *S. longiseti*, sed gracilior.

Hab. On trees in deep ravines. Nupe; River Niger (*Barter*, 1422).

Pale yellowish green, shining. Remarkable on account of its very short seta; in other respects closely agreeing in structure with *S. longisetus* = *Neckera longiseta*, Hook.

Tab. V. fig. 2. 1. Plant (of the natural size); 2. a leaf; 3. perichætium, male flower, and capsule (magnified).

Stereophyllum, Mitten, Musc. Ind. Orient. *l. c.* p. 117.

S. nitens, Mitten. Monoicum; foliis elliptico-lingulatis basi contractis apice subacutis, nervo tenui medio evanido, marginibus superne subserratis, cellulis basi ad angulos quadratis inde ad apicem elongatis angustis parietibus crassis; perichætialibus parvis ovatis acuminatis parce serrulatis; theca in pedunculo gracili rubro parva ovali inclinata horizontalive, operculo brevi-rostrato, peristomio interno processibus longitudine dentes æquantibus in membrana ad tertiam partem longitudinis dentium exserta.—Habitu staturaque *S. radiculosi.*

Hab. On decayed wood, Fernando Po (*Barter*).

Very nearly resembling *S. radiculosum* = *Hookeria radiculosa*, Hook. Musc. Exot. t. 51; but with leaves of a more equal width above and below the middle, and contracted at the base, the margin slightly serrulate, and the upper cells elongate. *S. schistocalyx* (*Hypnum*), C. Müller, has shorter leaves, more sharpened above, and with the upper cells nearly round.

Tab. V. fig. 3. 1. Plant (of the natural size); 2. a leaf; 3. capsule; 4. perichætium and male flower; and 5. a portion of the peristome (all magnified).

S. rivulare, Mitten. Ramis elongatis; foliis subcompressis ovato-lingulatis acutis basi contractis, nervo crasso paulo infra apicem evanido, marginibus superne erosis; cellulis superioribus minutis ovalibus obscuriusculis, basi brevioribus subquadratis.—*S. radiculoso* robustius.

Hab. On rocks in small rivulets at the bottoms of ravines. Nupe; River Niger (*Barter*, 1420).

In the firmer substance of its leaves allied to *S. radiculosum*, but a larger moss, with leaves more narrowed below, and more acute at their apices.

Tab. V. fig. 4. 1. Plant (of the natural size); 2. a leaf (magnified).

Neckera, Hedw.

N. foveolata, Mitten. Monoica; foliis perichætialibus inferioribus parvis apicibus patulis, interioribus magnis latis ellipticis, vaginantibus, acumine elongato patulo; theca ovali-cylindracea brevi-pedicellata immersa, operculo acuminato-rostrato, calyptra mitriformi vel uno latere fissa ramentis obtecta.—*N. undulatæ* simillima.

Pilotrichum undulatum, Beauv. Prodr.

Hab. Afrique (*Beauvais* in Hb. Hooker.).

Very closely resembling *N. undulata*; but its perichætium entirely different, the ramenta (*i. e.* leaf-like paraphyses) being absent. According to a specimen marked *Daltonia*? (*Neckera*) *undulata*, from the herbarium of Dr. W. Arnott, this species is found also at Rio de Janeiro.

Tab. V. fig. 5. 1. Plant (of the natural size); 2. a leaf; 3. perichætium, capsule, and male flower (all magnified).

N. flagellacea, Mitten. Caule primario repente, ramis arcuatis prolifero-ramosis pinnatis bipinnatisve filicinis planis compressis, ramulis apicem versus decrescentibus, sæpe in filum elongatum productis; foliis in caulis parte stipitiformi erectis appressis ovatis acuminatis subenerviis, superioribus lateralibus, caulinis ramulinisque divaricatis latissime ovatis asymmetricis obtusiusculis obtusisque apiculo parvo terminatis, marginibus ubique crenulatis, nervo supra medium desinente; cellulis inferioribus elongatis angustis, superioribus rotundatis minutis firmis.

Hab. River Niger (*Barter*).

In size and appearance resembling *Neckera Korthalsiana*, Dzy. et Molk. Bryol. Surinam. t. ix.; but its branches more regularly pinnate, and its leaves shorter, with a different areolation.

Tab. V. fig. 6. 1. A branch (of the natural size); 2. a lateral leaf from the middle of the branch, 3. a leaf from the ramuli (both magnified).

Leskea, Hedw.

L. subfalcata, Mitten. Monoica; foliis caulinis hastato-subulatis caulem vestitum latitudine æquantibus, e basi patula erectis, marginibus minutissime crenulatis subintegerrimis, nervo valido in apice evanido, cellulis minutis rotundatis obscuriusculis; rameis ramulinisque subfalcatis patenti-incurvis compressis ligulato-lanceolatis, apicibus latis subacutis, nervo pallido sub apice evanido, marginibus minutissime crenulatis, dorso minute papillosis; perichætialibus e basi ovali longe subulatis attenuatis integerrimis, nervo percurrente, cellulis elongatis pellucidis; theca in pedunculo rubro asperrimo.—*L. gratæ* simillima.

Hab. Moist rocks. Onitscha; River Niger (*Barter*, 1424).

Closely resembling *L. grata*, which was also gathered by Mr. Barter, but distinguished by the leaves of its ramuli being ligulate and not ovate, and by its entire perichætial leaves.

Tab. V. fig. 7. 1. Plant (of the natural size); 2. a cauline leaf, 3. a leaf from the branches, 4. perichætium and male flower (magnified).

L. Nigeriana, Mitten. Monoica synoicave, caule foliolis vestito; foliis patentibus hastato-ovatis acutis, nervo percurrente, marginibus minute crenulatis, cellulis rotundatis minutis obscuris papillosis; rameis divergentibus complanatis parum asymmetricis ovato-lanceolatis acutis, nervo sub apice evanido, marginibus crenulatis; perichætialibus erectis, e basi lata ovata longe (interdum subito) in subulam contractis, angulis paucis crenatis integerrimisve; theca in pedunculo elongato rubro asperrimo ovali horizontali cernuave, operculo subulato æquilongo; peristomio externo dentibus valde trabeculatis, interno processibus subsolidis ciliis in unum coalitis æquilongis interpositis.—*L. gratæ* similis.

Hab. River Niger (*Vogel*).

Resembling very nearly *L. grata*=*Hypnum gratum*, Beauv.; but its branches more generally simple, cauline leaves not incurved from a patent base, those of the ramuli longer, divergent, and very much compressed, the perichætial leaves longer and not lacerate. From *L. subfalcata* it differs in the form of its cauline, and less ligulate ramuline leaves.

Tab. V. fig. 8. 1. Plant (of the natural size); 2. a leaf from the stem, 3. a leaf from the branches, 4. a perichætial leaf, 5. capsule (magnified).

Callicostella, Mitten, Musc. Ind. Orient. *l. c.* p. 136.

C. africana, Mitten. Synoica, habitu staturaque *C. Merkelii*; foliis in series denas dispositis compressis, marginibus e medio ad apicem argute serrulatis, nervis binis ad apicem percurrentibus ibique dorso serrulatis papillosis; seriebus tribus dorsalibus reliquis dimidio fere brevioribus erecto-patentibus appressis ovatis obtusis breviacuminatis, cellulis parvis abbreviatis fere rotundatis subobscuris; seriebus lateralibus utrinque binis patenti-divergentibus e basi ovata uno latere inflexo-lingulatis obtusis apiculo brevi semitorto, cellulis superioribus oblongis, inferioribus laxioribus prosenchymaticis; serie ventrali media cauli parallela appressaque ovato-lanceolatis breviacuminatis, cellulis laxis prosenchymaticis fere lævibus; perichætialibus patentibus e basi ovata in acumen lanceolatum angustatis; theca in pedunculo elongato flexuoso rubro lævi apice (sicco) ruguloso ovali cernua; operculo subulato æquilongo; peristomio satis magno, dentibus medio linea pallidiore notatis valde trabeculatis crassis, interno processibus paulo longioribus solidis in membrana ad tertiam partem dentium longitudinis producta; calyptra superne scabra.

Hab. River Niger (*Vogel*); Nupe (*Barter*).

Leaves narrower than in any of the described species; seta smooth below, appearing slightly rough in the upper part when dry.

TAB. V. fig. 9. 1. Plant (natural size); 2. leaves, *a.* lateral, *b.* dorsal, *c.* ventral; 3. perichætial leaf, 4. the capsule, 5. calyptra (all magnified).

FISSIDENS, Hedw.

F. VOGELIANUS, Mitten. Monoicus, caule brevi; foliis patentibus elongate lanceolatis siccitate vix mutatis ubique tenuiter marginatis, lamina vera ultra medium producta, nervo obscuro percurrente, cellulis distinctis iis laminæ apicalis diametro circiter $\frac{1}{2000}$ unciæ mensura; theca in pedunculo gracillimo quadrilineari suberecta ovali, operculo subulato æquilongo, peristomio generis, flore masculo gemmiformi ad pedem rami fœminei.

Hab. River Niger (*Vogel*).

A small species agreeing in size and habit with the Javan *F. Zollingeri*, but with leaves of a firmer substance, of an obscure olive-brown colour.

TAB. V. fig. 10. 1. Plant (natural size); 2. the same, and 3. a leaf (magnified).

F. OPACIFOLIUS, Mitten. Monoicus, caule brevi; foliis patentibus late lanceolatis acutis siccitate non mutatis, lamina vera ad medium producta subinæquali crassiuscule hyalino-marginata, lamina apicali latiuscula dorsalique tenuiter crenata, cellulis opacis obscuris, nervo pellucido luteo percurrente; theca in pedunculo bilineari ovali erecta, operculo subulato, peristomio generis, calyptra basi integra papillosa, floribus masculis gemmiformibus in foliorum caulinorum axillis reconditis.

Hab. River Niger (*Vogel*); Natal (*Guenzius*).

The opaque rather broad leaves, pellucid nerve, and strongly margined border of the true leaf distinguish this species from its allies. The calyptra resembles that of *F. serratus* from the Nilgiri Mountains.

TAB. V. fig. 11. 1. Plant (natural size); 2. the same, 3. a leaf, 4. calyptra (all magnified).

F. RAMULOSUS, Mitten. Dioicus? caule fertili brevi, ramis gracilioribus e basi egredientibus ramoso; foliis patentibus siccitate crispatis lanceolatis immarginatis, lamina vera ad medium producta apice subinæquali, nervo subpellucido percurrente, marginibus ubique tenuiter crenatis, cellulis minutis obscuris diametro $\frac{1}{4000}$ unciæ metientibus; theca in pedunculo trilineari gracillimo ovali erecta, operculo subulato, peristomio generis, calyptra basi integra lævi.

Hab. River Niger (*Vogel*).

Allied to *F. elegans*, Schw., but with a different habit. From *F. opacifolius* it differs in the absence of margin to the true leaves, as well as in their form and in the inflorescence, and also in the smooth calyptra.

TAB. V. fig. 12. 1. Plant (natural size); 2. the same, 3. leaf, 4. calyptra (magnified).

F. sciophyllus, Mitten. Monoicus, statura *F. bryoidis*; foliis patentibus oblongo-ellipticis latiusculis acutis, nervo pallido percurrente, lamina vera ad medium producta, omnibus laminis immarginatis tenuiter crenulatis, cellulis opacis; theca in pedunculo gracillimo ovali subæquali siccitate urceolata; flore masculo in apicibus ramorum.

Hab. Interior of Africa (*Mungo Park*).

Nearly allied to *F. opacifolius*, but the lamina vera is without the hyaline margin, and the inflorescence and capsule are different; it is also allied to *F. Hornschuchii*, Mont., and agrees with it in inflorescence, but the structure of the leaves is not the same.

Tab. VI. fig. 13. 1. Plant (natural size); 2. the same, 3. leaf (magnified).

F. curvifolius, Mitten. Dioicus? humilis, gracilis; foliis plurijugis patentibus falcato-curvatis elliptico-lanceolatis, nervo pallidiore sed obscuro percurrente, lamina vera supra medium producta, lamina dorsali in caulem decurrente, omnibus laminis immarginatis tenuissime crenulatis integerrimisve, cellulis minutis obscuris diametro circiter $\frac{1}{3000}$–$\frac{1}{4000}$ unciæ mensura; theca in pedunculo gracili luteo? ovali inclinata, operculo subulato.

Hab. On the earth. Niger (*Vogel*).

Almost intermediate between the species which, without any margination to the apical lamina, have their leaves entire or crenulate; in the present the crenulation is indistinct, but the cells, although obscure, are distinguishable, and, together with the form and flexure of the leaves and inclined capsule, distinguish it from its allies.

Tab. VI. fig. 14. 1. Plant (natural size); 2. the same, 3. leaf (magnified).

F. ripensis, Mitten. Cæspitosus, caule elongato; foliis patentibus siccitate parum mutatis ligulato-lanceolatis acutis, nervo percurrente, lamina vera ad medium producta apice inæquali, lamina dorsali basi contracta, omnibus laminis immarginatis tenuiter crenulatis, cellulis distinctis diametro circiter $\frac{1}{2000}$ unciæ metientibus.

Hab. On moist rocks. Niger (*Barter*).

This appears to be the largest known species belonging to the group with immarginate crenulate leaves, and is easily known by its distinct and pellucid areolation.

Tab. VI. fig. 15. 1. Plant (natural size); 2. portion of stem and leaves (magnified).

F. gladiolus, Mitten. Dioicus? humillimus, parvulus; foliis circiter trijugis anguste lanceolatis sensim angustatis acutis, nervo intensius colorato percurrente, lamina vera ad medium producta, omnibus laminis immarginatis integerrimis, cellulis elongatis laxiusculis distinctis; foliis perichætialibus lamina vera apice inæquali, uno latero libero; theca in pedunculo gracillimo ovali inclinata, operculo brevirostrato.

Hab. Interior of Africa (*Mungo Park*).

This minute slender species is remarkable for its narrow, loosely areolate leaves. The whole plants are about three lines high.

Tab. VI. fig. 16. 1. Plant (natural size); 2. the same, 3. leaf (magnified).

F. porrectus, Mitten. Cæspitosus, caule elongato rubro; foliis patentibus siccitate immutatis elliptico-lanceolatis acuminatis, acumine ad caulis apicem leniter curvato, nervo percurrente, lamina vera ad medium producta, omnibus laminis margine obscuriore subopaco limbatis, cellulis distinctis diametro circiter $\frac{1}{2000}$ unciæ metientibus.

Hab. On moist rocks. Niger (*Barter*).

Growing in large patches, of a fresh green colour, here and there tinged with red, slightly glossy, in appearance nearly resembling *F. rigidulus*, H. f. et W., but with a margin, although distinctly cartilaginous, like the nerve obscure. The fructification is evidently terminal, from the presence of archegonia on a few of the stems; but the perichætial leaves have no difference in form from the cauline.

Tab. VI. fig. 17. 1. Plant (natural size); 2. portion of the stem and leaves (magnified).

F. flaccidus, Mitten. Dioicus? statura *F. palmati*; foliis patentibus flaccidis late elliptico-lanceolatis apice acutis, nervo debili sub apice evanido, lamina vera ad medium producta, omnibus laminis hyalino-marginatis; cellulis oblongis longitudine circiter $\frac{1}{1000}$, latitudine $\frac{1}{2000}$ unciæ mensura, pellucidis; theca in pedunculo gracili rubro ovali erecta, operculo subulato.

Hab. On the earth. Niger (*Vogel*).

Similar to *F. palmatus*, Sw., but with an erect capsule and less acuminate leaves. From the other African species it is readily known by its lax areolation.

Tab. VI. fig. 18. 1. Plant (natural size); 2. the same, 3. leaf, 4. young calyptra (all magnified).

F. Parkii, Mitten. Dioicus? perpusillus; foliis 4–5-jugis patentibus ambitu late elliptico-lanceolatis obtusiusculis, nervo concolori percurrente, lamina vera ultra medium producta, lamina dorsali supra basin evanescente, omnibus laminis immarginatis integerrimis, cellulis minutis subobscuris diametro circiter $\frac{1}{5000}$ unciæ metientibus; foliis perichætialibus lateribus laminæ veræ inæqualibus, uno latere apice libero in nervum ascendente; theca in pedunculo brevi erecta æquali brevi ovali.

Hab. Interior of Africa (*Mungo Park*).

Yellowish green. Scarcely two lines high. The seta of the same length as the perichætial leaves. This is probably the species gathered by Park when reduced to a deplorable state, and the contemplation of which so revived him as to enable him to proceed and obtain succour. It will be easily seen that it is remote from the European *F. bryoides*, to which it was formerly referred, and that it is more nearly allied to *F. asplenioides*, Sw., and *F. obtusifolius*, Wils.

Tab. VI. fig. 19. 1. Plant (natural size); 2. the same, 3. leaf (magnified).

Pogonatum, Brid.

P. flexuosum, Mitten. Foliis e basi latiore erecta angustatis longe loriformi-lanceolatis latiusculis acutis patentibus, siccitate incurvis falcatisve rigidis, nervo dorso superne serrato, margine a basi ubi angustare incepit serrato, pagina superiore fere toto lamellis brevissimis vix conspicuis obtecta; floribus masculis foliis internis brevioribus latioribusque.—*P. convoluto* simile.

Hab. Niger (*Barter*).

Intermediate between *P. convolutum*, Brid. and *P. macrophyllum*, Dzy. et Molk. In the firm substance of its leaves it agrees with the first, but their outline is more nearly that of the last-named species. The specimens vary from 4 to 5 inches in height.

TAB. VI. fig. 20. 1. Plant (natural size); 2. leaf (magnified).

PLAGIOCHILA, Nees et Mont.

P. NECKEROIDEA, Mitten. Caule repente, ramis iterato dichotomis; foliis basi imbricatis divaricatis ovato-lanceolatis apice obtusis bidentatisve, margine dorsali recurvo integerrimo, ventrali apiceque parce dentatis, cellulis parvis oblongis interstitiis angustis; involucralibus dentibus spinosioribus; perianthio obovato truncato compresso, labiis spinoso-dentatis.

Hab. On trees. Niger (*Barter*).

Very nearly resembling *P. abrupta*, L. et L., but with leaves composed of cells very much smaller and with thin walls. From *P. disticha*, L. et L. (gathered also by Barter), it is immediately distinguished by the plants being scarcely altered when dry, and the different form of the perianth. The more robust stems have much the appearance of *P. cristata* Sw., but they are far smaller and the leaves are not cristatebehind.

TAB. VI. fig. 21. 1. Plant (natural size); 2. leaves, 3. perianth and involucral leaf (magnified).

CHILOSCYPHUS, Corda.

C. OBLONGIFOLIUS, Mitten. Caule repente parce ramoso; foliis horizontalibus divergentibus oblongis parallelogrammaticis apice integris sinuatis uni- bi- tridenticulatis, cellulis interstitiis obscuris grossiusculis, amphigastriis parvis bipartitis laciniis extrorsum unidentatis, uno latere in folium anguste decurrente; perianthio (juvenili) laciniis dentatis.

Hab. On moist rocks, Onitscha; and on oil palms, Brass; Niger (*Barter*).

Dark brown. In size and habit resembling the Oriental *C. argutus*, Nees, but with leaves of a different substance and truncate at their apices.

TAB. VI. fig. 22. 1. Plant (natural size); 2. portion of stem with leaves and amphigastria; 3. the perianth spread open.

LEPIDOZIA, Nees, Ldbg. et Gottsche.

L. SUCCIDA, Mitten. Caule procumbente inordinate pinnato, ramis decurvis flagelliformi-attenuatis; foliis caulinis erecto-patentibus caulem latitudine vix superantibus ovali-oblongis, apice inæqualiter brevi bi- tri- quadridentatis, amphigastriis parvis quadripartitis; rameis majoribus imbricatis rhomboideo-ovalibus, apice superiore sinu parvo bidentatis, cæteroquin integerrimis, amphigastriis parvis trifidis, cellulis oblongis magnis pellucidis.

Hab. On moist rocks. Nupe; Niger (*Barter*).

Somewhat resembling *L. Wallichiana*, Gottsche, and *L. centipes*, Taylor, but remarkable for the rhomboidal subentire leaves of its branches.

TAB. VI. fig. 23. 1. Plant (natural size); 2. a portion of the stem, 3. portion of a branch with leaves (magnified).

Lejeunia, Gottsche et Ldbg.

(*Phragmicoma.*)

L. excavata, Mitten. Ramis cæspitosis dichotome ramosis; foliis divaricatis imbricatis rotundatis, apice decurvis sinu parvo minute bidentatis, basi lobulo oblongo unidentato complicato, amphigastriis appressis orbiculatis foliis dimidio minoribus, cellulis parvis rotundatis; involucralibus conformibus, lobulis minoribus; perianthio oblongo obtuso appresso, dorso concavo, ventre convexo, lævi.

Hab. On trees. Niger (*Barter*).

In size and appearance resembling *Omphalanthus geminiflorus,* Nees, but more nearly allied to *Phragmicoma Mackaii,* Dumort.

Tab. VI. fig. 24. 1. Plant (natural size); 2. portion of stem with leaves and amphigastria; 3. perianth and involucral leaves; 4. transverse section of perianth.

(*Acrogonia.*)

L. astroidea, Mitten. Epiphylla, maculas astroideas formans; foliis patentibus rhomboideis integerrimis, angulo externo superiore acuminato, inferiore rotundato lobulo minuto inflexo; cellulis heteromorphis, minoribus rotundatis interstitiis crassiusculis, majoribus 3–5-seriatim inordinatimve per folium dispositis, una majore semper in angulo inferiore partim a lobulo obtecta; amphigastriis alternis ad basin in lacinias duas patentes subulatas divisis.

Hab. On living leaves. Niger (*Barter*).

Loosely appressed to the surface of the leaves, in company with a species of *Radula* which, in so far as it can be judged of in a barren state, does not differ from *R. Grevilleana,* Taylor. This *Lejeunia* evidently belongs to the same curious section as *L. Krausiana* and a number of other tropical species, for the most part growing on the surface of leaves, and producing a turbinate pentagonal perianth, the angles being more or less produced into a horn-like point.

Tab. VI. fig. 25. 1. Plant (natural size); 2. portion of stem with leaves and amphigastrium (magnified).

Anthoceros, Micheli.

(*Notothylas,* Sullivant.)

A. decurvus, Mitten. Fronde pusilla planiuscula ambitu radiatim lobata, lobis sinuatis dentatisque, involucris brevibus decurvis lacinulis sparsis vestitis, capsula inclusa subsessili, sporis luteis, columella nulla.

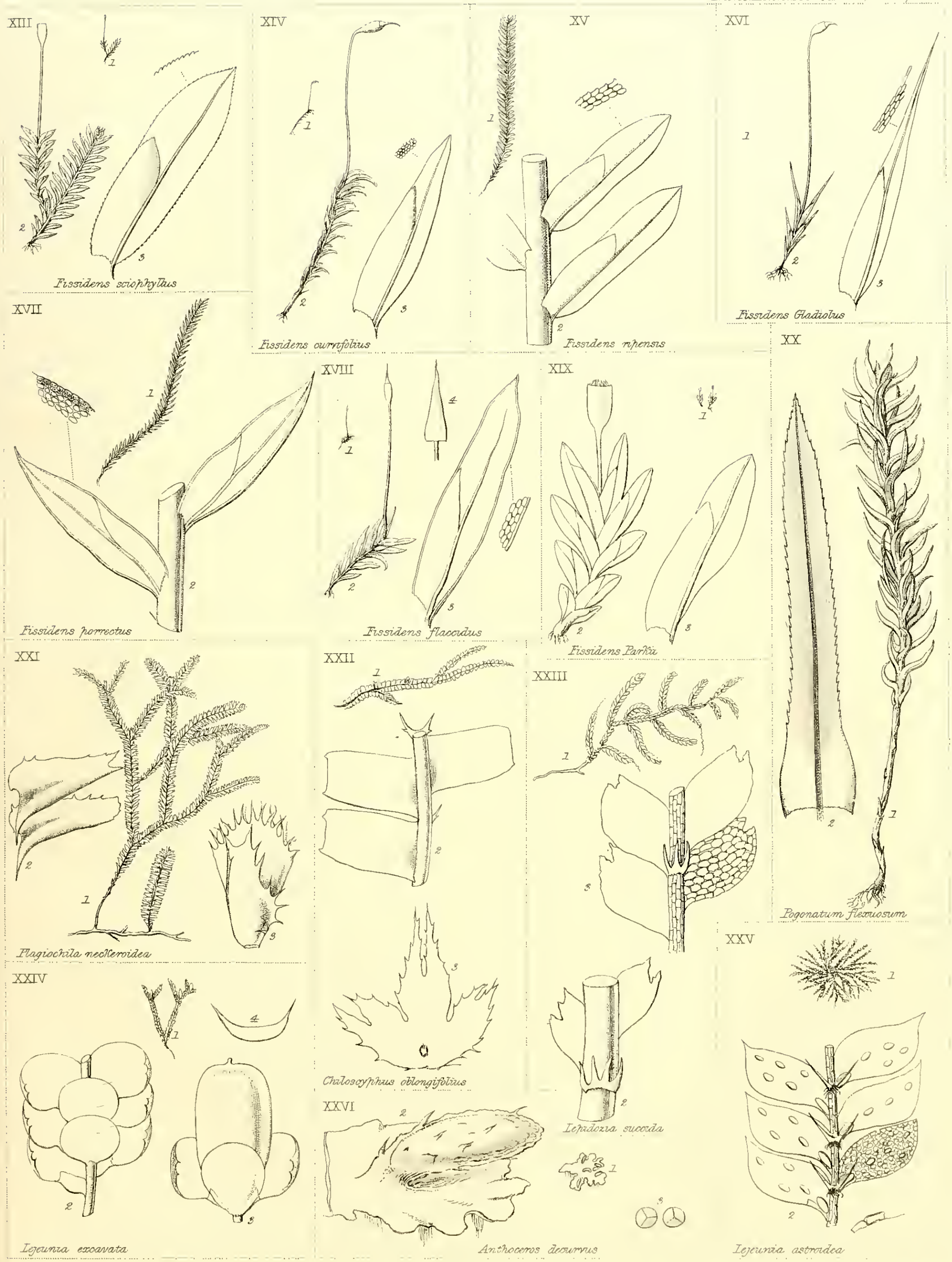
Hab. On the earth with a *Riccia.* Niger (*Barter*).

Resembling *Notothylas valvata,* Sullivant (in 'Memoirs of the American Academy of Arts and Sciences,' vol. iii. new series, pl. 4); but, in proportion to the size of the frond, the involucra are much smaller. The capsule is not protruded in the few specimens examined, but seems entirely enclosed in the involucre; no trace of the suture or columella was visible. *Anthoceros Brentelii,* Gottsche, found in the West Indies, is another species of this curious group; its capsule is protruded, and opens with a suture.

Tab. VI. fig. 26. 1. Plant (natural size); 2. a portion with an involucre, 3. spores (magnified).

W. Mitten, del.

G Jarman, sc



W. Mitten, del — G. Jarman sc

IV. *Further Researches on* Tomopteris onisciformis, *Eschscholtz*. *By* William B. Carpenter, *M.D., F.R.S., F.L.S., F.G.S., and* Edouard Claparède, *M.D., Fellow of the Physical Society of Geneva.*

Read January 19th, 1860.

HAVING been fortunate enough to capture a considerable number of specimens of this interesting Annelid during our joint sojourn at Lamlash Bay, Arran, during the month of September last, and having been able to add much to the knowledge previously obtained of its organization and reproduction, we have agreed to lay the results of our observations before the Linnean Society, in the form of a continuation of the memoir already communicated to it by one of us, and printed in its Transactions (vol. xxii. p. 353). Although we have much to add, we find nothing to correct in any of the positive statements of fact which that memoir contained; and we have the satisfaction of bearing our joint testimony, based on a renewed comparison of Mr. George West's delineations with the objects from which they were taken, in regard to the truthfulness with which they represent the conformation of this interesting animal*.

In the first place, with respect to the specific diversity affirmed by Drs. Leuckart and Pagenstecher † to exist between *Tomopteris onisciformis* and *T. quadricornis*, chiefly on the ground of the presence in the latter of a pair of cephalic appendages not possessed by the former, we have to state that the conviction already expressed by one of us ‡ as to the insufficiency of this character has been fully borne out by our subsequent observations, which have entirely satisfied us that the presence or absence of the appendages in question depends solely upon the grade of development which the individual has attained. We have been led, however, by certain minute differences between the organization of the *Tomopteris* described by Leuckart and Pagenstecher, and that of the *Tomopteris* which we have studied, to suspect that the forms we have severally described under the designation *T. onisciformis* may not be specifically identical.

The *T. onisciformis* and the *T. quadricornis* of Leuckart and Pagenstecher both possess that remarkable pair of "frontal horns," projecting laterally from the most anterior part of the head, which, as Mr. Huxley has remarked, give to the animal the aspect of a hammer-headed shark; and they both possess that pair of greatly elongated appendages designated in the former memoir as the "styliform," but which we now prefer to term the *second antennæ*. These organs are far longer, relatively as well as absolutely, in the

* In transferring these figures to copper, and in reducing their scale, the engraver has imparted to them a hardness and stiffness which the originals do not possess; and has also, by too deeply shading them, destroyed the effect of *transparency* which the artist had aimed to give.

† Müller's Archiv, 1858, p. 588.

‡ See vol. xxii., supplemental note in p. 362.

advanced stage of the life of *Tomopteris* than in the earlier (compare figs. 1 and 6 of Plate LXII. vol. xxii.); and we have found that this difference results from a gradual increase in their proportional length, which bears a constant relation to the stage of development attained by the body. In an example of this type which we believe to be one of the earliest yet met with (fig. 14, Pl. VII.), these second antennæ (*b*, *b*) were very short, and presented a much nearer resemblance to the ordinary lateral appendages of the body than they do at a later period. But the distinction between *T. onisciformis* and *T. quadricornis* is mainly rested by Drs. Leuckart and Pagenstecher upon the absence in the former of the pair of cephalic appendages borne by the latter, between the "frontal horns" and the "second antennæ;" these, which were designated in the former memoir as the "second pair of horn-like appendages," will now be spoken of by us as the *first antennæ*, since it is clear that they have more relation to the pair of appendages immediately behind them than to those in advance of them. For, in common with the "second antennæ," they are setigerous, each of them bearing two setæ within its terminal portion (fig. 6); and in the early form just now alluded to, in which the "frontal horns" were entirely wanting, these first antennæ were of such a length as to be the principal appendages of the head (*a*, *a*, fig. 14). A careful study of the successive stages of the development of *Tomopteris*, in fact, makes it obvious that these *first antennæ* are to be considered as *larval*, and the *second* as characteristic of the *adult*; for the former progressively diminish in relative size, and at last (in most cases) disappear altogether, whilst the latter progressively increase both absolutely and relatively. In the stage represented in fig. 1, Plate LXII. (vol. xxii.), which seems to correspond to the *T. quadricornis* of Leuckart and Pagenstecher, the setigerous portion of the first antennæ is separated from the basal by a constriction which suggests the idea of an articulation (Pl. VII. fig. 6. *a*); about the time when the caudal appendage begins to be developed, the setigerous portion usually detaches itself, while the basal part remains as a mere knob or tubercle; and in the most advanced forms, this tubercle is commonly found to have entirely disappeared. A vestige of it, however, is still to be seen in some specimens; and it would appear, not only from the observation made by one of us last year, but also from the mention of these appendages by Mr. Huxley (p. 359), who described and figured them as "long, curved, spine-like processes arising from the ventral surface of the narrow neck," that these first antennæ are occasionally retained even in the stage of advanced development. It is obvious, therefore, that no distinction between *Tomopteris onisciformis* and *T. quadricornis* can be drawn from the presence or absence of the first antennæ; and if no other constant and important characters of difference can be specified than such as clearly arise out of the respective ages of the specimens, the last-named species must be abolished.

In stating the other additional results of our observations, we shall for the most part enumerate these, for the sake of convenience, in the order in which they occured to us in proceeding from before backwards along the body of the animal.

In the advanced specimens (by which we mean those in which the caudal prolongation is beginning to show itself), the head bears on its dorsal surface a pair of *ciliated epaulettes* (Pl. VII. fig. 5. *a*, *a*), which extend over the edges of the bilobed nervous ganglion. These, at a certain stage of development, are fringed with long cilia both at their margins and at their base; but the cilia are only occasionally to be seen in activity; and we suppose it to have been either from the absence of the cilia, or from their not having been in motion, that they escaped the notice of Mr. Huxley, who describes the epaulettes as rounded elevations on either side of the narrow neck, from which a sort of band or ridge runs back upon the dorsal surface (vol. xxii. p. 359). No trace of these organs is to be seen in the earlier stages of the animal's life.

The lens-like body in each of the pair of *ocelli* (fig. 12. *b*, *b*) which are seated upon the bilobed ganglion, is not single but double, as has been already stated by Leuckart and Pagenstecher.

We were able clearly to distinguish the spheroidal cells of which the bilobed ganglion is composed; and in its anterior part we noticed (as Leuckart and Pagenstecher had previously done) a pair of vesicles imbedded in its substance (fig. 12. *a*, *a*). These vesicles are nucleated; but we could not distinguish either otoliths or ciliary movement in their interior. How far they are to be considered as analogous to the auditory vesicles of other Invertebrata, we are therefore unable at present to determine.

After a careful search for *nerve-fibres* in connexion with these ganglia, we feel unable to speak positively either as to their presence or their absence. There is certainly some appearance of a nerve-fibre on either side passing from the ganglion towards the frontal part of the head (as described by Leuckart and Pagenstecher), and also of one passing into the base of the second antennæ (as noticed in the former memoir); but we are not at all sure that these appearances are to be trusted, having now satisfied ourselves that the linear trace which passes on the median line along the dorsal surface is not (as was suggested in the former memoir that it possibly might be) a band of fibrous nerve-substance, but is simply the mark of the attachment of a mesentery by which the intestine is held in its place. We have been unable, notwithstanding our careful and repeated search for it in living specimens, to detect the ventral nervous cord and œsophageal ring described by Grube (see vol. xxii. p. 361); and we cannot but believe that he must have been deceived by appearances produced by the change which the textures of this delicate creature had undergone in the process of conservation to which his specimens of it had been subjected.

The observation of a considerable number of specimens in various stages of development enables us now to state that the *alimentary canal* may present itself at any period either in the state of contraction shown in Plate LXII. fig. 1 (vol. xxii.), or in that of distention shown in Plate VII. fig. 6, or in any intermediate condition. Even when the canal has been most distended, however, it has generally seemed to contain little else than water, very few solid particles being visible in its interior. In one individual, however, we observed in the intestine several fragments of a *Beroë* which had been captured at the same time and had been broken in the tow-net; and these fragments were kept in continual agitation by the persistent movements of their large cilia. This unusual exercise of voracity seemed to have an injurious effect upon the individual; for it was found dead the next morning, whilst several other specimens in the same jar survived. The caudal prolongation of the body is generally in a state of greater or less contraction longitudinally;

and the alimentary canal is thrown by this contraction into convolutions, which are sometimes slight and easily distinguishable, as shown in Plate VII. fig. 2, but which, when the caudal appendage is greatly contracted (as shown in figs. 6 & 7 of Plate LXII. vol. xxii.), may be so close as to render it difficult to follow their course, by reason of the opacity which the part then acquires. The part of the intestine contained in the caudal prolongation has its external surface clothed with cilia; but these are most apparent along particular bands. Cilia are also distinguishable on certain parts of that innermost layer of the general integument which forms the external boundary of the perivisceral space, their action being especially apparent near the ends of those lateral appendages which give support to the pinnulæ. By the agency of these cilia a more special movement is imparted to the corpuscles of the fluid contained within the perivisceral cavity, than that which they receive from the movements of the body generally, and from the peristaltic contractions of the alimentary canal. Although these corpuscles, which are usually of a spheroidal form and of a diameter of about $\frac{1}{5000}$th of an inch, very commonly float singly, they are often to be seen aggregated in smaller or larger numbers into masses, which sometimes attain a considerable size (fig. 10); and we cannot doubt that the bodies supposed by Mr. Huxley to be young spermatozoa (p. 359, vol. xxii.) were of this nature.

We have given much attention to the ciliated canals, first observed by Leuckart and Pagenstecher, which originate in two orifices near the base of the lateral appendages of each side (figs. 7, 8. *a*, *b*) on their dorsal aspect, and which then rapidly incline towards each other, so as to converge into a single canal, that runs along for some distance in the wall of the body, and then terminates in the perivisceral cavity (fig. 7. *c*). One of these orifices (*a*) is situated in the centre of a sort of rosette*, marked by radiating ridges furnished with large cilia; the other (*b*) has round it a smaller rosette, which does not possess any such ciliated ridges. These ciliated canals are obviously the homologues of those which attain so much greater a complexity in the higher Annelida (the "segmental organs" of Dr. T. Williams). Although they are represented by Drs. Leuckart and Pagenstecher as existing in their specimens on every one of the pinnulated appendages, and even in the bases of the second antennæ, we can state most positively, both from the observation of numerous living individuals, and from the evidence of well-preserved specimens now before us, that, in the form of *Tomopteris* observed by us, they do not exist in the five lateral pairs which immediately follow the second antennæ. And this fact is the more remarkable, since, as will presently appear, there is a stage in the animal's life at which it does not possess more than five pairs of pinnulated members, and in which, therefore, it is entirely destitute of ciliated canals. The direction of the ciliary current always appeared to us to be from without inwards (as affirmed by Leuckart and Pagenstecher, in opposition to what is generally stated on this point); and we repeatedly witnessed the passage through the canals, in this direction, of spermatozoa which had been emitted from the testes into the surrounding water.

Each of the pinnulæ, in our specimens of *Tomopteris*, presented (fig. 7. *d*, *d*) the peculiar

* This rosette was noticed by Busch; but he only imperfectly made out the canal of which it is the entrance.

"rosettenförmiges Organ" which was noticed by Leuckart and Pagenstecher upon the two first pairs of appendages of their *T. quadricornis*, and which is affirmed by them to be entirely wanting in *T. onisciformis*. This is alike remarkable for its form (fig. 9), which somewhat resembles that of a melon, and for its colour, which, being a bright sulphur-yellow, distinguishes it from the coloured spots noticed in the former memoir, these being of a reddish orange. In the very young specimen already adverted to, these organs presented themselves at the bases of the pinnulæ (fig. 14. *c*, *d*) of the two most developed pairs of members. Of their nature and purpose we have not been able to form even a probable guess.

It is in regard to the *caudal prolongation* of the body, and the organs which it contains, that we have the most novel and important information to offer. We can now state with certainty that the large specimen represented in Plate LXII. figs. 6 & 7 (vol. xxii.) was a *male*,—the eight pairs of ovoidal bodies from which the rudimentary pinnules appeared to spring being really the testes, which occupy the parts of the perivisceral cavity that are prolonged into the short lateral appendages whereon these pinnules are really borne. Each testis (Pl. VII. fig. 2. *a*, *a*) is an undivided sac, whose cavity, when the organ has attained its maturity, is almost entirely filled with a mass of spermatozoa. The individual parts of this mass are in continual movement upon each other, their motion being kept up chiefly, if not entirely, by the action of the cilia clothing that part of the inner wall of the testis which is near its external orifice. Each testis (fig. 3) can discharge its contents, either externally through an orifice (*a*) in the wall of the lateral appendage within which it is lodged, or internally through another orifice (*b*) into the perivisceral cavity. That the external orifice is distinct from that of the larger, ridged rosette (*c*) of the ciliated canal, we feel ourselves able to affirm with certainty; but we are not equally sure of its distinctness from that of the smaller rosette in its neighbourhood. The internal orifice, by which the spermatozoa escape into the general cavity of the body, can only be seen occasionally; and we are disposed to think that it is formed only when the contents of the testis are fully matured. Whenever we caused these to be discharged by pressure, it was through the external orifice that they escaped.

The *spermatozoa* of *Tomopteris* (fig. 4), which we had abundant opportunities of observing, are peculiar in having *two* flagella—a feature which, although general among the antherozoids of the Algæ, is very rare (if not unique) among the spermatozoa of animals *,—and also in being able to move in either direction with apparently equal facility.

It will presently appear that the testes occupy exactly the same place in the lateral appendages of the caudal prolongation as the ovaria do in those of the body generally,—the chief difference in their apparent positions arising from the smaller size of the lateral appendages in the former region, and from the more complete occupation of the cavity of these appendages by the oval sacs of the testis.

* In his 'Naturalist's Rambles on the Devonshire Coast,' Mr. Gosse mentions (p. 213) that he witnessed the exit from the mouth of *Pedicellina Belgica* of numerous minute pear-shaped bodies, each having "a little tubercle at its larger end, around which are set a few (about four or five) long cilia or setæ, twice or thrice as long as the body. These are not used for vibratile action, but as oars slowly waved through the waters." Although these are termed "germs" by Mr. Gosse, yet it seems to us probable that they were multiflagellate spermatozoa.

A considerable number of males came under our notice before we met with any specimens whose female sexuality was indicated by the presence of ova: of these, however, we subsequently encountered several; and our observations on them are in accordance with those previously made by Huxley, Busch, and Leuckart and Pagenstecher. In a mature female (fig. 1) the ova are to be seen lying, in great numbers and in various stages of development, in every part of the perivisceral cavity of the body and of its caudal prolongation, and also in the extensions of that cavity into the lateral appendages, including even the basal portion of the second antennæ. From a comparison of the conditions under which they may be seen in one and the same individual, it becomes obvious that they originate in the terminal wall of the cavity of the pinnulated appendages,—a fact that seems to have been first recorded by Drs. Leuckart and Pagenstecher, though we learn from Mr. Huxley that he had arrived at the same conclusion ten years ago. This terminal wall, which gives support on its outer side to the bases of the pinnulæ, presents on its inner surface a number of transparent tubercular elevations (fig. 7. *e*), which progressively become hemispherical, then pear-shaped, and finally give exit to peculiar nucleated cells which float in the fluid of the perivisceral cavity. These cells multiply by self-division after the ordinary mode (fig. 13); and it is only after their number has thus been considerably augmented, that they begin to increase in size and to assume the characteristic appearance of ova. It is not only in the lateral appendages of the body, however, that ova thus originate; for it is clear to us that they are developed also in the caudal prolongation; and it would seem probable (though we could not satisfy ourselves of the fact) that they there originate in the corresponding situation—that is, on the terminal walls of those extensions of the perivisceral cavity into the rudimentary appendages, which, as just shown, are the seat of the testes in the male.

It is a fact not to be passed without mention, that rudimentary ovaria are to be seen in mature males,—the terminal walls of the lateral appendages of the body presenting those tubercular elevations whose presence constitutes the first stage in the development of ova in the female. Whether at some other period these may develope ova (as is the case with certain other worms, which are really hermaphrodite, but which mature their male and their female products at different periods), or whether they are merely persistent rudiments not destined to undergo any further development (like the mammary glands of the male mammal), is a question to be determined by future observation.

We have not been able to detect the mode in which the *ova* make their exit from the body,—the transverse fissures in the outer wall of the perivisceral cavity, which are described by Leuckart and Pagenstecher as presenting themselves in the third and fourth segments, not having been noticed by us, probably because they had not yet been formed. Nor have we been able to satisfy ourselves whether the ova are fecundated before their escape, by the entrance of spermatozoa through the ciliated canals into the perivisceral cavity, or whether they receive the fertilizing influence after their emergence.

Although we have had no opportunity of following out the development of this interesting creature *ab ovo*, yet it has been the good fortune of one of us to capture, off the coast of Skye, what we cannot doubt, from the conformity of its general organization to the type we have been describing, to be a very early form of the same *Tomopteris*. This specimen, represented in fig. 14, was not more than $\frac{1}{25}$th of an inch in length, and seems to correspond in its grade of development with one which came under the observation of Busch. The following are its most noticeable features of difference from the more advanced form :—The "frontal horns" were entirely wanting. The first antennæ (*a*, *a*) were relatively very long, but presented only a trace of articulation. The second antennæ (*b*, *b*) were relatively very short, and presented a bifid termination which clearly indicated their homology with the ordinary members; only one of the pinnulæ was setigerous, and it would seem as if this alone were destined to undergo further development, while the other becomes obsolete. Behind these were only four pairs of lateral appendages, the fourth being as yet rudimentary; these were formed by pinnulæ only, which were sessile on the trunk of the body, the lateral extensions which bear the pinnulæ at a later period not having been as yet developed. No trace was to be seen either of the ciliated canals or of their rosette-like orifices; near the junction of the pinnulæ, however, in the two most developed pairs of appendages, a single sulphur-yellow "rosettenförmiges Organ" presented itself. The ventral surface of the pinnulæ, and the surface of the whole posterior part of the body, were ciliated. The body was bifurcated at its posterior extremity.

We think it proper to record the fact, that in a single *Tomopteris* of tolerably advanced development (the caudal prolongation beginning to show itself) we found the pinnulæ covered with large trichocysts or thread-cells (fig. 11). Notwithstanding a careful search, we failed to meet with these in any other individual. However strange this circumstance may appear, it is not altogether without parallel,—the trichocysts usually seen in *Paramecium aurelia*, *P. bursaria*, and other Infusoria, having been frequently observed by us to be wanting in those of particular collections of water.

It will, we think, be obvious from the details we have given of the structure of this interesting creature, that it is a degraded form of the *Annelidan* type,—its nearest affinities being (as already pointed out by Drs. Leuckart and Pagenstecher) to the chætopod or setigerous Annelids. Every part of the characteristic organization of that type is here reduced to the extreme of simplicity. The alimentary canal passes in a straight line from one extremity of the body to the other, without either sacculations or glandular appendages. The nutritive fluid which transudes through its walls, and which thus finds its way into the perivisceral cavity, is distributed throughout the body solely by means of extensions of that cavity; through which it is propelled in part by the agency of the cilia that clothe its walls, and in part by the general movements of the body and appendages. This fluid is so obviously the homologue of the blood of higher animals, that we cannot but regard the existence of the type of structure before us (the wonderful transparency of the body not permitting the slightest doubt as to the absence of anything resembling a dorsal vessel) as affording a further confirmation of that view of the (so-called) circulating apparatus of the higher Annelida, which regards their perivisceral cavity and its extensions as representing the proper sanguiferous system, and which looks upon the system of vessels containing coloured fluid as a special arrangement having reference rather to the respiratory function*. The extreme tenuity of the walls of the body and of its appendages, renders it un-

* See Prof. Huxley's Lectures in 'Medical Times and Gazette,' July 12 & 26, 1856.

necessary that any special provision should be here made for the aeration of the nutritive fluid; and we accordingly find neither branchiæ nor any trace of what is commonly described as the sanguiferous system in Annelida. The centres of the nervous system would seem to consist solely of the cephalic ganglia,—the absence of the ordinary longitudinal series being apparently related to the very incomplete segmentation of the body, and constituting a link of affinity to the Turbellarian Worms. The ocelli present a condition of extreme simplicity; yet the duplication of the corneule in each of them marks that tendency to repetition which so peculiarly distinguishes the Articulate type. It is, however, the extreme simplicity of its generative apparatus, that constitutes one of the chief points of interest in the organization of *Tomopteris*. It is clear that both ova and spermatozoa are first developed within those prolongations of the general cavity of the body which support the pinnulæ,—the "germ-cells" being certainly, and the "sperm-cells" probably, contained in the substance of their walls. The ova being speedily set free, escape into the general cavity of the body, no proper ovarium being formed; but the spermatozoa remain enclosed within a sac, which is probably formed by an extension of the inner layer of the wall of the perivisceral cavity, and thus constitutes a definite testis. It seems clear that the ciliated canal or "segmental organ" has here only a secondary relation (if any) to the genital apparatus. It has no other character in the ovigerous appendages, than it has in the lateral appendages generally; and if in the spermigerous appendages the contents of the testis escape through its minor orifice, they do so without traversing the principal canal. Whether the spermatozoa, when diffused through the surrounding water, normally pass into the ciliated canals of the female, and thus make their way to the ova contained in the perivisceral cavity, or whether their entrance (as seen by us) was merely accidental, like that of any other minute particles that might be drawn in by the ciliary current, is a point to be determined by further inquiry.

To the notices we have already given of the accounts of *Tomopteris* recorded by previous observers, we have to add that this creature long since presented itself to that indefatigable student of the Marine Zoology of our coasts, the late Sir John G. Dalyell; and that it is described and figured in his work on the 'Powers of the Creator displayed in the Creation' (vol. ii. p. 260, plate 36. figs. 16, 17) under the designation of *Nereis phasma*, or the Spectre Nereis It may be well to cite his account of the animal, for the sake of his vivid description of its extraordinary transparence, and also because comparatively few have access to the work in which it appeared.

"One evening, early in January, while inspecting a vessel of sea-water, my attention was attracted to an indistinct vortex amidst it, without presenting any definite object to the view. This motion was connected, however, with an air-bubble, certainly shifting it to different parts of the vessel. I could account for neither. Nothing else was perceptible; and it seemed still more singular that I should afterwards witness the same by day. But on altering the position of the vessel so as to throw different shades of light upon it and its contents, I discovered with much surprise that the agent was a very active animal, by no means so diminutive as to escape detection, but of such excessive transparence as to

Ed. Claparède, del.

J. Jarman sc.

disguise its form. Nor is this any exaggeration of the fact: for having sent the vessel to an accomplished artist already named, Mr. Peter Syme, for the purpose of obtaining a delineation, I found, on reaching him, that he had been unable to discover the object. However, by resorting to similar expedients as practised by myself, he could now represent the most conspicuous parts of the animal.

" Nearly three years afterwards, I obtained another specimen in November. Both occurred in a capacious jar of sea-water taken from about the same place, Newhaven Pier. But, with ample opportunities, none have been again found there.

" Twenty years later, six specimens were obtained from the Isle of May, not less than thirty miles distant; and from the whole I have been able to gain some slight acquaintance with this singular animal—singular because human vision can scarcely discover, what is of sufficient size to expose every feature. Hence it is that there must always be slight discrepancies between the drawings of different artists."

Of the two representations given of the animal in Sir J. G. Dalyell's 36th Plate, that which was drawn by Mr. Syme from the specimen first seen departs greatly from its true proportion,—the pinnulated appendages, of which there are sixteen on either side, being drawn much too long (as in the figure of MM. Quoy and Gaimard), whilst the second antennæ are as much too short. The caudal prolongation in this specimen appears to have been just beginning to show itself. The second figure, which appears to have been drawn from the specimens obtained at a later period, is a much truer representation of a more advanced stage of development, the length of the caudal prolongation being about one-third of that of the body. Some of the specimens are said by Sir J. G. Dalyell to have had only four or five, or seven, pairs of limbs. He remarks that the animal " can be preserved with difficulty, from being liable to entangle itself in every foreign substance, and is easily mutilated in its struggles for liberation. None have survived longer than twenty-four days; they generally live only a week." We have have not ourselves succeeded in preserving them for more than the shorter of the periods just named.

EXPLANATION OF THE PLATE.

Tab. VII.

Tomopteris onisciformis.

Fig. 1. Posterior portion of the body, and caudal prolongation, of a female, showing the ova in various stages of development, lying in the perivisceral cavity. Magnified 40 diameters.

Fig. 2. Caudal prolongation of a male, showing the testes *a*, *a* occupying the cavities of the rudimentary pinnulæ. Magnified 65 diameters.

Fig. 3. One of the testes, more enlarged, showing at *a* the orifice through which the spermatozoa are discharged externally, at *b* the orifice leading to the perivisceral cavity, and at *c* the larger ridged rosette of the ciliated canal. Magnified 150 diameters.

Fig. 4. Biflagellated spermatozoa. Magnified 300 diameters.

Fig. 5. Portion of the head, seen on its dorsal aspect, showing the ciliated epaulettes *a*, *a*. Magnified 65 diameters.

Fig. 6. Second antenna of a young specimen, showing the terminal portion to be setigerous and to be separated from the basal portion by a constriction at *a*.

Fig. 7. One of the ordinary lateral appendages, showing the position of the ciliated canal with its two external orifices *a*, *b*, and its internal orifice *c*, and of the "rosettenförmige Organe" *d*, *d*; at *e*, *e* is shown the incipient development of the germ-cells in the terminal wall of the perivisceral cavity.

Fig. 8. External portion of the ciliated canal, more highly magnified: *a*, larger ciliated rosette; *b*, smaller rosette.

Fig. 9. Yellow "rosettenförmiges Organ" of Leuckart and Pagenstecher.

Fig. 10. Corpuscles floating in the fluid of the perivisceral cavity, some of them aggregated into masses.

Fig. 11. Trichocysts or thread-cells in pinnula of one specimen of *Tomopteris*.

Fig. 12. Bilobed ganglion, showing the spheroidal cells of which it is composed, with the pair of peculiar nucleated vesicles *a*, *a* imbedded in its anterior part, and the ocelli *b*, *b* each with its double lens.

Fig. 13. Germ-cells multiplying by self-division to produce ova.

Fig. 14. Very early larva of *Tomopteris*: *a*, *a*, the long first antennæ; *b*, *b*, the short second antennæ; *c*, *d*, *e*, *f*, four pairs of sessile pinnulæ, of which *c* and *d* show the "rosettenförmige Organe." Magnified 65 diameters.

V. *Further Observations on the Metamorphosis of* GASTEROPODA, *and the Affinities of certain Genera, with an attempted Natural Distribution of the principal Families of the Order.* *By* JOHN DENIS MACDONALD, *Assistant Surgeon of H. M. S.* "Herald," Captain H. M. DENHAM, *R.N., F.R.S.* *Communicated by* Professor HUXLEY, *F.R.S., F.L.S.*

Read February 16, 1860.

IN offering to British Zoologists the following remarks on the metamorphosis of Gasteropoda, I am anxious to premise that, as my present opportunities of consulting the researches of others in this field are extremely scanty, it is quite possible that my independent observations may appear to be but newly garbled statements of already published facts. I am willing, however, to risk this, feeling that confirmation, which is the only prop of simple assertion however truthful, must widen the basis of even accepted views. If such confirmation be afforded by this paper, it will not be altogether unimportant; but if the facts are new, which they are likely to be, so much the better.

When I first recognized a conformity in the dentition of numerous pelagic Gasteropods with that of certain clearly defined families, the inference was natural enough, that those little creatures formed a group in themselves, admitting of a like classification, though still, as it were, of a representative value zoologically speaking. Another idea, however, gained weight in my mind, namely, that they were merely the larval forms of genera better known to us in their perfect or adult state. This view I have endeavoured to sustain, in a former paper, with the evidence available at the time; and however inconclusive the arguments then adduced may have been, I am quite satisfied that the facts and materials since obtained will place it beyond all reasonable doubt.

While H. M. S. "Herald" lay at anchor on the leeward side of the Wreck* and Cato† Reefs, the tideway caused by the water sweeping over and around those obstructions brought many interesting objects to the towing net, including several genera of pelagic Gasteropoda, with which we are more immediately concerned in the present paper.

To enter at once into particulars, I first observed a little shell bearing the toothed and sinuated lip of a *Cheletropis*, and appearing to be a new species of that genus; but, having been previously placed on my guard against this deceptive resemblance, which I detected in another instance, I watched the movements of the occupant the more closely. I soon found that the great activity of the little creature and the peculiar form of its foot, which had a broad anterior margin, sloping sides, and a bifid posterior extremity, gave evidence of its being the young of a species of *Nassa*; and when its lingual dentition was examined under the microscope, this proved to be the case. I may remark that the lingual strap of *Nassa* is distinguished from that of *Buccinum* and *Pisania* by the absence of smaller denticles between the two principal fangs of the pleuræ, so characteristic of the *Buccinidæ*.

* Lat. 22° 10′ 30″. Long. 155° 30′ 00″.

† Lat. 23° 15′ 00″. Long. 155° 35′ 00″.

I next observed a stout little shell, much resembling a *Macgillivrayia* in form, but having the spire more minute and sharply marked, and the whorls beset with epidermic spines, disposed in close spiral lines. The microscopic examination of the animal gave unmistakeable proof of its being a *Ranella*, the lingual dentition agreeing, at least generically, with my figures and specimens. The rachidian plates of *Ranella* are boomerang-shaped, with the convexity in front, bearing a recurved angular process divided into sharp denticles. There is often also a small tooth on the posterior border of each arm, near its outer extremity. The uncini of the first series are sickle-shaped and serrulated, with a tooth on the inner side of the base, and those of the second and third claw-shaped, simple.

On examining the operculum, which in *Ranella* is so very remarkable, exhibiting three successive stages of growth, I found that it was quite of the same character, only that it had but yet attained the second stage. Finally, on comparing the whole operculum, and the little shell, respectively, with the nucleus of the operculum, and the apex of the shell of an adult *Ranella* obtained on the reefs, I could detect no points of difference, even with magnifying powers; the conclusion, therefore, is irresistible, that the one is but the young state of the other.

The young of *Triton* was also determined by the same mode of analysis, and I have been able to confirm my former conviction, that *Cheletropis* belonged to the *Muricidæ*, and that certain other pelagic shells, which I also figured and described, were referrible to the *Naticidæ* and *Strombidæ* respectively.

Of *Macgillivrayia* I obtained a new species, closely resembling that named *M. echinata* by Mr. A. Adams, only that the spines, which are disposed in a single row on the dorsum of the whorls, were perfectly straight and not "recurved;" and the later additions made to the outer lip extended as a thin lamina over the whorls towards the apex of the shell,—a condition which I have also discovered in the young of *Triton*, and which affords one amongst many reasons for placing *Dolium* and *Malea* (to which the several species of *Macgillivrayia* appear to belong) with *Triton* and *Ranella* in one natural family, culling them from amongst the very numerous and heterogeneous genera of the two families, *Strombidæ* and *Buccinidæ*, in which they are at present to be found. All these animals have a protractile proboscis with a septiserial lingual ribbon, partaking of the characters of that of *Ranella*, as above described. A pair of lateral oral plates, in general composed of indurated rhomboidal cells, is also invariably present; and if these particulars cannot be affirmed of a genus selected for this family from some fancied resemblance of its shell-characters, nothing is more certain than that some other natural family will be minus a member.

I obtained once more the little Gasteropod which I was unfortunate enough to name *Jasonilla*, it having previously, according to Mr. Adams, received no less than three titles, viz. *Brownia* (D'Orb.), *Echinospira* (Krohn), and *Calcarella* (Souleyet), though the anatomy of the animal remained unknown. I am now fully satisfied that the true shell is developed within the outer cartilaginous case which rejoices in the above synonyms, and that it is merely the young state of *Lamellaria* (a Gasteropod with a concealed spiral shell), of which we obtained a living specimen at the Cato Reef.

Having thus fallen in with the genus which I believe to be the adult state of *Brownia*, I transcribe its characters from rough notes taken at the examination of the solitary example alluded to:—

"*Shell* thin, membranous, depressed, paucispiral, with an open columella, communicating with a shallow and expanded aperture; completely inclosed in a thick outer mantle covering the back. This mantle may be described as a convex, mushroom-like shield investing the shell and viscera, and arching over the whole foot and head, with an emargination in front, admitting of the protrusion of the latter, and corresponding with the true mantle opening.

"A combed gill is distinctly visible in the mantle cavity, and the genital and excretory orifices are also included, on the right side. The foot is elongate, truncated and dilaminated in front, but flat and pointed behind, lying altogether in a depression within the thick margin of the epipodial shield. Tentacula conical, flattened, arising from the angles of a thin frontal lobe overlapping the muzzle; the ocelli placed behind the tentacula and close to the outer side of their base.

"The muzzle appears to be proboscidiform, and the mouth is armed with two strong lateral labial plates, jagged in front and united in a hinge-like manner in the middle line.

"Lingual ribbon of moderate length, triserial, with arched rachidian plates, armed with small teeth recurved from the anterior convex border. The uncini are sickle-shaped, serrulated internally and externally, and interlock over the rachis as in *Brownia*. Spherical otoliths are contained in the acoustic sacs; and the sexes appear to be distinct; but of this I cannot be certain, having had but a single individual to examine, which had been for some time preserved in spirits."

The animal is very different from *Natica* and its allies, and I know of no family into which it may be with propriety received, except perhaps the *Velutinidæ**. Its true position appears to me to be between the *Muricidæ* and *Ranellidæ*, and side by side with *Velutina*.

I have already figured and described a little larval Gasteropod, having a subglobular cartilaginous case including the true spiral shell of the animal; and to this I have to add another and very beautiful species, of which we obtained several specimens off the Wreck Reef. In this instance the transparent outer case is subcylindrical and spirally fluted, one flute commencing at the apex, and then crossing the others obliquely, so as to form the principal part of the columellar lip, which is completed by a prominent and slightly involute process near the base of the slit-like aperture. The little contained animal, with its spiral shell and operculum, is distinctly visible within; but, as in the other examples noticed, the shell is so thin as to require additional protection in the morning of life. It must be stated, as furnishing one link in the series of changes here supposed to take place, that considerable numbers of the empty cases, rejected by their former occupants, are occasionally to be met with—a fact which I particularly observed at the Conway Reef. As to the mode of development of these curious structures I have but little to say. From the comparison of numerous specimens, it appears to proceed *pari passu* with that of the

* Dr. Gray established this family for *Velutina* with a (?), which latter I anticipate we shall soon find reason to remove.

shell. Ample provision is made for this contingency by a dense epithelial pavement, which lines the cartilaginous shell, and which may possibly be homologous with that by which the test is evolved in the Tunicata. As the chief agent in the development of the outer shell, it may be termed the outer mantle; and there is much reason to believe that it is persistent in the adult *Brownia* and in many other cases. It is probably within an outer mantle, homologous with this, that the first rudiments of the shell are formed in the *Helicidæ*, and the outer thickened rim of the mantle in the adult animals may be the remnant of such a structure. Its coexistence with the true epipodia in *Aplysia* and other instances precludes the notion that it may be altogether composed of these processes which have coalesced over the back. These facts and considerations afford a simple explanation of the development of internal shells in general, not even excluding those of the Cephalopoda, into which the homologues of the retractor muscles of the Gasteropoda are fixed, although the shells themselves in the two Orders are not generally admitted to be homologous, even against the light which the scutellum of the slug is calculated to throw on the subject.

I must not omit to notice the capture of a minute *Pleurobranchus* in company with the pelagic forms, off the Cato Reef. It was entirely naked, with broad ciliated head-lobes, or festooned folds, apparently continuous with the epipodia. The large and beautiful labial plates exceeding the dimensions of the double lingual pavement of uncinate teeth, and the auditory sacs (in this stage containing single but minute otoliths) lying wide apart from the eye specks, at once distinguished it from *Doris* and other allied genera.

Besides the numerous groups yet to be determined as fulfilling the conditions set forth in this paper, I believe that I have already identified members of no less than six or seven natural families, which may be distinguished by the simple characters given in the following Table.

PELAGIC GASTEROPODA (so called).

With strap-like dentition and otoliths in the ear-sacs.

Shell & Operculum.	Outer lip entire.	Operculum with a strong spine in front		STROMBIDÆ. . . .	Ciliated arms 6.	Dentition septiserial.	Animal.
		Operculum simple.	Nucleus minute, not continuous with the subsequent lines of growth	RANELLIDÆ	Ciliated arms 4.		
			Nucleus large, continuous with the lines of growth	NATICIDÆ			
	Outer lip with claw-like lobes.	Cancellated . . . . ?		CALYPTRÆIDÆ & CYPRÆIDÆ.			
		Double-keeled		MURICIDÆ.	Ciliated arms 4.	Dentition triserial.	
		Smooth		BUCCINIDÆ.			

To these may be added *Brownia*, and those species which are included in a cartilaginous case.

General Classification of the GASTEROPODA.

I am thus insensibly led into the subject of classification, which I must say I approach with considerable diffidence, being fully conscious of the danger of falling into a dictatorial style, where the results of my own researches are at variance with the views of many worthy cultivators of the science of Malacology. It is quite foreign to my present purpose to enter upon the analysis of any single system. Well-informed zoologists naturally make what they believe to be truthful selections from all available systems, and thus, as it were, compound their own creed; hence I have to deal rather with such matters as are generally accepted than with the tenets of particular men. In justice to Mr. S. P. Woodward, I do not hesitate to state that the soundest general work on the Mollusca that has hitherto appeared in England is his little Manual published by Weale. There is more nature, truth, and judicious conciseness in all the descriptive parts than one is accustomed to meet with in works of this kind; and, although I am sometimes at issue with him, I trust that my opposition is never factious or merely for victory's sake.

Mr. Woodward has availed himself of the characters afforded by the lingual dentition more extensively, I believe, than any previous writer, if we except Professor Lovèn; but much remains to be done before these can be successfully applied in the defining of the natural families, and still more before all the genera of Gasteropods can be referred to their proper places in the system. In the following Table, showing the general nature of the lingual dentition and of the auditory concretions in the principal families, I have merely endeavoured to make a step in the right direction; though I have little doubt that when the numerous errors which are always incident to attempts embracing so wide a scope shall have been cleared away, and the right exposition given of the value and bearing of assumed points of affinity, a system will result inferior to none in the whole department of Zoology in the truthfulness of its natural arrangement.

From more extended study of the subject, since my former paper on the materials of classification was written, I have arrived at the conclusion that the nature of the contents of the auditory sacs is of minor importance to the primary characters of the lingual dentition, as to whether it is elongated and strap-like, or broad and pavimental. Two circumstances in particular suggest this view, viz.:—1st. The close anatomical relationship existing between *Cerithium* and *Planaxis*, and even the almost actual similarity of their lingual teeth, although the auditory sacs in the former contain otoconia and in the latter spherical otoliths. 2ndly. Several of the *Eolidæ* (if I am not mistaken, I think I may venture to add the genus *Flabellina*) have otoconial particles, while the others in general have otoliths. It cannot be supposed, however, on this account that the few belong to a different family; for their whole anatomy refutes such a supposition.

I may remark that amongst the *Doridæ* also I have observed the occasional occurrence of minute otoliths instead of *otoconia*. It is worthy of note that the *otoliths*, wherever they occur in such families as usually present *otoconia*, are exceedingly small, like the single primordial otoconial particle of the young *Pteropod* or *Nudibranch*; and in the converse examples, as in the *Cerithiidæ*, where the presence of otoconia might *a priori* be quite unexpected, they are, as a rule, both few and large.

We now know enough of the distribution of otoliths and otoconia in the Molluscous Orders to perceive that there is a definite purpose in the bestowment of the one or the other, in particular cases; and as this purpose is never the subject of caprice, but permanent, the resulting characters must be always significant, and therefore available in classification.

The division of the lingual dentition into straps and pavements, as previously defined, is not altogether free from imperfection, although it is most satisfactorily available in by far the greater number of genera. Indeed, it is only amongst the *Opisthobranchiata* that any difficulty in this respect presents itself. Can anything, for example, be more diversified than the characters of the lingual dentition in the *Bullidæ* of authors? No less than four distinct types are distinguishable in this family, thus:—

Central series absent.		Central series present.	
Laterals 1 or 2, uncinate, as in SCAPHANDER and BULLÆA. (Philinidæ of Gray.)	Laterals more numerous, as in BULLINA (Risso)* and APLUSTRUM. (Bullinidæ and Amplustridæ of Gray.)	Laterals more numerous, as in BULLA (numerous species) and CYLINDRELLA. (Bullidæ of Gray.)	Laterals 1 or 2, the third rudimentary, as in BULLA *ampulla* and AMPHISPHYRA. (Occurring respectively in the Bullidæ and Philinidæ of Gray.)

The aggregate character of the dentition here tabularized is pavimental; but in *Bulla ampulla* it is more strap-like, on account of the great breadth of the rachidian plates, and the remarkable difference between these and the laterals.

It would be difficult also to form a judgment of the dentition of *Bullæa* taken by itself, the rachis being altogether absent, and the laterals much reduced in number.

In the Nudibranchiata, moreover, the pavimental character prevails, although in the *Elysiidæ* and *Eolidæ* the teeth are reduced to a single strap-like series; and, considering the collateral relationships of both families, I think that this view is more natural than to assume that their dentition is essentially constructed on the type of the strap. With this explanation, the consistency of the present system of determining affinities is quite unaffected by the retaining of *Eolis* and its allies in that position, which their general anatomy indicates to be the natural one. On comparing the median row of teeth in the broad pavement of *Phyllirrhoë* with the single series of *Glaucus* or *Eolis*, a close observer cannot fail to be struck with their great similarity. According to my own experience, the formula of the dentition of *Phyllirrhoë* (3.0.3), as given by Mr. Woodward, is incorrect.

I have, I trust, already sufficiently proved the impropriety of founding a classification on the physiology of respiration alone, to say nothing of the peculiar anatomical conditions respecting it, which we may presume are always present, though not sufficiently known to be available. We know, from the analogy of the Crustacea in particular, that whether an animal breathe in water (fresh or salt) or in air, the general scheme of its structure exhibits no necessary restriction to this habit. The principle here indicated

* *Cylichna* (Lovèn) and *Cylindrella* (Swn.) are regarded as synonyms of *Bullina* (Risso), though the two former genera present a central series in the lingual pavement, while Dr. Gray gives the dental formula of *Bullina* as 6·6.

is altogether ignored when all the air-breathing Gasteropods are associated in one so-called natural Order, *Pulmonifera*. Indeed the difference is so great in the two principal divisions of this Order, that the most superficial of all distinctions, namely, the presence or absence of an operculum, is sufficient to distinguish them. In this way, bisexual animals with a pavimental dentition are associated with unisexual animals having a lingual ribbon, and several more striking external differences. Indeed the characters common to both are such as apply to Gasteropods generally, affording no proof of their morphological agreement. This, therefore, must be my apology for separating the *Pulmonifera operculata* in the subjoined Table from their supposed alliance with *Limax* and *Helix*, and placing them in another division, with animals having an organization in more complete harmony with their own. The *Pulmonifera inoperculata* together with the *Opisthobranchiata* (M. Edwards) are retained in the position which Mr. Woodward gives them, as two natural series demanding no special change. I have, however, been obliged to place between them the transitional genera *Siphonaria* and *Amphibola*, removing the former from the *Patellidæ*, which it resembles only in the shell, and the latter from the Apple-snails (*Paludinidæ*), with which, even taking into account the obscure resemblance of its shell, it cannot have the remotest affinity. I refrain from the use of a family term to include those genera, because I have much reason to believe that *Siphonaria* is a member of the *Onchidiidæ*, while *Amphibola*, though *prosobranchiate*, exhibits an alliance with the Tectibranchs. However this may be, taking them in the order given, they render the passage from the *Pulmonifera inoperculata* to the Opisthobranchiate families easy and natural.

The members of the second division in the Table are unisexual, and in this primary character differ from those of the first. They admit of arrangement into three sections, in one of which the dentition is pavimental; in another altogether absent, while in the third it is strap-like. From actual observation and comparison of genera belonging to all the families cited, with one or two trifling exceptions, I am convinced that, first, the character, and, next, the number of the dental plates and processes, afford a truly natural test of the affinities of unisexual genera with strap-like dentition.

In studies of this kind I always bear in mind a grand principle, for which I am indebted to Mr. W. S. Macleay, namely, that *no character is natural until it has been proved to be so*. No scheme, for example, however plausible from its delusive applicability to a certain number of cases, can be accepted as natural, when conditions of greater value are violated by its adoption. The employment of the mere number of longitudinal rows of teeth in the lingual ribbon as a means of classification may be compared to the method of Linnæus, who based his Botanical System on the number and arrangement of the stamens, and would threaten at first sight to be equally artificial; but I find that the legitimate sway of characters of greater as well as of minor value is not interrupted or violated by its adoption. Hence it proves to be natural, sustained also by the axiom, "*natura non facit saltum*."

Errors with respect to sex may still lurk in the present Table, as I know to have been the case in a former one. I must state, however, that the sexual character of those instances which I have not been able to determine personally is supported by good authority; and even though errors should here and there occur, it is much better, if possible, that nothing should be taken for granted merely because it might appear to harmonize with a pet theory.

Malacologists have always been at a loss to ascertain the natural position of *Janthina*; and the whole truth seems to be this—that it is not correctly referrible to any of the families already formed. Even though it should be placed by itself, as has been done by several authorities, its true relationship to other families in the series is still a matter of doubt. Dr. Gray interposes *Janthinidæ* between the Apple-snails and the Heteropods, though the general disposition of authors is to place the solitary genus near *Nerita* or in some neighbouring family. Mr. Woodward has selected the *Haliotidæ* for it, probably conceiving that the notch at the outer angle of the shell represented that of *Scissurella*, *Pleurotomaria*, &c. Taking the anatomy of the animal into consideration, however, it is easy to show that this position is most unnatural. It has often suggested itself to me, that *Janthina* was in some particulars related to the Opisthobranchiate families; and, although the affinity is certainly not immediate, I apprehend that it will be difficult to find a better place for it than between these and the very natural family composed of the genera *Solarium*, *Torinia*, *Scalaria*, and perhaps some others. If the latter family, which may be named *Solariidæ*, and the *Janthinidæ* are really unisexual, they will form a remarkable and beautiful link or passage between the Opisthobranchiata and the unisexual Gasteropoda with a lingual ribbon.

The following extracts from my notes will show that the family of the *Solariidæ* is founded on no hypothesis, but on facts:—

" In upwards of ten fathoms at the Feejee Islands we obtained a small species of *Solarium*, apparently quite new. The shell is orbicular, much depressed, with a wide umbilicus, increasing with the growth of the whorls, and bounded by an angular and minutely beaded border, corresponding with the union of the lower and inner walls of the shell. This results from the revolution of a small lunated notch at the base of the columella, which is perfectly straight, directly joining the body-whorl. The outer lip is thin, and slightly angular at its central or more convex part. The mouth of the shell is trapezoidal, the angles being situate respectively at the base and summit of the pillar, at the middle of the outer lip, and at the union of this latter with the body-whorl. The most interesting part of this little shell is discovered on looking down to the bottom of the deep umbilicus, in which the sinistral nucleus, smooth, polished and completely inverted, may be distinctly seen. Operculum thin, horny, multispiral, slightly concave externally and minutely tuberculated." (The operculum of the typical *Solaria* is paucispiral.)

" The animal, in general appearance, much resembles one of Cuvier's Tubulibranchiata. The creeping-disc of the foot is small, but the operculigerous lobe is large and subcylindrical. The tentacula are moderate, conical, with the eyes on the outer side of the base.

" The proboscis is armed with two lateral oral plates, and the tongue with several series of tenaculiform teeth, of which the innermost are simple, the external trifid, and the intermediate bifid. Finally, the acoustic capsules contain minute *otoconia*.

" *Solarium perspectivum*. This species occurs plentifully on the sea-side of Kamba point, *Na Viti Levu*, Feejee group; and several specimens were selected for examination. The tentacula are stout, conical, and closely approximated above the mouth, with a longitudinal groove on their inner surface, and a somewhat sunken eye in a slight elevation or gibbosity at the outer side, near the base.

"The animal is furnished with a retractile proboscis of considerable length; and when retracted, the external aperture is quite round and so small as to be scarcely perceptible. The anterior border of the foot is dilaminated, the plates or lips being separated by a deep transverse recess, which appears to have some communication with the sinus of the foot. The creeping-disk or mesopodium is well developed, and the lateral borders, which are produced into a simple lobe, are probably confluent with the epipodia. Its posterior extremity is very thin, but rounded, and surmounted by the metapodium, which is a subcylindrical mass of muscular fibres, continuous with those of the great retractor, and abruptly truncated posteriorly, where it presents a subcentral recess, which lodges the internally produced nucleus of the paucispiral operculum.

"The oral teeth form a narrow circular band consisting of a pavement of sharp dental cells, whose points, as in other cases, are directed forwards.

"The lingual pavement is small, but elongated in form and divided into two lateral areæ, supporting several series of long and gracefully curved uncinate teeth, which seem to decrease in length from within towards the lateral borders of the membrane, where they also become bifid in the vertical direction.

"The auditory sacs are of comparatively large size, containing *otoconia*.

"*Torinia* (Gray). The anatomical characters of this genus (distinguished by the peculiar gun-screw form of the operculum, so much resembling that of *Siliquaria*) agree in every essential particular with the foregoing.

"*Scalaria*. From a critical examination of the anatomy of *Scalaria*, I have no hesitation in placing it in the same family with *Solarium*. Its principal characters are as follow:—Proboscis long, retractile, with stout muscular walls; the oral aperture furnished with lateral plates, composed of small dental cells with their points directed forwards. Lingual membrane supporting a double pavement of tenaculiform teeth, rather stout, but still very similar to those of *Solarium*, and not, as has been supposed, like those of *Bulla*. Thus the outer teeth present one or two secondary prongs, while the inner remain simple. The eyes are placed at the outer side of the base of broadly conical tentacula; and the auditory sacs contain vibrating *otoconia*.

"The foot is dilaminated in front, and in general configuration resembles that of *Solarium*."

From the above facts I think it may be affirmed that it is a violation of the simplest anatomical principles to place *Scalaria* with the *Turritellidæ*, and *Solarium* with the *Litorinidæ*, the genera in both of which families, as now received, are otherwise heterogeneous enough.

The vermetiform character of the animal of *Torinia* on the one hand, and the peculiar structure of the operculum of *Siliquaria* on the other (so closely aping that of the former genus), afford some indication that both may belong to the same family. Moreover the groove in the outer lip of *Solarium* would appear to represent the branchial slit of *Sili-*

quaria; but until something more is known of the anatomy of the latter, I cannot hazard any further speculations on the subject of its natural position.

It may now be asked, what is to be done with the *Pyramidellidæ*, in which the lingual membrane is quite unarmed and consequently can afford us no guide in classification. The legitimate course in such a case as this would be to compare the whole tenor of the anatomy with that of other families, whose position has been better determined. With the hope of arriving at some successful result in this respect, I separately passed in review the anatomy of *Pyramidella*, *Odostomia*, and *Eulima*, all of which genera are rightly referred to the same family. But as the species of *Pyramidella* are usually more suited for examination, their study has given me the chief grounds for the conclusion I have formed, namely, that in their general anatomy they accord more closely with *Solarium* and its allies than with any other family that I can suggest. From these, however, they differ in two striking particulars, viz., the presence of minute *otoliths* in the ear-sacs instead of *otoconia*, and the absence of dental organs both labial and lingual. In these conditions, nevertheless, if my determination be correct, *Pyramidella* permanently represents the early state of *Solarium*. It is therefore not improbable that, if by any change in the routine of nature dental organs were to make their appearance in *Pyramidella*, they would assume the pavimental arrangement. However this may be, there can be little objection to the position chosen for the *Pyramidellidæ*, immediately succeeding the *Solariidæ*, while there is much to sustain it.

The fore part of the head (or the muzzle) of Gasteropods presents at least three different modifications which may be of service in classification. Thus, 1st, it may be simple, incapable of retraction beyond what is distinguished as mere contractility; 2ndly, proboscidiform or retractile from the apex, invaginating itself with one simple fold; or, 3rdly, it may be a true proboscis, retractile from or near the base, with two resulting folds. The latter form is present in all unisexual Gasteropods having a lingual ribbon with three rows of teeth and under, and in some few families in which this organ presents seven rows. The 2nd occurs in the *Cypræidæ*; and all the rest, with one or two questionable exceptions, have simple muzzles with a dental armature of seven series and upwards. *Pileopsis Hungaricus* is figured and described as possessing a retractile proboscis of considerable length; while the other members of *Calyptræidæ* have plain though more or less produced muzzles; and it is very doubtful whether the animal in question properly belongs to this family, there being much in favour of its affinity to *Velutina*, as suggested by Mr. Woodward. I must say that I have never discovered a true proboscis in the animals of the numerous *Pileopsis*-like shells which I have examined from time to time. The importance of the distinctions here indicated is also exhibited in the case of the genus *Erato*, which is admitted on all hands to belong to the *Cypræidæ*.

Erato is anatomically related to *Triton*, or probably to *Cassis*, rather than to *Cypræa*, as the inspection of its labial and lingual dental organs will at any time prove. Its lengthy proboscis is retractile from the base; and the extremity of the tongue-sac can therefore never lie freely in the visceral cavity—one of the most essential characters of the *Cypræidæ*, though not peculiar to this family.

The last case which I have to notice in this connection is that of *Triforis*. In a dextral example of this genus *, which I collected myself on the Wreck Reef, I found that all my previous remarks on its anatomy were correct, save that the lingual membrane was stated to support a "multiserial pavement of minute teeth." Employing a one-sixth-of-an-inch objective (Ross), I discovered my mistake with regard to this very small strap; and I think I may now very safely say that it is septiserial; and so far, indeed, *Triforis* agrees with *Cerithium*. But when we take its otoliths, retractile proboscis, and lateral labial plates (composed of amber-tinted rhomboidal cells) into consideration, a place near *Triton* or *Ranella* can scarcely be denied to it. I am still convinced that the early state of its shell affords only an apparent mark of affinity to *Cerithium*. On the other hand, three openings homologous with those of *Triforis* are strikingly apparent in some *Ranellidæ*.

Having made one flagrant mistake, however, with regard to *Triforis*, I feel now rather disposed to leave the determination of its true status to more able malacologists, throwing out one hint—that its operculum is pointed, with an apical nucleus, as in *Cerithiopsis* (Forbes), which also possesses a retractile proboscis.

An error of observation is far more unpardonable than the false determination of the genus to which any particular shell may appear to belong; for it often happens that in the short but indefinite descriptions of the shell-characters given by authors, perspicuity is sacrificed in the attempt to attain conciseness. On this account I fell into another mistake, confounding a short and stumpy *Fasciolaria*, having very obscure plates on the pillar, and a crenulated outer lip, with Swainson's *Tritonidea*, which has now become synonymous with *Pisania*. The operculum in both genera is stout and claw-shaped, and the animals themselves are not at all unlike each other.

The lingual dentition of *Fasciolaria*, *Fusus*, and *Clavella*, however, may be at once distinguished from that of *Pisania*, which I believe to belong properly to the *Buccinidæ* and not to the *Muricidæ*, if the *Buccinum cinctum* of Quoy, and *Pusiosterna* of Swainson may be taken as true examples.

So far as I have been able to discover, besides *Murex* itself, *Hemifusus* (Sw.) is the only genus, in the whole of the *Muricidæ*, having an operculum with an approach to an apical nucleus, which is essential to *Pisania*.

The family-difference observable in the dentition of the *Buccinidæ*, *Fusidæ*, and *Muricidæ* is so distinctive, that, when once recognized, no confusion of the species of one family with those of another can possibly occur; and thus an unfailing guide is afforded in the determination of doubtful cases, which may be more or less conformable with the definition of *Pisania* or any other ambiguous genus.

I leave the case of the *Aciculidæ* † an open question until I shall have the opportunity of comparing the anatomy of *Geomelania* and *Acicula* with that of *Egea* (Benson?), which I think may possibly be identical with the former genus; and if so, it will bring along with it some freshwater and littoral genera, viz., *Hydrobia*, *Syncera*, and a number of beautiful little *Paludina*-like shells now placed in the *Rissoïdæ*.

Truncatella is doubtless close at hand, though perhaps sufficiently distinct to form the

* Having obtained a second dextral *Triforis* at Moreton Bay, it may be safely stated that the shell is not invariably sinistral, though commonly supposed to be so by conchologists.

† As accepted by Mr. Woodward.

type of a separate family, with some more truly marine examples of which I am well acquainted. Many *Truncatellæ* live far inland, exhibiting a terrestrial habit as obviously as any of the operculate Pulmonifera; and their anatomical characters are well worthy of a rigid comparison with those of *Acicula*.

The *Patellidæ* exhibit many points of affinity to *Fissurella*, *Nerita*, and the series to which they belong. Several members of the family manifest a tendency to deviate from the typical species, in their dental formula in particular; and indeed the whole lingual armature in *Patella* appears but to represent the rachidian area of *Turbo* or *Nerita*,—the pleural teeth being suppressed, as in the mooted cases of *Elysia*, *Eolis*, &c., noticed in the first part of the paper.

The affinity here advocated is still further suggested by the peculiar sculpturing, olivaceous colouring, and nacreous lining of the shell, in some species of *Acmæa*.

The *Patellidæ* and *Dentaliidæ* have a broad upper-lip mandible, and their ear-sacs contain otoconia, but the resemblance ceases here; while on the other hand in the *Chitonidæ* no upper-lip mandible exists, and I have never been able to detect either visual or auditory organs. I must give up the attempt to class the two latter families; but I think that the *Patellidæ* may be placed provisionally at least as an appendix to the *Fissurellidæ*.

I have no desire to repeat former observations, and therefore refrain from any further comment on the particular families contained in the Table. I can only say that I have endeavoured as much as possible to make the order of their arrangement in strict accordance with their anatomical relations. With all its imperfections, therefore, the scheme is submitted to the judgment of the zoologist, purporting to be merely a help to the attainment of a precise conception of the natural affinities of Gasteropoda.

CLASSIFICATION OF THE GASTEROPODA,

Showing the nature of the Lingual Dentition and of the Auditory Concretions in the principal Families.

Division I.—Sexes combined.

Lingual dentition pavimental, though in a few instances reduced to a single strap-like series.
Ear-sacs containing otoconia in general, but which are reduced to a single particle in several genera.

1. *Pulmonifera inoperculata*, breathing in air, with lung-chamber alone.

- Limacidæ.
- Helicidæ.
- Lymnæidæ.
- Auriculidæ.
- Onchidiidæ.

2. *Bisexual Prosobranchiata*, breathing in air and water, with lung-chamber and gill.

- Siphonaria and Amphibola.

3. *Opisthobranchiata*, breathing in water alone, with special branchiæ or by the general surface.

- Tectibranchiata.
  - Tornatellidæ.
  - Bullidæ.
  - Aplysiadæ.
  - Pleurobranchidæ.
  - Phyllidiadæ.
- Nudibranchiatæ.
  - Doridæ.
  - Tritoniidæ.
  - Phyllirrhoïdæ.
  - Elysiadæ.
  - Eolidæ.

Division II.—Sexes distinct.

Including the unisexual Prosobranchiata and the Pulmonifera operculata.

Section A.

Lingual dentition in the form of a double pavement.
Proboscis retractile.

1. Teeth uniformly simple, uncinate, Proboscis short, stout.
Ear-sacs with minute otoliths &c.

- Ianthinidæ.

2. Outer uncini furnished with one or more supplementary cusps.
Ear-sacs with otoconia. Proboscis lengthy, &c.

- Solariidæ.

Section B.

Lingual membrane wholly unarmed.
Ear-sacs with minute otoliths, but in other particulars resembling Solariidæ.

- Pyramidellidæ.

Section C.

Lingual dentition ribbon-like.

1. Dental processes directed backwards from the posterior part of the dental plates.

- Ear-sacs with otoliths.
  - Strap uniserial.
    - Volutidæ.
  - Strap biserial.
    - Teeth straight for piercing.
      - Conidæ.
    - Teeth gently curved.
      - Pleurotomidæ.
  - Strap triserial.
    - Pleural plates broadly attached, fixed.
      - Cynodontidæ.
      - Mitridæ.
      - Fusidæ.
    - Pleural plates with antero-posterior motion.
      - Buccinidæ.
    - Pleural teeth uncinate with lateral motion.
      - Columbellidæ.
      - Costellariidæ.
      - Muricidæ.

2. Dental processes recurved from the fore part of the dental plates.

- Ear-sacs with otoliths.
  - Strap triserial.
    - Lamellaria.
  - Strap septiserial.
    - Proboscis retractile.
      - ?Lamellaria.
      - Ranellidæ.
      - Naticidæ.
      - Strombidæ.
      - Cassidæ.
    - Muzzle simple.
      - Cypræidæ.
      - Calyptræidæ.
      - Vermetidæ.
      - Litorinidæ.
      - Paludinidæ.
      - Melaniidæ.
      - Truncatellidæ.
      - Egeidæ.
      - Planacidæ.
- Ear-sacs with otoconia.
  - Strap septiserial.
    - Cerithiidæ.
    - Cyclophoridæ.
  - Strap multiserial.
    - Helicinidæ.
    - Neritidæ.
    - Turbidæ.
    - Haliotidæ.
    - Fissurellidæ.
    - Patellidæ.

Not classed—Dentaliidæ *and* Chitonidæ.

VI. *On* Sycopsis. *By* Daniel Oliver, *Esq., F.L.S.*

Read March 15, 1860.

Sycopsis. Genus novum *Hamamelidearum*.

Char. ess. Flores abortu uni-sexuales [an etiam nonnunquam polygami?].

Fl. ♂. Calyx brevissimus, irregulariter v. obliquè dentatus lobatusve. Corolla 0. Stamina 8, calycis tubo inserta; filamenta brevia, in connectivum continua; antheræ basifixæ, biloculares, oblongæ, apice breviter productæ. Gynœcium rudimentum bifidum.

Fl. ♀. Calyx semisuperus, tubo ovarium arctè cingente, limbo deciduo. Corolla 0. Ovarium biloculare; styli duo, distincti, subulati, intus canaliculati, minutè papilloso-stigmatosi; ovula in loculis solitaria, pendula.

S. Griffithiana, *species unica.*

Frutex verisimiliter (v. arbor parva), ramosissimus.

Ramuli cortice cinerascente, vix lævi, glabro v. ultimorum minutè puberulo. *Folia* numerosa, alterna, minutè stipulata, petiolata, integra, ovali-lanceolata, lanceolata v. obovato-lanceolata, acutè acuminata, coriacea (perennia?), discolora, glabra v. primùm pilis stellatis conspersa; costâ (in spp. exsicc.) supra depressâ, subtèr valde prominente, venularum reti inconspicuo. *Stipulæ* lanceolatæ, minutæ, citò caducæ. *Inflorescentia* axillaris, e glomerulis paucifloris vel racemis abbreviatis petiolum subæquantibus composita. *Flores* ♂ et ♀ intermixti (an semper?), primùm sessiles v. subsessiles, ante florescentiam in axillis bractearum nidulantes, omnes plus minusve pubescentiâ minutâ stellatâ obsiti. *Calyx*, ♂ brevissimus, triangulari-dentatus v. obliquè lobatus, in ♀ ad faucem, stylorum basin arctè cingentem, squamis minutis pilosis instructus; limbi lobi denique curvi v. revoluti, citò decidui. *Stamina* nonnunquam partim imperfecta; *fertilia* (cum sterilibus minoribusque non alternantia) filamentis brevibus, glabris, crassiusculis, calycem excedentibus, antheris (bilocularibus, dehiscentiâ —— ?) pro ratione magnis, ovato-oblongis, apice breviter et vix acutè apiculatis; stamina *sterilia* parva. *Ovarium* semi-inferum, stellato-pilosum, usque ad basin stylorum calycis tubo crasso arctè cinctum. *Styli* a basi distincti, divergentes, infra stellatim pilosi.

Folia laminâ $1\frac{1}{2}$ ad $3\frac{1}{2}$ poll. (sæpius circa $2\frac{1}{2}$ poll.), petiolo 2–5 lin. longis.

Further information is needed as to (1) whether the flowers are ever really hermaphrodite, (2) if both ♂ and ♀ are alike protected singly in the axils of the early caducous bracts or scales of the inflorescence (these bracts are mostly ovate or rotundate, the outer one sometimes produced above), (3) the mode of dehiscence of the anthers, (4) the ripe fruit. It is doubtful how far the lobation and degree of obliquity of the calyx-limb may be constant; I have therefore omitted, in the foregoing diagnosis, to describe the forms observed in the comparatively few good flowers which I have had an opportunity of examining*. The young subobovate fruits, narrowed and (from drying?) more or less sulcate below, together with the general appearance of the plant, recall some of the narrower-leaved

* It is probable that the limb of the calyx, both in ♂ and ♀ flowers, may be 4-toothed or -lobate (? sometimes 5-lobate),—one or more lobes in the ♀, being linear-lanceolate, subtriangular at the base.

species of East Indian *Fici*. Until the calyx-tube be laid open by dissection, the ovarium of the young fruit appears quite inferior.

The foregoing description of *Sycopsis* rests upon specimens met with in the course of arrangement of the late William Griffith's herbarium. These, although very numerous, appear to be all of one gathering, and, unfortunately, are almost all a little too far advanced to enable me to furnish, from a sufficient number of female flowers, complete details of their earlier condition. It was indeed not without a close examination of the specimens, that a few glomerules bearing staminate flowers were obtained for analysis. The examples being unaccompanied by any MS. of Mr. Griffith's, it is not improbable they may have been obtained by some of the collectors despatched by that most zealous botanist to the Khasia Hills, and that he had not had an opportunity of examining better ones himself.

In his roughly published posthumous 'Itinerary Notes,' I do not find any description referable to them. From the available material (which offers several peculiar points of structure), assisted by a drawing of Mr. Fitch's, I believe, however, that I am warranted in seeking permission to bring it before the notice of the Linnean Society, especially as a further interest attaches to what may be termed the constitution, as well as to the geographical distribution, of the natural order to which it manifestly belongs, as I shall endeavour in the course of this memorandum further to indicate.

In northern India we are already acquainted with six species, belonging to as many genera, of *Hamamelideæ*. In the consideration, therefore, of the new form, I have tried to ascertain whether, after a fresh comparison of specimens, it might not be possible, by the modification of generic diagnoses already published, to assign to some one of these the Khasian plant. I feel satisfied, however, that such cannot be accomplished with a proper regard either to the community of appreciable affinities which constitute and characterize natural genera, or to the practice of those botanists (some the most conservative of comprehensive genera) who have been engaged in the study of this group. I consider *Sycopsis* to be most nearly allied to *Distylium* (Sieb. and Zucc.), a second species of which (*D. indicum*) has been recently remarked by Mr. Bentham from Khasia.

To this genus it approximates in the ♂ ♀ tendency of the flowers, the absence of petals, the structure of the stamens and their insertion in the ♂ flower, and the axillary shortly racemose inflorescence,—differing from it most conspicuously in the adhesion of the ovary, the closely surrounding calyx-tube of the ♀ flower reaching to the base of the styles, and the number of stamens. The calyx of *Distylium racemosum* is irregularly divided almost quite to the base, the ovary superior, and the stamens five in number. The remaining uni-ovulate apetalous Asiatic genera, *Parrottia*, *Eustigma*, and *Tetrathyria*, are hermaphrodite, and in several respects abundantly diverse—*Parrottia* in its capitate precocious flowers, *Eustigma* in the extraordinarily developed stigmata and the presence of alternating didymous squamæ replacing the petals * as in *Tetrathyria*, which latter genus is also further removed by its remarkable anthers, which closely resemble those of *Hamamelis chinensis* † in the produced connectivum and double-valved loculaments. The

* Or perhaps, with a greater probability, these may be regarded as abortive stamens.

† In reference to this species, Robert Brown observed, in his account of Abel's Plants (Appendix to Abel's Narra-

anthers of *Sycopsis* I have not been fortunate enough to find subsequent to dehiscence; they are very similar before bursting to those of *Distylium* and the African genus *Trichocladus*.

In connexion with this notice it is scarcely within my province to inquire at length into the general relations of the *Hamamelideæ*. Excepting a somewhat anomalous mode of dehiscence in the anthers of a few species (at least of *Eustigma*, *Tetrathyria*, and *Hamamelis chinensis*), and the singular stipules of *Bucklandia*, the order does not offer any very salient peculiarity, neither does it afford any well-marked type of structure pervading its members. Mr. Griffith, in his 'Observations on Cantor's Plants *,' and Tulasne in "Fragmenta Floræ Madagascariensis †," remark the rather complex character of the affinities of the order, and the variety in the structure and disposition of some of the floral whorls presented by its various genera. The more characteristic features of the *Hamamelideæ* may be said to reside in their arborescent or frutescent growth; the prosenchyma bearing discoid markings from the presence of minute intercellular lenticular cavities; leaves nearly invariably alternate and stipulate; perigynous or epigynous and definite stamens in nearly all of the hermaphrodite species; the more or less inferior bicarpellary and bilocular ovary (in *Distylium* quite superior) with distinct styles; the ovules solitary and pendulous, or in the pluriovulate genera, with the exception of one or two in each loculament, mostly abortive. The order presents in these characters much in common with *Cornaceæ* (including *Alangieæ* and *Nyssa*), near which Dr. Lindley disposes it. Of this order it may not improbably be regarded as a section, especially as a *Trichocladus* of South Africa and a *Dicoryphe* described by Tulasne, from Madagascar, have opposite leaves; and as, further, in some genera we find the flowers closely aggregated into a dense capitulum (as in *Benthamia* or in *Nyssa* ‡), and sometimes also provided with conspicuous involucral bracts analogous to those of some species of *Cornus* (as in *Rhodoleia* and *Parrottia*): the frequently tetramerous symmetry of the flower and the tendency to a valvate æstivation of the petals favour this view of their affinity. With *Cunoniaceæ* and the *Saxifragal* alliance (as observed by Drs. Hooker and Thomson §) an affinity is indicated by the curious stipules of *Bucklandia*, as well as by other of the characters above enumerated. To *Bruniaceæ* the order is allied in some important particulars, as noted by Robert Brown and Prof. Lindley.

tive, p. 375), that it might not improbably be considered generically distinct from *H. virginica*, on the ground chiefly of the different structure of the anthers; and Asa Gray remarks ('Botanical Memoirs' [from Mem. Am. Acad. of Arts and Sciences, new ser. vol. vi.], p. 390), that *H. japonica* (a species which I have not myself examined) is close to *H. virginica*, "its only other strict congener"—implying, consequently, his sense of the importance of this distinction. *H. chinensis* ought, perhaps, to be separated from the American species, under the name of *Loropetalum*, suggested by R. Brown (*l. c.* p. 375).

The question may be open whether *Tetrathyria*, with the same stamens, but having the petals represented by didymous scales, ought to be reduced to the same genus with this plant. As *Hamamelis* stands at present, including both the American and Chinese species, this feature in *Tetrathyria* must be held of less than generic value, estimated by the range permitted in the yet more important particular of the structure of the anthers.

* P. 24.

† Annales des Sciences Naturelles, 4me sér. vol. viii. p. 142.

‡ The elongate revolute laterally-stigmatose style of *Nyssa* recalls that of some *Hamamelideæ*.

§ Proc. Linn. Soc. vol. ii. p. 54.

With respect to orders, on the other hand, presenting a less degree of complexity in the structure of the flower, a resemblance (to say the least of it) is presented to us between *Liquidambar*, the catkin-flowered though hermaphrodite *Corylopsis*, *Distylium*, and *Sycopsis*, and the *Plataneæ*, *Ulmaceæ*, and *Betulineæ* *.

The number of species at present known which may be referred to the *Hamamelideæ* I reckon at from 26 to 30 (28). These are grouped under 13 genera, hence in the strikingly small relative proportion of about 2 or 2·3 species to a genus. Upon the value of those characters which have been considered to possess a generic importance in this order, I may observe that, from the important bearing which it appeared to have in connexion with the distribution of its members, I have endeavoured, by the comparison and dissection of various species, to form an opinion, although with a view chiefly to determine the position and affinities, &c. of *Sycopsis*. Having in the preceding observations alluded to some of these, it is not needful here to enter upon this point, further than to observe that nearly each genus is characterized by marks of considerable importance estimated by the value ordinarily attached to them in other Dicotyledonous orders, and might only from special considerations which I think we are not yet in a position to decide upon be deemed of less than generic import.

Coupled with a regard to these peculiar intergeneric relations and one or two other concomitants, which I shall briefly touch upon, a consideration of the geographical distribution of the *Hamamelideæ* acquires considerable interest. The order is tolerably widely dispersed; at least, there occur outlying individuals or small groups far removed from what may be regarded as being at the present period their focus. None of the species, however, and, with one or two exceptions, none of the genera, present in themselves a great extension of area; on the other hand, not a few of the genera are, so far as our knowledge extends, very unusually restricted in this respect, although from our very imperfect acquaintance with the botany of the interior of Eastern Asia, probably not so remarkably as from our present data it would appear. Dr. Royle, in his valuable 'Illustrations of the Botany of the Himalaya †,' calls attention to the wide extension of the genus *Hamamelis*, of which he states one species to grow in China, a second in Peru, and a third in North America. Some singular mistake, however, must have here occurred, no species of this genus, nor, to my knowledge, of the order, having been as yet discovered in South America, and, indeed, the question as to the propriety of retaining in *Hamamelis* the Chinese species now assigned to it being quite open to doubt, as noted by Robert Brown in his paper on the plants of Abel's Journey ‡.

Dr. Royle would appear to have based his statement upon the localities given in the 4th vol. of the 'Prodromus,' in which work are enumerated three species of *Hamamelis*—*H. virginica*, *H. persica* (now *Parrottia*), and *H. chinensis*. I have little doubt that, through some *lapsus*, Peru has been substituted for Persia. The distribution of the *Hamamelideæ* is pretty nearly as follows:—

* Agardh, in 'Theoria Syst. Plant.' p. 155, says, "*Altingiaceæ* sunt *Fothergilleis* fere collaterales formam aliquantulum perfectiorem *Platanacearum* constituentes," and "*Hamamelideæ* sunt evolutione florum *Corneis, Bruniaceis, Araliaceis, Rhizophoreis* &c. analogæ."

† P. 234.

‡ *l. c.* p. 375.

In Japan, China, and the Chinese Islands, there are 9 species belonging to 7 genera —*Liquidambar, Distylium, Corylopsis, Hamamelis, Eustigma, Tetrathyria, Rhodoleia.* (1·3 : 1). Himalaya, Khasia, and the eastern peninsula, 8 species of 7 genera—*Liquidambar, Distylium, Corylopsis, Hamamelis, Parrottia, Bucklandia, Sycopsis* (1·1 : 1). [I include here an undescribed *Bucklandia* (?), of which I find specimens destitute of flower or fruit, from Malacca, in Griffith's herbarium; Griffith, from his MS. attached to these, considered them as belonging probably to this genus; the woody tissue presents the characteristic disks of the order. An imperfect fruiting specimen of probably a new *Distylium* is in the same collection, but without a locality; this I pass by.] In western Asia, Persia 1 species (*Parrottia persica*), and Asia Minor 1 (*Liquidambar orientale*), both growing socially, the latter over a very limited area. In the Indian Archipelago, according to Prof. Miquel's 'Flora Indiæ Batavæ*' are 2 species of 1 genus (*Liquidambar*); in Madagascar 1 genus (*Dicoryphe*), containing, according to Tulasne†, from 5 to 6 species; South Africa 1 genus (*Trichocladus*), of, say, 2 species; North America (U.S.) 3 species, referred to 3 genera (*Liquidambar, Fothergilla, Hamamelis*).

From the preponderating number of genera occurring in the belt extending from Japan through China to the Himalaya, this may be regarded as the centre of the order,—a circumstance presenting a possible significance when we note that it is in the same area there remains what, with some considerable show of reason, may be accepted as perhaps the oldest type of Gymnospermous structure extant in the isolated genus *Salisburia*‡. This significance is enhanced by the fact that the *Hamamelideæ*, with at least the Coniferous Gymnosperms, are alike entirely absent from the Western Indian peninsula, although, from the presence of species in the Khasia Hills, the Malay peninsula, and Madagascar, there is no reason to suppose climatic conditions at present obtaining necessarily prevent their extension thither. Viewed in connexion with the important hypotheses advanced by Messrs. Darwin and Wallace, and, in reference to plant-distribution, by Dr. Hooker, recollecting the peculiar structure of the prosenchyma of the wood, which closely resembles that of the *Coniferæ* in some respects, and also the remarkable relative proportion of species to genera, the circumstances above noted appear of interest, and with other parallel cases, which may no doubt be correlated§, are calculated to assist us towards a solution of some of the most important problems engaging the attention of botanists. It may be noted that the *Hamamelideæ* are absent from Australia, the Polynesian Islands, and South America; nor do they occur in North America, except on the eastern side of the Mississippi, the botany of which part, as has been observed by Dr. Asa Gray, presents a notable relationship with that of Japan.

Mr. Griffith first called attention to the peculiar histological character of the wood of *Bucklandia populifolia*, which attracted his attention while on a stay in the Khasia Hills

* Vol. i. pp. 836, 1097. † *l. c.* p. 142.

‡ Consult an important paper on *Trigonocarpon*, &c. in Phil. Trans. 1855, by Dr. J. D. Hooker and Mr. Binney.

§ For example, that of the anomalous group of *Calycantheæ*, like *Hamamelis*, Japanese and North American, and exhibiting, as noted by Prof. Lindley (Veg. Kingd. p. 541), discoid markings on its tissue. These markings I have seen only in *Calycanthus occidentalis* and *Chimonanthus fragrans*; I have not minutely examined their character.

in 1835*. From an examination of the wood of this species, and of a second undescribed Malayan *Bucklandia* (?), of *Rhodoleia*, *Trichocladus*, *Hamamelis*, *Sycopsis*, *Eustigma*, *Distylium*, *Corylopsis*, and *Liquidambar*, I find a close uniformity throughout in respect to its minute structure. The more or less circular and faintly defined disks of the often much elongated and tolerably thick-walled prosenchyma of the wood are, as in the *Coniferæ*, due to the presence of minute lenticular cavities between the adjoining wood-cells: the canals traversing the secondary layers of these cells are opposed on each side to these intercellular spaces, and are almost invariably elongated laterally in a direction transverse or oblique to the axis of the cell, although sometimes nearly circular and very minute, and then in all respects quite similar to those of the so-called "glandular markings" of coniferous wood†. In all the *Hamamelideæ* examined I have found a proportion of vessels in the wood fully equal to that obtaining in the more familiar Dicotyledonous structures; in some (*Corylopsis* for example) the vessels in a cross section of the wood, occupy an area about equal to that of the other tissues. Generally the vessels are transversely barred. The medullary rays are numerous and narrow, consisting of plates of but one cell (though often of two or three) in thickness. In the present state of knowledge, it would be useless to speculate on the purport of the intercellular spaces which constitute the peculiarity of the wood of these plants; nor can we indicate how far an identity of structure in this particular alone with that of Gymnosperms affords a ground for the notion that, possibly, through a long-continued series of widely receding divergences in respect to all the reproductive apparatus, the histological character of the elementary tissue of the vegetative organs might afford a contrasting constancy.

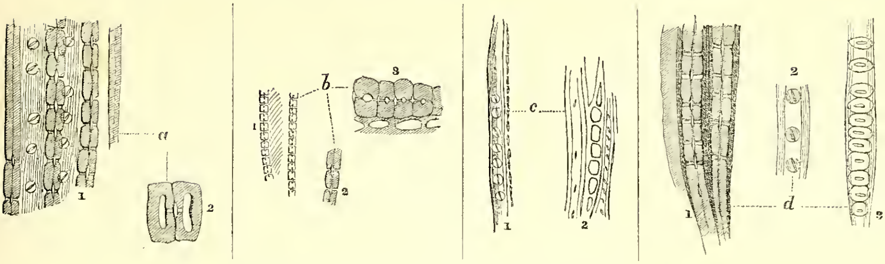
If, however, connecting links between these remarkably different groups ever existed, assuredly none now remain. If the tissue characteristic of Gymnosperms has been rightly designated by a distinguished naturalist "the highest specialized tissue known‡" (I presume, on the ground of its discoid markings), it does become of some interest to trace a close approach to it throughout a group presenting in hardly any other respect a single feature in common. In the absence, however, of vessels from the dense bundles of prosenchyma of the cone-bearing Gymnosperms (in which the markings are especially well developed), although their rôle is almost as obscure to us as that of the interspaces of the wood-cells, I should scarcely regard this tissue as offering, in its structure, a higher measure of specialization than obtains in the little order under consideration.

* Private Journals, p. 4.

† In some Gymnosperms, however, the canals are often thus elongated, and become slit-like, as occurs in *Callitris* and *Araucaria Bidwellii*. In *Salisburia* the disks are irregularly scattered and small.

‡ Dr. Hooker in 'Essay on the Flora of Australia,' p. xxii.

W. H. Fitch, del. Sycopsis Griffithiana. Jarman sc.



EXPLANATION OF WOODCUTS.

a. Liquidambar Altingia. 1. vertical, 2. transverse sections, showing the lenticular intercellular cavities, with their canals.

b. Trichocladus. 1 & 2. vertical, 3. transverse sections.

c. Corylopsis Himalayana. Vertical sections, in fig. 2 traversing a medullary plate.

d. Sycopsis Griffithiana. Vertical sections of wood-cells.

DESCRIPTION OF THE PLATE.

Tab. VIII.

Sycopsis Griffithiana.—Natural size.

Fig. 1. Young ♂ flower, nestled in a slightly hollowed recess exterior to the base of a bract of the yet unexpanded inflorescence.

Fig. 2. ♂ flower, with subtending bract; but three stamens developed.

Fig. 3. The same, showing obliquity of the calyx.

Fig. 4. The same, laid open.

Fig. 5. Rudimentary stamen.

Fig. 6. Bifid rudiment of pistil from ♂ flower.

Fig. 7. Glomerule of ♀ flowers.

Fig. 8. Single ♀, with lobes of the calyx, tolerably perfect, still remaining.

Fig. 9. Vertical section of ♀ flower.

VII. *On two Tuberiform Vegetable Productions from Travancore.* *By the* Rev. M. J. Berkeley, *M.A.*, *F.L.S.*

Read May 3, 1860.

In the spring of the year 1858 a short notice was read of some remarkable vegetable productions from China*. Two similar organisms have lately been transmitted by Dr. E. J. Waring of Trevandrum, Travancore, to Mr. Hanbury, who has kindly entrusted them to me for examination. Prepared sections accompanied the specimens, and I have had the advantage of Mr. Currey's assistance in their examination; after all, however, I can do little more than place on record the account transmitted to Mr. Hanbury.

The first, called in the Tamil language புற்றுமாங்கா *Puttu-manga*, a name which I understand may be translated *White-ant Mango* or *White-ant Fruit*, occurs in Travancore. The following history of it was sent with the specimens to Mr. Hanbury:—"Three weeks since, I had occasion to open the floor of the centre room of my house for the purpose of building two walls; and on digging to the depth of three feet below the surface, I found several holes scooped out in the earth, perfectly smooth and circular, of sufficient size to admit a man's hand. Hanging down from the sides of these cavities were clusters of 4, 5, 6, or 10 of the accompanying fruits, of various sizes and shapes. On showing them to the native practitioners, they eagerly took possession of the greater number, calling them by the name of *Puttu-manga*, and stating that they were found, though but rarely, under the foundations of old buildings, and that they were formed or produced by the white ants. They likewise stated that they were highly valued for medicinal purposes. The cavities above alluded to are doubtless the chambers or galleries formed by the white ants."

They look at first sight extremely like some neat variety of *Xylaria polymorpha*, with a slender stem and pointed barren apex. There are, however, no perithecia beneath the jet-black cuticle; and the structure is not delicately filamentous, as in *Xylaria*. On the contrary, the mass consists of very irregular, swollen, and sometimes constricted, more or less anastomosing, and more or less densely compacted threads. Towards the margin the substance is firm, but looser towards the centre, so that the individual threads easily separate. The structure in some respects resembles that of *Pachyma*; but there is no indication of the threads having undergone any chemical change. I should say that it is certainly not the root of any Phænogam, but of a fungous character, though it does not exactly agree in structure with any thing that I know. Notwithstanding some little resemblance, it cannot, I think, be associated with *Pachyma Cocos*; and therefore, if it be desirable to give so very doubtful a production a name, it may be called *Sclerotium stipitatum*, Berk. & Curr. It is distinguishable at once by the stem and the shining

* Journ. of the Proceedings of the Linnean Society, vol. iii. (1859) Botany, p. 102.

black continuous cuticle. The total absence of veins and different texture forbid its junction with *Mylitta*.

The second production, also sent by Dr. Waring to Mr. Hanbury from Travancore, is known by the name of Carom-pallagum, which may be rendered *Black Pallagum*, *Pallagum* signifying *a medicinal substance*. It is dug from the chalk-beds in the mountains which separate Travancore from Tinnivelly. The hill people, who bring it occasionally into Trevandrum for sale, state that it is the root of a small plant with a red flower. It is much esteemed by the native doctors for various complaints.

The account, however, which the natives give of its origin is evidently wrong; for it cannot be pretended that, like *Pachyma*, it may be a peculiar state of the root of some Phænogam. Its structure is in fact very like that of *Mylitta australis*; and though there is a slight difference in the outer coat, it is probably the same thing with the *Mylitta* of China, known under the name of *Luy-wan*, and to which Horaninow has given the name of *Mylitta lapidescens* ('Catalogus Medicamentorum Sinensium,' Petropoli, 1856, p. 34).

The specimens, indeed, are not so much advanced as those of the Luy-wan, so that the peculiar sacs are few and only partially developed; but there is no doubt that the structure of the two is identical.

VIII. *Remarks on* Sclerotium stipitatum, *Berk. et Curr.*, Pachyma Cocos, *Fries, and some similar productions. By* Frederick Currey, *Esq., M.A., F.R.S., F.L.S., and* Daniel Hanbury, *Esq., F.L.S.*

Read May 3, 1860.

We have investigated with some attention the nature of the body to which, in the preceding paper, Mr. Berkeley has given the name of *Sclerotium stipitatum*, and have compared it with the other tuberiform bodies described by him in a former paper published in the 3rd volume of the Journal of this Society. These other bodies are, *Pachyma Cocos*, Fries (the *Pe-foo-ling* of the Chinese); the substance called in China *Choo-ling*; and Professor Horaninow's *Mylitta lapidescens*. We have thought that a few additional remarks, accompanied by figures of the specimens and of their microscopic structure, may facilitate future inquiries, which are much needed in order to arrive at a satisfactory conclusion as to the nature of these anomalous productions.

And first with regard to *Sclerotium stipitatum*. Pl. IX. figs. 1, 2, and 3 represent the only three specimens which have hitherto reached this country, drawn to their natural size. We are quite of Mr. Berkeley's opinion, that they are of a fungoid nature, although it is impossible to speculate as to what the perfect state may be. Several hard, shapeless, fungoid bodies, the nature of which was long misunderstood, have been found to produce, under favourable circumstances, perfect *fungi* of well-known and very diverse genera. The tuber from which *Peziza tuberosa* is ultimately produced was supposed by Hedwig to be a dried Anemone root; and the true nature of the common Ergot of Rye was quite unknown until Tulasne called attention to the fact that it consists only of compact mycelium, which, under particular treatment, may always be made to produce a species of *Cordyceps*,—an observation which has since been verified by Mr. Berkeley and other mycologists. There is a black, cylindrical, fungoid body found in the interior of the stems of rushes, long known by the name of *Sclerotium roseum*, which has lately been found to give rise in the spring of the year to a species of *Peziza*, a description of which will be found in the 1st volume of the Journal of this Society*. This *Sclerotium* has also been treated successfully under cultivation: a specimen was gathered last November, and kept during the winter under the requisite conditions of moisture; and in the first week in April the *Peziza* appeared, a few days only before its occurrence in its native habitat. We think it not improbable that *Sclerotium stipitatum* might be treated so as to induce it to perfect its fructification; and we have some hope of procuring a further supply of specimens from India, to enable us to institute the necessary experiments. The specimens hitherto received, besides being only three in number, were destined by their sender, Dr.

* "On a new Species of *Peziza*, being the full development of *Sclerotiumr oseum*, Kneiff." by F. Currey, Esq., F.L.S. (*op. cit.* vol. i. p. 147).

Waring, for the Museum of the Pharmaceutical Society. Pl. IX. fig. 4 represents a thin section of the white inner substance of the *Sclerotium*, taken from near the circumference. The threads are of very irregular shape, and hardly similar in any two sections; but their general nature may be seen from the figure just referred to.

2. *Pachyma Cocos*, Fries. The variety of names which this remarkable substance has received, renders a list of its synonyms not undesirable; we therefore subjoin one which, with the needful references, will, we believe, be found nearly, if not quite, complete.

Pachyma Cocos, Fries, Syst. Mycologicum, vol. ii. (1822) p. 242, vol. iii. (1829) p. 223; Elenchus Fungorum, vol. ii. p. 39. Oken, Lehrbuch d. Naturgeschichte, 2ter Theil, Botanik, 2te Abtheil. 1te Hälfte (1825), p. 93. Tulasne, Fungi hypogæi, p. 197.

P. solidum, Oken, Lehrbuch d. Naturgeschichte (*l. c.*), p. 93.

P. Pinetorum, Horaninow, in Tatarinov, Catal. Medicamentorum Sinensium (Petrop. 1856, 8vo), pp. 2–23.

P. Coniferarum, Horaninow in litt.

Sclerotium Cocos, Schweinitz, Synopsis Fungorum Carolinæ superioris, in Act. Societatis Naturæ Scrutatorum Lipsiensis, tom. i. (1822) p. 56.

Lycoperdon cervinum, Walter, Flora Caroliniana (1788), p. 262.

L. solidum, Gronovius, Flora Virginica (1762), p. 176. Macbride, Linn. Trans. vol. xii. (1818) p. 368.

Tubera Terræ maxima, externe pulla et scabra, intus candida, Gronovius, Flora Virginica (1743), pars ii. p. 205.

Indian Bread or *Tuckahoe* M. J. B. in Gardeners' Chronicle, 16 Dec. 1848.

Pĕ fŏ lîm, Cleyer, Specimen Medicinæ Sinicæ (1682), Med. Simp. No. 189.

茯苓 (*Fŭh-ling* vel *Foo-ling*), Pun-tsaou-kang-muh, cap. xxxvii. sect. 4 (cum icone).

Fine specimens of this production, received many years since from Dr. Macbride of South Carolina, and described by him in the 12th volume of the 'Linnean Transactions,' under the name of *Lycoperdon solidum*, are to be seen in the Museum of the Society; and one of the most characteristic of these specimens is represented in Pl. X. fig. 5. Pl. X. fig. 6 represents a longitudinal section of a very similar specimen, and is interesting as exhibiting very completely the manner in which the root has been affected by the *Pachyma*. Dr. Macbride states that the *Pachyma* originates between the wood and bark of living roots, that it gradually detaches the bark, while it spreads round the wood and converts it into a substance similar to itself. The present section, however, exhibits an intermediate condition; for, although the bark is detached and the *Pachyma* interpolated between it and the wood, a great part of the wood itself is but little affected. The portion referred to by the letter *a* retains its natural colour and appearance; and when examined in section under the microscope, is found to consist of healthy woody tissue in an almost perfect state. This portion, when looked at with a lens, or even with the naked eye, may be seen to be traversed by narrow longitudinal white streaks, which the microscope shows to be very similar in composition to the part marked *b*, next described. This part (*b*) to the naked eye looks like wood of a very pale colour, but it presents a totally different appearance under the microscope. It consists of what appears to be a mass of mycelium, the threads of which have forced their way through the substance of the wood in every direction, separating the cells and converting them into irregularly shaped bodies of a highly refractive nature, having a good deal the appearance of starch-granules, but without any concentric markings, and exhibiting no reaction with iodine. A section of this portion is shown in Pl. IX. fig. 7. The remaining parts of the specimen, marked *c* and *d*, and which constitute the main portion of the *Pachyma*, bear a general resemblance, when seen under the microscope, to the section shown in fig. 7; but the component bodies vary more in size, and many of them attain larger dimensions: the mycelium also is far less plentiful. A reference to Pl. IX. fig. 8 will show the form of a few of the latter bodies, a combination of which with tissue, such as that shown in fig. 7, constitutes the mass of the *Pachyma*. We entertain no doubt that the bodies shown in Pl. IX. fig. 8 are of the same nature as those in Pl. IX. fig. 7; *i. e.* they are wood-cells, in a more advanced state of disease and distortion. If it is wished to examine the threads or mycelium separately from the substance of the *Pachyma*, it may be done by selecting a specimen such as that shown in Pl. X. fig. 9, in which the substance is traversed by cracks. It will then be seen that (at least in some specimens) the opposite walls of the cracks are united by masses of white woolly fibres; and by taking a small quantity of the wool in forceps, and placing it under the microscope, it will be seen to consist exclusively of delicate threads entirely free from the irregularly shaped starchy-looking bodies forming the mass of the *Pachyma*. These threads are similar to those in Pl. IX. fig. 7, and are, we suspect, of fungoid origin; and although we see no reason to doubt that the *Pachyma* is in the main (as has been long supposed) only an altered state of the root of the tree, we think it highly probable that that altered state is the effect of fungoid disease, and that all the threads above alluded to may be the mycelium to which the disease is due. The section shown in Pl. X. fig. 6 exhibits at one end, at the points *e*, a brown dusty mass, formed by the disintegration of the inner bark. The greater part of the interior of this specimen is of a dirty brown colour, produced by a copious admixture of the particles of the bark with the substance of the *Pachyma*, which latter is not so pure and white as is usually the case.

3. *Choo-ling*, Berkeley, Journal of Proceedings of Linn. Soc. vol. iii. (1859) Botany, p. 102.

Chū lîm, Cleyer, Specimen Medicinæ Sinicæ (1682), Med. Simp. No. 207.
Czżu-lin, Tatarinov, Catal. Medicamentorum Sinensium (Petrop. 1856), p. 17.
豬苓 (*Choo-ling*), Pun-tsaou-kang-muh, cap. xxxvii. sect. 4 (cum icone).
? *Hoelen*, Rumph. Herb. Amb. xi. p. 123.

Pl. IX. figs 10–13 represent specimens of this production, as to which we have little to add to Mr. Berkeley's account (*ut supra*). No botanical name has yet been proposed for it, which, in the uncertainty that exists respecting its origin and nature, is not to be regretted. Its microscopic structure is similar to that of *Pachyma Cocos*; but the threads by which its substance is traversed are much more interwoven and more branched, being in fact almost reticulate: they have not the appearance of being the mycelium of any fungus. We observe the same irregularly shaped bodies as in the *Pachyma*; but their dimensions, as remarked by Mr. Berkeley, are smaller: like the *Pachyma*, they are not rendered blue by iodine. In one or two specimens we have noticed an abundance of doubly pyramidal crystals, and we have also observed that the substance of the interior is much more tough and leathery than in *Pachyma*, which latter is in fact easily pulverizable. The specimens of *Choo-ling* vary much in size as well as in form. The largest we have (and which is drawn in Pl. IX. fig. 10) weighs 481 grains, and the smallest 15 grains; the average of 46 specimens is 86 grains. All exhibit a thin, black, more or less shrivelled cuticle, closely investing the uniform, corky, cream-coloured substance of which the mass of the tuber consists.

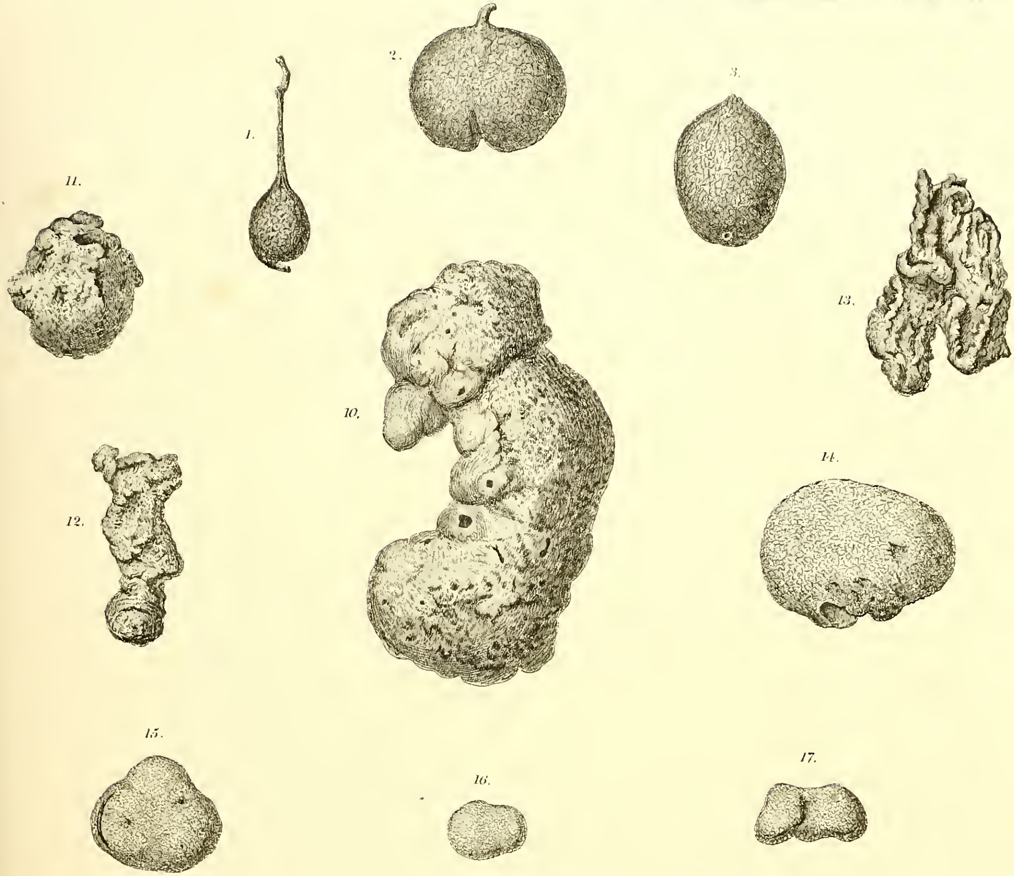
4. *Mylitta lapidescens*, Horaninow, in Tatarinov, Catal. Medicamentorum Sinensium (Petrop. 1856), p. 34.

Lûi uôn, Cleyer, Specimen Medicinæ Sinicæ (1682), Med. Simp. No. 227.
雷丸 (*Luy-wan*), Pun-tsaou-kang-muh, cap. xxxvii. sect. 4 (cum icone).
கரும்பாலகம் *Carom-pallagum.*

The fourth tuberiform substance to which we have alluded is that named by Horaninow *Mylitta lapidescens*. Specimens of this production, both from India and China, are drawn in Pl. IX. figs. 14–17. In a dry state they are extremely hard, so much so that, in the case of the Indian specimens, they might easily be supposed at first sight to be some stony substance from the chalk-beds out of which they are dug. There can be no doubt, however, of their vegetable nature, and but little, we think, as to their affinity with the hypogæous fungi. Although no trace of fruit is discernible, the inner substance is marked with veins, and a microscopic section shows the division of the tissue into *areolæ* similar to that exhibited by the hypogæous fungi. It is not easy to say whether it is truly of parasitic growth, though the natives of India assert it to be so. It will be seen, by referring to Pl. IX. fig. 15, that the specimen there represented has a small root-like excrescence on the left-hand side; and this excrescence, of which we have examined sections, is certainly of woody structure, although we are unable to say to what plant it belongs. Out of fifty Chinese specimens, however, only four exhibit these roots, which it is possible may be of accidental occurrence. The largest of these specimens weighs 106 grains, and the smallest 5 grains, the average weight of 50 being 24·6 grains. The largest Indian specimen weighs 268 grains.

We are informed by Dr. Waring that the native Indian name, *Carom-pallagum*, means literally, *Black pallagum, pallagum* signifying *a medicinal substance*. Our specimens are all grey or brown rather than black; but the wrinkles on the surface, which are very minute and which cannot be seen clearly without a lens, are of a very dark colour. It is possible that the specimens, when moist and fresh, may be of a darker colour than when in the hard and dry condition in which they reach this country. We think it hardly probable that the dry specimens in our possession should be brought to fructify, although the instance of Ergot of Rye producing fruit after having been baked in an oven shows that fungi may undergo a good deal of hard treatment without losing their vitality.

We are experimenting with the *Mylitta*; and if we succeed in causing it to produce fruit, we shall not fail to report the result.



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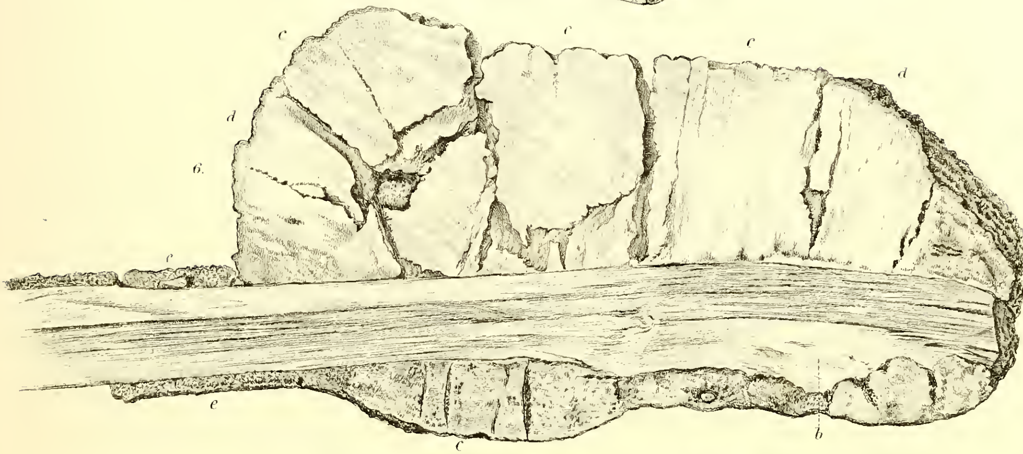

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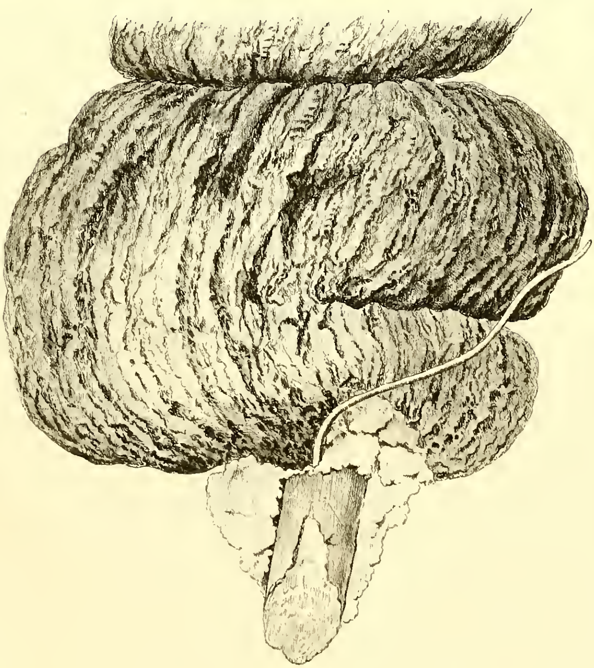


EXPLANATION OF PLATES.

Plates IX. & X.

Figs. 1, 2, 3. Specimens of *Sclerotium stipitatum*, Bk. & Curr., natural size.

Fig. 4. Thin section of the inner substance of *Sclerotium stipitatum* highly magnified.

Fig. 5. Specimen of *Pachyma Cocos*, Fr., in the Linnean Society's herbarium, natural size.

Fig. 6. Longitudinal section of another specimen in the same herbarium.

Figs. 7 & 8. Thin sections of portions of the latter specimen, highly magnified.

Fig. 9. Portion of another specimen of *P. Cocos* in the Linnean Society's herbarium, showing cracks in the substance, the walls of which cracks are united by woolly fibres.

Figs. 10–13. Specimens of *Choo-ling*, natural size.

Figs. 14–17. Specimens of *Mylitta lapidescens*, Horan., natural size.

IX. *On some New Zealand* Verrucariæ. *By* Charles Knight, *Esq., F.L.S.*

Read February 16th, 1860.

THE following paper contains a description of certain corticolous Lichens of New Zealand, accompanied by figures of the spores.

The size of the spores of the same Lichen is found to vary within certain limits. Those contained in the ascus are frequently much smaller than some of the loose spores found solitary on the field of the microscope. Spores of a brown colour when mature, are of a lighter colour, or even diaphanous, when young. The septa are not always visible until after the spores are perfectly mature; frequently the number of the septa is fewer in the young spore.

A. *Sporæ uniseptatæ.*

1. Verrucaria minutella; thallo tenui, cinereo, lævigato, effuso; peritheciis madefactis immersis, siccis innatis, minutissimis, confertis, integris, globosis; ascis oblongo-ellipticis, sporas luteolas clavatas foventibus. Matrix non mutatur.

Pl. XI. fig. 1. Spores magnified.

2. V. binucleolata; thallo brunneo, effuso; peritheciis parvis, superficialibus, dimidiatis, basi patente; ascis longis, cylindricis, sporas brunneas uniseptatas binucleolatas obovatas foventibus.

Pl. XI. fig. 2. Spores magnified.

3. V. epidermidis, Ach., Schærer Lich. Helv. Exs. 107, 108.

Var. *gemellipara*; thallo fulvo v. cervino, linea atra limitato; peritheciis confertis, hemisphæricis, madefactis thalli epidermide velatis, basi late patente; sporis obovatis, cellula superiore majore, margine crassa.

Pl. XI. fig. 3. Spores magnified.

Var. *pseudo-punctiformis*; thallo fulvo; peritheciis confertis, siccis prominulis tandem plus minus superficialibus, dimidiatis, basi amplificata; sporis obvatis. Sporæ interdum 5-septatæ, fusiformes.

Pl. XI. fig. 4. Spores magnified.

4. V. magnospora; thallo atro-cinerascente, contiguo, effuso, linea nigra limitato; peritheciis nudis, magnis, margine dealbato cinctis, dimidiatis, basi patente; ascis clavatis; sporis maximis, tandem leviter brunneis, in medio constrictis, margine duplici hyalino.

Pl. XI. fig. 5. Spores magnified.

B. *Sporæ triseptatæ.*

5. V. nitida, Schrad.

Var. *a. pseudo-nitidella*; thallo ferrugineo, effuso; peritheciis parvis, nudis.

Pl. XI. fig. 6. Spores magnified.

6. V. GLABRATA, Ach.

Var. *α.* thallo albo aut cerino, nunc diffracto nunc contiguo, effuso v. punctiunculis nigris limitato; peritheciis magnis, interdum thalli epidermide plus minus velatis, demum denudatis, hemisphæricis, arcus basi nigra. Matrix valde mutatur. Crusta maculis pallidis non aspergitur.

Pl. XI. fig. 7. Spores magnified.

Var. *β. cinereo-alba*; thallo membranaceo, cinereo-albo, contiguo, lineis nigris flexuosis limitato (?); peritheciis parvis, prima ætate crusta obtectis, hemisphæricis, arcus basi nigra; sporis biserialibus. Matrix valde mutatur.

Var. *γ. deprimens*; thallo cinereo, effuso; peritheciis integris v. dimidiatis. Sporæ interdum uni- bisep-tatæ, loculo superiore multoties majore.

Pl. XI. fig. 8. Spores magnified.

Var. *δ. homalisma*; thallo fusco-luteo, effuso, lævigato; apotheciis maximis, applanatissimis, integris, late patentibus. Matrix nonnihil mutatur. Crusta maculis pallidis non aspergitur.

Pl. XI. fig. 9. Spores magnified.

C. *Sporæ multicellulosæ vel muricatæ.*

7. V. MONILIFORMIS; thallo olivaceo, effuso, inæquabili; peritheciis integris, innatis v. superficialibus, basi patente, nucleo subgloboso fulvo; ascis cylindricis; sporis 7-septatis, brunneis, ellipticis, nucleolis sæpe moniliformibus.

Pl. XI. fig. 10. Spores magnified.

8. V. DELIQUESCENS; thallo fulvo, effuso, glabro; peritheciis thalli epidermide plus minus velatis, integris, crassis, basi patente; sporis subcurvis, 10-nucleolatis v. uni-septatis, brunneis; nucleolis elliptico-lenticularibus, sæpe deliquescentibus.

Pl. XI. fig. 11. Spores magnified.

9. V. PYRENASTROIDES; thallo luteo aut griseo, effuso; peritheciis integris, confluentibus, thalli epidermide plus minus velatis, demum denudatis, ostiolis distinctis areola pallida cinctis; sporis oblongo-ellipticis, magnis, brunneis, multicellulosis, 8–10-annulatis, annulis quadrate cellulosis.

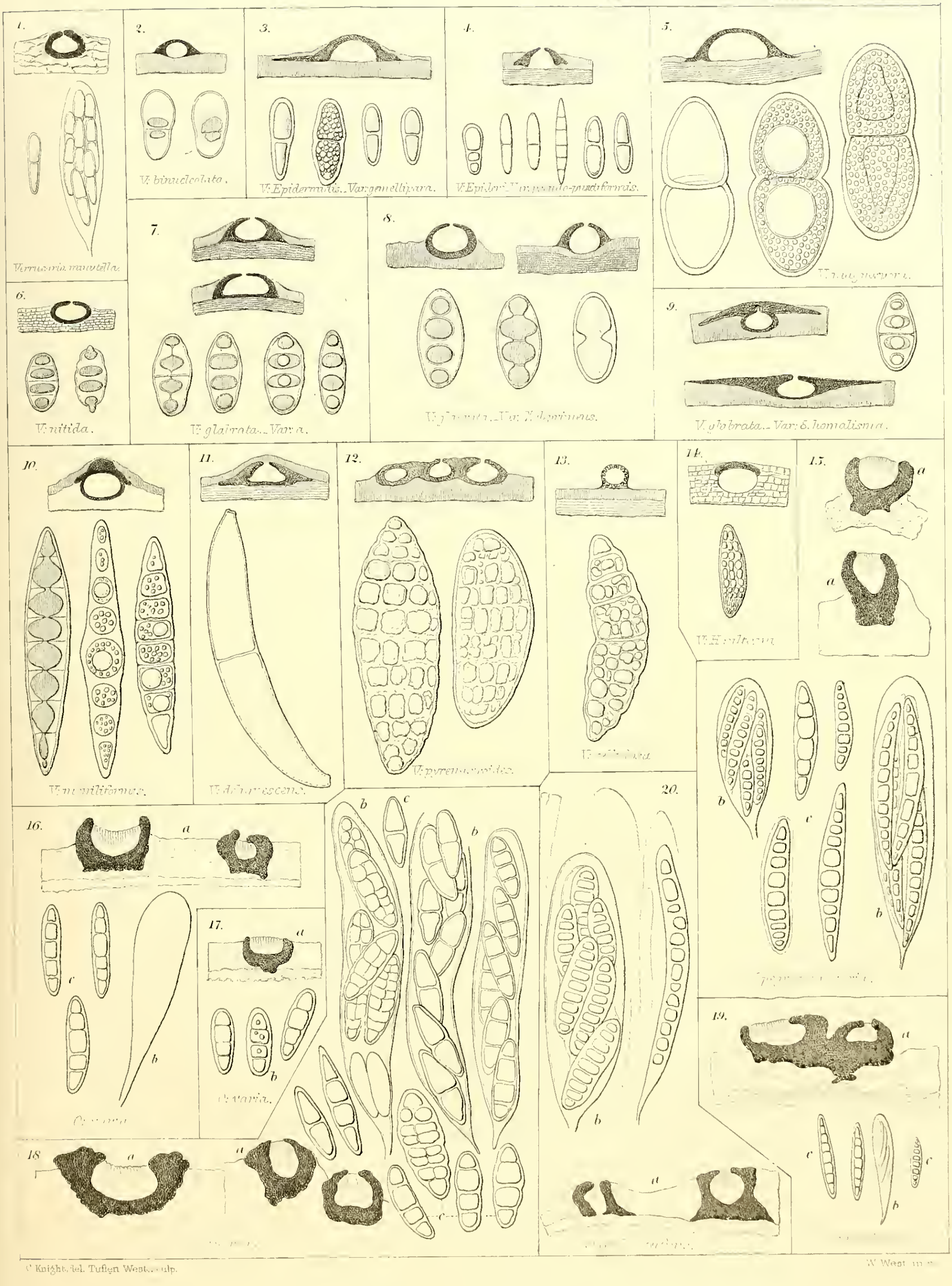
Pl. XI. fig.12. Spores magnified.

10. V. CELLULOSA; thallo olivaceo, effuso; peritheciis minutissimis, integris, cellulosis, superficialibus, nucleo fuligineo; ascis subrotundis, sporas magnas oblongo-ellipticas biseriales brunneas muricatas foventibus.

Pl. XI. fig. 13. Spores magnified.

11. V. HAULTAINI; thallo olivaceo vel ochraceo, inæquabili, effuso; peritheciis minutissimis, madefactis immersis, dimidiatis, nucleo globoso; ascis clavatis, sporas subclavatas muricatas magnas foventibus. Matrix non mutatur.

Pl. XI. fig. 14. Spores magnified.



C. Knight del. Tuffen West sculp. W. West imp.

X. *Contributions to the* Lichenographia *of New Zealand; being an account, with figures, of some new species of* Graphideæ *and allied Lichens. By* Chas. Knight, *Esq., F.L.S., Auditor-General of New Zealand; and* W. Mitten, *Esq., A.L.S.*

Read April 19th, 1860.

THE following enumeration of the species of *Graphideæ*, additional to the Flora of New Zealand, includes some very curious tropical forms, as well as a proposed new genus for the reception of two nearly allied Lichens which do not appear to correspond with any of the numerous genera with which this group seems overburdened. Great difficulty, however, attends the investigation of these obscure plants; and much more seems yet required to be known of the tropical forms, before the genera, as at present constituted, can be considered as more than arbitrary divisions.

Opegrapha, Ach.

O. varia, Pers.

Hab. On trees, Auckland.

The following forms have been observed:—

1. Thallus olive-brown; apothecia superficial, slender; rima a mere chink; spores 5–9-septate, measuring from 0·0003 to 0·00115 of an inch.

Pl. XI. fig. 15. *a.* sections of the apothecium; *b.* thecæ; *c.* spores.

2. Thallus olive-brown tending to grey; apothecia more or less immersed when moist, the margin separating in the middle; spores 4–5-septate, measuring from 0·00024 to 0·0009 of an inch.

Pl. XI. fig. 16. *a.* section of thallus and apothecium; *b.* theca; *c.* spores.

3. Thallus dusky-grey; apothecia immersed when moistened, oblong, open; spores 3–4-septate, measuring from 0·00025 to 0·0007 of an inch.

Pl. XI. fig. 17. *a.* section of thallus and apothecium; *b.* spores.

The form 2 closely resembles the *O. varia* var. *tridens*, Schær. Lich. Helv. Exsic. No. 98. In all essential particulars the New Zealand forms agree with the European.

O. cinerea, Knight & Mitten. Thallus ashy-grey, pulverulent, sometimes obsolete; apothecia superficial, simple, oblong, straight or curved, closed; spores brown, 3-septate, sometimes 1-septate, and then contracted in the middle, frequently mural, measuring from 0·00025 to 0·00075 of an inch.

Hab. On trees, Auckland.

The short thick closed apothecia readily distinguish this species from the preceding.

Pl. XI. fig. 18. *a.* sections of apothecia; *b.* thecæ; *c.* spores, in which the different degrees of septation are seen.

O. PROMINULA, K. & M. Thallus white, uneven or minutely warty, moderately thick, its substance containing extensive patches of green round gonidia; apothecia superficial, crowded, subparallel or disposed in all directions, straight or sometimes curved, closed; spores elliptical or oblong, 7-septate, measuring from 0·00015 to 0·0008 of an inch.

Hab. On trees, Auckland.

This species resembles *O. varia*; but the crust is more even and whiter, and the apothecia for the most part entirely closed by the more prominent border of the perithecium.

PL. XI. fig. 19. *a.* section of thallus and apothecia; *b.* theca; *c.* spores.

GRAPHIS, Ach.

G. CONFINIS, K. & M. Thallus cream-coloured or grey; apothecia immersed, elongate, wavy, sometimes branched or forked, the ends acute, closed by the inflexed perithecial margin; perithecium entire below, or dimidiate; spores 6–8-septate, intermediate spaces transversely oval, measuring from 0·00034 to 0·0011 of an inch.

Hab. On the bark of trees, Auckland.

The paler thallus and narrower and thicker border of the perithecium easily distinguish this from the *Graphis scripta*, Ach., with which it most nearly agrees in the form of its spores, but from which it differs in the generally entire perithecium (which is also closed above), and, as it would appear, in the smaller size of the entire plant.

PL. XI. fig. 20. *a.* section of the thallus and apothecia; *b.* theca containing spores.

FISSURINA, Fée.

F. INSIDIOSA, K. & M. Thallus thick, uneven, warty, dull green, brownish when dry; apothecia crowded, simple or branched, deeply immersed in the thallodal warts, closed, their lips slightly paler; spores in a single series, oval or obovate, yellow, before maturity with a broad hyaline margin, measuring from 0·00035 to 0·0007 of an inch.

Hab. On the bark of trees, Auckland.

In the dried state the thallus is of a dull brownish colour, and it appears to be surrounded by a narrow black border. The apothecia, which are quite undistinguishable from the thallus by the naked eye, appear, when magnified, to be but fissures; in the more perfectly developed ones there is seen to be a slightly paler margin, sunk below the surface of the thallus, representing the lips of the lirella; a transverse section shows no trace of a perithecium, beyond a dark spot in the interior of the substance of the margin of the fissure. The thalamium is opaline, the epithecium brown.

PL. XII. fig. 21. *a.* section of thallus and apothecium; *b.* thecæ; *c.* spores.

F. INQUINATA, K. & M. Thallus cartilaginous, polished, ashy-grey or brown, uneven; apothecia deeply immersed, elongate, wandering, variously branched and wavy, narrow, almost covered by the darkened border of the thallus; spores oblong or obovate, yellow, 3–4-septate, with a narrow hyaline margin, measuring from 0·00040 to 0·00084 of an inch.

PL. XII. fig. 22. *a.* section of thallus and apothecium; *b.* thecæ; *c.* spore.

A browner-coloured species than the last, the thallus less warty, and the apothecia indistinctly marked out to the naked eye by a stained line; when magnified, there is nothing, beyond the fissure, to be seen of the epithecium; on making a transverse section, it becomes evident that the stained appearance surrounding the fissure is due to the almost black traces of the sides of the perithecium imbedded in the thallus, more evident in some examples than in others. The thalamium is opaline, considerably dilated below, and the epithecium deep brown. This species very closely resembles *F. nitida*, Mont., and may be a form of that species; but the spores could not be found in an authentic specimen.

PLATYGRAPHA, Nyl.

P. MICROSTICTA, K. & M. Thallus dusky grey; apothecia round or oblong, flexuose, simple or branched, broader at one end, ends rounded; epithecium dark brown; hypothecium black; spores fastigiate, fusiform, 3-septate, measuring from 0·00010 to 0·00140 of an inch.

Hab. On bark, Auckland.

Thallus everywhere covered at equal distances by the apothecia, which to the naked eye resemble minute black specks.

PL. XII. fig. 23. *a.* section of thallus and apothecium; *b.* theca; *c.* spores; *d.* apothecium as seen from above.

P. INCONSPICUA, K. & M. Thallus brown, with a slight lilac tinge when dry; apothecia very minute, roundish or oblong, with one end acuminate, immersed; hypothecium black; epithecium contracted, blackish-brown; spores fastigiate, not? septate, fusiform, measuring from 0·00120 to 0·00175 of an inch.

Hab. On bark, Auckland.

This species seems remarkable for a dull lilac-brown colour. The apothecia are quite invisible to the naked eye, and when magnified resemble black dots. The spores appear to be without any trace of septa.

PL. XII. fig. 24. *a.* section of thallus and apothecia; *b.* theca; *c.* spore.

P. TUMIDULA, K. & M. Thallus dark yellowish-brown, somewhat swollen around the elongate curved or short apothecia; epithecium flat, irregular, bistre, defined by a very narrow dark line; hypothecium brownish-black; spores fastigiate, fusiform, measuring from 0·0001 to 0·0014 of an inch.

Hab. On bark, Auckland.

The colour of the thallus in the dried state resembles that of *Lecidea parasema.* The apothecia are conspicuous to the naked eye, and are very irregular in their form and size. The spores, like those of the preceding species, have no septa.

PL. XII. fig. 25. *a.* section of thallus and apothecium; *b.* theca; *c.* spores; *d.* apothecia as seen from above.

P. OCCULTA, K. & M. Thallus reddish-brown, obscure, apothecia irregularly branched, subradiate, angular, edges torn; thallodal margin raised, powdery white; epithecium flat, blackish-brown; hypothecium black; spores fastigiate, fusiform, 4?-septate, measuring from 0·00005 to 0·00160 of an inch.

Hab. On bark, Auckland.

Thallus very obscure, scarcely evident, and apothecia quite imperceptible to the naked eye. This species agrees with the preceding ones in the arrangement of its spores.

PL. XII. fig. 26. *a.* section of thallus and apothecium; *b.* theca; *c.* spore; *d.* apothecium as seen from above.

PLAGIOGRAPHIS, new genus.

Thallus very thin, obscure (hypophleode?); apothecia elongate rimæform, surrounded by a perithecium which is covered by the thallus, connivent above, and divaricated and oblique below; hypothecium free; thecæ pyriform; spores bilocular.

P. DEVIA, K. & M. Thallus smooth, thin, yellow or grey; apothecia blackish brown, elongate, flexuose or branched, here and there contracted, thallodal margin very thin, at length erect; epithecium nearly covered by the walls of the perithecium, dark-coloured; spores contracted in the middle, 1-septate, upper cell the larger, measuring from 0·00030 to 0·00065 of an inch.

Hab. On smooth bark, Auckland.

Apothecia externally like small black specks; when magnified, they appear as long or short almost closed lirellæ; on making a vertical section, they are seen to have on each side a black wall of perithecium immediately beneath the surface of the thallus, extending a considerable distance in its substance away from the epithecium, and leaving the lower part of the thalamium and its base entirely free. At first sight, the appearance of this species is entirely that of an *Arthonia*.

PL. XII. fig. 27. *a.* section of thallus and apothecia; *b.* thecæ; *c.* spores.

P. RUBRICA, K. & M. Thallus corneous, polished, red or reddish brown; apothecium round, oblong, or elongate and curved, without any thallodal margin, blackish-brown, slightly prominent, open; perithecium extending far under the thallus; spores 1-septate, measuring from 0·00020 to 0·00053 of an inch.

Hab. On smooth bark, Auckland.

Similar to the preceding species, but with a differently coloured thallus and open apothecia, which in a vertical section exhibit the dark-brown perithecial walls extending far under the thallus on each side, and, as in the other species, leaving the lower part of the thalamium entirely free.

PL. XII. fig. 28. *a.* section of the thallus and apothecium, with a portion of the bark beneath; *b.* thecæ and spores; *c.* apothecium as seen from above.

ARTHONIA, Ach.

A. LOBULATA, K. & M. Thallus ochreous or grey; apothecia angular, lobed or subradiate, plane, margin defined by a narrow line, deep-brown, almost black; spores 1-septate, oblong, light yellow, measuring from 0·0002 to 0·0006 of an inch.

Hab. On bark, Auckland.

Pl. XII. fig. 29. *a.* section of the thallus and apothecium; *b.* theca; *c.* apothecia as seen from above.

This species differs from the following in its clavate thecæ. In the other New Zealand species they are turbinate or pyriform, and the spores disarranged. In *A. lurida* Ach., the spores are one-septate, measuring from 0·00018 to 0·00050 of an inch; but the apothecium is roundish and convex above.

A. indistincta, K. & M. Thallus grey, thin; apothecia irregularly elongato-oblong, simple or branched, margin ragged and obscure; epithecium greyish-black, convex; spores 3-septate, oblong, constricted in the middle, terminal cells much the smallest, light yellow, measuring from 0·0004 to 0·0010 of an inch.

Hab. On bark, Auckland.

The apothecia to the naked eye resemble small black specks; when magnified, they appear at their margins to fade into the thallus.

Pl. XII. fig. 30. *a.* section of thallus and apothecium; *b.* theca; *c.* spores; *d.* apothecium as seen from above.

A. albida, K. & M. Thallus white or dull white, smooth; apothecia prominent, irregularly lobed or angular, with a thin erect thallodal margin; epithecium lilac-brown, pulverulent; hypothecium pale, but a black spot sometimes present at its sides; spores 3-septate, obovate, yellow, upper cell the largest.

Hab. On smooth bark, Auckland.

Thallus nearly white, fading away at the margin like the mycelium of a fungus; apothecia evenly dispersed over the thallus, of a dull lilac-brown. In general appearance this species resembles *A. cinnabarina*, Wallr.; but the apothecia are smaller, and there is no trace of the red exudation. *A. cinereo-pruinosa*, Schær. (*A. biformis*), Lich. Helv. Exsic. No. 251, has roundish or irregularly oblong, not angular apothecia, and the spores reddish-brown, measuring from 0·00020 to 0·00052 of an inch.

Pl. XII. fig. 31. *a.* section of the thallus and apothecium; *b.* theca; *c.* spores; *d.* outline of the apothecium as seen from above.

A. ramulosa, K. & M. Thallus dull white, very thin; apothecia superficial, black, with a dark-brown base and sides, much branched, bordered by a narrow undulating line; spores 3-septate, oblong or obovate, brown, upper cell the largest, measuring from 0·00020 to 0·00045 of an inch.

Hab. On wood, Auckland.

Apothecia more branched than those of *A. astroidea*, Ach., and more prominent.

Pl. XII. fig. 32. *a.* section of the thallus and apothecium; *b.* theca; *c.* outline of the apothecium as seen from above.

A. AMPLIATA, K. & M. Thallus grey, apothecia scattered or arranged in a somewhat parallel manner, roundish or oblong, partially veiled by the ruptured thallus, blackish-brown; spores brown, 5-6-septate, the upper cell much the largest, the adjoining and sometimes all the other cells divided by a longitudinal septum, measuring from 0·0005 to 0·0013 of an inch.

Hab. On bark, Auckland.

Thallus an inch or more in diameter, thickly covered with the black-looking rather large apothecia. *Opegrapha atra*, *γ. obscura*, Schær. Lich. Helv. No. 517, which has also 5–6-septate spores, is distinguished by its ochreous thallus and small yellow spores, measuring from 0·00025 to 0·00065 of an inch, having their upper cell of the same size as the lower.

PL. XII. fig. 33. *a.* section of thallus and apothecium; *b.* theca; *c.* spore.

A. NIGRO-CINCTA, K. & M. Thallus moderately thick, light brown or dull white, edged by a dark line; apothecia superficial, simple, irregular, roundish, oblong, bent or curved, one end larger, blackish-brown; spores obovate, 4-septate, light yellow, measuring from 0·00030 to 0·00084 of an inch.

Hab. On bark, Auckland.

In a dried state, the thallus is of a whitish-brown colour with a tinge of lilac, the dark margin wide and very evident; it appears to form patches of an inch or more in diameter. The apothecia are thinly scattered, their internal substance brown; there is no dark marginal line as in most of the allied species.

PL. XII. fig. 34. *a.* section of thallus and apothecium; *b.* spores.

COLLEMA, Ach.

C. CONTIGUUM, K. & M. Thallus obscure green (when dry, black), consisting of tufted complicate lobes containing moniliform green filaments; apothecia small, close together, arising just within the margin of the thallus, and projecting beyond it, pale brown; spores ellipsoid, multilocular, measuring from 0·0003 to 0·0008 of an inch.

Hab. On wood, New Zealand.

The aspect of this species in the dried state is at first sight very similar to that of *Synalyssa symphoria*, De Cand.; but on being moistened, it immediately becomes evident that the numerous small apothecia arise from just within the edge of the erect or ascending entire lobes of a complicate thallus. In size, too, it resembles *Collema microphyllum*, Ach., but is distinct from that species in its differently lobed thallus.

PL. XII. fig. 35. *a.* thallus (natural size); *b.* portion of thallus with apothecium in section; *c.* theca and paraphyses; *d.* spore; *e.* moniliform filament from the substance of the thallus.

C. Knight, del. Tuffen West, sculp

XI. *The Nervous System of the* Asteridæ; *with observations on the Structure of their Organs of Sense, and remarks on the Reproduction of lost Rays. By* Henry S. Wilson, *M.D., Junior Demonstrator of Anatomy in the University of Edinburgh. Communicated by* Thomas Anderson, *M.D., F.L.S.*

Read June 7th, 1860.

Comparative anatomists have hitherto adhered very closely to Tiedemann's description of the nervous system of the Asteridæ. Müller was the first to point out certain errors in his description, and to substitute for it a more perfect anatomical arrangement, although he did not enter into a minute detail of the nerve-centres.

In the month of June 1858, I submitted to the Senatus Academicus of the University of Edinburgh, as my graduation thesis, "Observations on the Nervous System of *Asterias*," which I had made, from time to time, during the preceding year. Since that date I have investigated the subject anew, and considerably extended my observations.

Dr. Haeckel, in Von Siebold und Kölliker's 'Zeitschrift für Wissenschaftliche Zoologie' of December 1859, published some observations on the eye-spots of *Astropecten aurantiacus*, *Asteracanthion glacialis*, and *Asteriscus verruculatus*, in which he incorporated some remarks on the microscopic characters of the nerve-cords ending in these eye-spots.

The nervous system consists, in *Asterias* and other Echinodermata, of a perioral ring, from which, opposite each ambulacral groove, nerve-cords pass along the ventral surface of the ray.

The ambulacral nerve-cords are, as stated by Müller, connected to each other by interambulacral cords,—the latter forming, as a whole, a more or less perfect ring according to the number of rays the animal may possess. Thus, in the 5-rayed starfishes the ring becomes pentagonal, whilst in the 13-rayed, it is almost circular. The ambulacral cord begins, in *Asterias*, with a ganglionic enlargement, which rests upon the first two or three of the long series of vertebræ forming the ambulacral groove. This ganglion consists of a cluster of nerve-cells, principally unipolar, whose filaments pass off obliquely from either side along each interambulacral cord, and mesially along the ambulacral cord. Other nerve-fibres may occasionally be seen running diagonally across, to the space between the rays, and then disappearing, probably to supply the viscera. The cord along the ambulacral groove is simply a continuation in structure of the ganglion itself. It consists of unipolar nerve-cells, arranged along the mesial plane of the groove, and lying immediately beneath the integument, between the two central rows of feet. Bipolar nerve-cells may occasionally be seen, though they are proportionately few. The fibres from the cells pass, some longitudinally with the cord, others laterally to either side, probably to supply the suckers, while a third set run vertically upwards (supposing the animal in its normal position, with the mouth downwards) through the intervertebral spaces, most likely to be distributed to the vesicles of the feet and the peritoneal covering of the cæcal chamber.

The nerve-cord terminates at the distal end or point of the ray, in a bulbous swelling coloured with different shades of red pigment and forming the eye-spots. From the cells lying immediately above the eye-bulb, filaments pass more or less obliquely downwards to the pigment-masses of the eye, termed cones by Haeckel. These eye-spots, as Haeckel has pointed out, consist of pigment-cones, each containing a globular lens, and having their bases directed towards the cornea.

Though the nerve-cells do not apparently pass beyond the eye-spot, yet a great number of their filaments extend further, to a curious contractile organ resembling, in many points, one of the suckers, and, most probably, performing the function of a tactile organ. The root of the eye-bulb rests upon the base of this tactile organ, and can thereby be moved about tolerably freely.

The nerve-cords, connecting the ganglia, are about half the thickness of the ambulacral cords, these latter splitting into two pretty equal portions. They lie in close proximity to the vascular perioral ring connected with the heart. Nerve-cells are found in them, though it is difficult to detect the relation of these to the filaments. Some of these filaments pass towards the mouth, while others are directed outwards. These nerve-cords are considered by Müller as simply the connective media, by means of which the motions and actions of the animal are harmonized. He supports this view by stating that those Star-fishes which break themselves to pieces on being handled, may be prevented from doing so if these cords are snipped through with a pair of scissors.

The above is a general view of the nervous system of the Asteridæ. We now proceed to consider in detail the species examined.

1. *Solaster papposa.*

This species is the best-adapted for making a microscopic examination, because it presents the most simple structure. Unfortunately, however, it cannot be preserved long alive in confinement, as it soon dyes the water with its pigment.

The ambulacral cord is easily reached, lying in the wide ambulacral groove, and flanked on either side by the single rows of comparatively thick suckers. The vertebræ forming the groove for the nerve-cord and feet are few in proportion, widely separated, and but loosely connected with one another. On a transverse section of the ray, they appear as broad, irregular-shaped, calcareous plates, resting against one another along a certain extent of their internal margins *. For convenience of description we may divide each plate into a vertical portion extending from x to c, and an oblique from x to d. The vertical portions are not equally in contact throughout their extent, but diverge above, owing to the bevelling off of their margins. The triangular space thus formed is filled up by fibrous tissue, which, for distinction, may be termed the superior ligament (c). The oblique portions of the plates pass off laterally more or less widely from each other according to the condition of the animal. Its ventral margin, or that turned towards

* See Plate XIII. fig. 1.

the ambulacral groove, presents near its upper part a quadrilateral tubercle (*a*), which gives attachment to connective fibrous tissue. This tissue stretches across from one side to the other, like a ligament, enclosing between itself and the vertical portion a triangular space, which lodges the water-vessel (*b*) for the supply of the vesicles (*i i*). We may term it the inferior ligament.

Both in the superior and inferior ligaments, in addition to the connective tissue, fusiform nucleated cells may be seen imbedded amongst flat riband-shaped fibres*. These structures are undoubtedly contractile, performing the function of muscle; for by the contraction of the inferior ligament the animal can adduct its divergent plates, and thus diminish the width of the ambulacral groove, and by a similar action of the superior ligament an opposite result is produced. It is evidently for this purpose that the upper margins of the vertebral plates are bevelled so as to recede from each other. And, though the superior muscle acts under great mechanical disadvantage (the fulcrum of the lever *x d* being at *a x*), yet a very small amount of requisite contraction compensates for this waste of power.

The margin of the oblique portion of the plate, below the inferior ligament, gives attachment to the muscular arrangement of the sucker; and its surfaces have here shallow vertical grooves on either side, for the passage of the cylindrical tubes from the vesicles. The latter rest on the dorsal or cæcal aspect of the vertebræ. To the inferior extremity of each plate is articulated a large rounded calcareous mass †, bearing on it from 8 to 10 or more spines (*f f*). Connective tissue, of the same nature as that forming the ligaments, binds, capsule-like, each spine to the rounded mass, and these to the vertebræ. The spines are moveable, as well as the masses on which they rest, and serve to close in the ambulacral groove. They, as also the external portion of the plates, are covered by the integument, there being, however, little more than cuticle over the former. The cæcal aspect of the plates is invested with a peritoneal layer. The ambulacral arches thus formed by the series of symmetrical plates do not rest against one another in parallel vertical planes, but incline obliquely towards the centre of the body, so as to rest on its proximal neighbour, and, in turn, be overlapped by its distal one.

The ambulacral cord lies between the inferior ligament and the integument (*g*). When examined without the use of reagents, it is found to consist of almost homogeneous but finely granular nucleated cells, resting upon the integument, or pendent from the ligament, along the mesial line. They lie in a coarsely granular and molecular matrix, and in a transverse section always appear unipolar.

Their filaments have the double contour indicative of primitive sheath and central axis, and are equally transparent with the cells. Some of them may be seen crossing the inferior ligament, occupying the space between the contiguous arches, and passing upwards round the water-vessel as far as the superior ligament, where they are generally lost sight of. Occasionally I have detected fibres turning round the upper extremities of the plates; but it is difficult to distinguish these from the fibres of the ligament. Many filaments run obliquely through the substance of the inferior ligament, diverging from the cells towards the vesicles. Other fibres are directed transversely outwards; but I have not been able

* Plate XIII. fig. 2.

† Ibid. fig. 1. *a*.

to determine if they go to the suckers. On examining, however, the feet while the animal is in motion, a delicate streak, more transparent than the surrounding structure, may be seen, which, probably, is the nerve-filament given to it.

In addition to the filaments already enumerated, very delicate fibres may be observed passing from the mass of cells towards the integument. I have not yet succeeded in tracing these to a cell; but should they prove more than connective tissue, the fact would greatly support Professor Goodsir's hypothesis, "that the so-called unipolar nerve-cells are in reality multipolar, of which one pole is an ordinary nerve-fibre, while the others consist of much more delicate and slender fibrils *." There is no doubt that the skin of the *Solaster* is exceedingly sensitive—so much so, that gentle irritation of any part will cause the suckers to be extended and withdrawn in a rapid and irregular manner, whereas the slightest wound of the cord itself causes their instantaneous contraction.

When the animal adducts its ambulacral plates, the integument covering the groove becomes folded into a ridge and carries some of the nerve-cells along with it, so that these appear to lie in the fold so formed. The ridge formed by the folded integument has a wavy outline given to it by the row of suckers on either side, and would indicate that the skin is not contractile †. By reflecting a portion of this fold, and spreading it carefully on a glass slide before examining it with the microscope, bipolar nerve-cells may often be seen. I have not as yet detected any in a vertical section. Their filaments run either obliquely outwards or in the direction of the cord. In a longitudinal section of the arm, made along the centre of the nerve-cord, we occasionally succeed in obtaining a view of the longitudinal arrangement of the cells. In such instances we often notice that they cluster somewhat more thickly opposite the intervertebral spaces, much in the same manner as the linearly arranged ganglia of some of the Articulata. Nerve-cells may be traced along the whole length of the cord, as far as the upper part of the bulbous enlargement of the eye-spot.

The eye of the *Solaster* is situated on the under surface of a well-marked peduncle, which is connected by its root, not only to the cord, but also slightly to the base of the tactile organ, from which it projects ‡. It is very mobile, and may be seen, if the animal is examined with a lens whilst moving, to be, to a great extent, the means of turning the eye laterally, upwards, or downwards. These movements may be carefully watched in the *Solaster*, as its eye-bulb is comparatively large, free of protective spines, and well elevated on its peduncle. On turning up the ray so as to expose its ambulacral or ventral surface, and removing, with the assistance of a dissecting-microscope, all the suckers around the eye, the latter appears more or less cylindrical, with its longest diameter in the longitudinal direction §.

The bulb rests partly on the inferior ligament, but mainly on two calcareous masses (*e e*) set side by side, being probably a coalescent condition of the ultimate vertebræ (*c c*), thus united for protective purposes. These masses bear on their ventral surfaces and distal extremities oblique rows of spines, corresponding serially with those already described in connexion with the vertebral plates. These spines can be turned inwards by the animal,

* MS. Notes of Lectures on Comparative Anatomy, by Prof. Goodsir. Summer of 1858.

† This fold is well seen in the transverse section of the arm of *Cribella oculata* in Plate XIV. fig. 1.

‡ Plate XIII. fig. 4.

§ Plate XIII. fig. 5.

one row crossing behind the other, so as to enclose the eye-bulb and the tactile organ in separate chambers. Owing to their being inclined towards the ray-point, they in a manner rest against their distal neighbour, and thus conceal from view the organs they protect.

In profile, the part of the bulb covered with pigment presents a convex outline, the convexity being greatest towards its free end, so as to give it the appearance of an irregularly convex cylinder. The bulb is, in addition, slightly bent upon itself at the root of the peduncle, so as to face towards the mouth *.

When examined microscopically, these eyes have, in many respects, the same structure as described in other genera by Haeckel. They are compound,—the individual eyes consisting of pigment-cones whose apices are directed towards the centre of the bulb, whilst their bases rest against the transparent cornea. Their arrangement on the surface of the bulb varies, the animal seeming to have the power of separating them more or less from each other, and thus, to a certain extent, altering their relative positions. Even while the Solaster is moving, we may observe these cones now having a concentric arrangement, and now placed in obliquely transverse lines diverging from a mesial one. This curious fact seems to depend on their being placed in lines radiating from a central equator, at more or less equal distances, not only from the contiguous eyes in the same radius, but also from the corresponding ones in the neighbouring radii †. Accordingly, if the animal decreases the distances between the radii, then the individual eyes appear as if arranged transversely ‡; but, on the contrary, if all the eyes in the different radii be separated from one another, the convex linear arrangement becomes evident §. All the apices are, however, in every case, directed, as Haeckel remarked, towards a mesial longitudinal line. The whole surface of the bulb is not equally furnished with individual eyes; for at its distal or free extremity there is a triangular central portion quite free from these, being only sparingly studded with pigment-points ‖. This more or less transparent part of the bulb gives it at first sight, especially when examined during the motion of the animal, a bifid appearance. Haeckel remarked an absence of pigment-cones in the same position in *Asteracanthion glacialis*. There is often an indentation of the bulb at this transparent free end, so as to make it heart-shaped¶. The individual eyes extend laterally quite round the free extremity of the bulb, and may be found even on the upper surface, which rests against the tactile organ. From what has been said it is evident that the eye has a bilateral arrangement; and this greatly favours the supposition that the nerve-cord is also bilateral or double, though apparently single.

The number of individual eyes varies with the age or size of the animal. If a single eye be examined with a higher power, it is found to consist of a cone formed of minute nucleated pigment-cells, vermilion in colour **. Near its base is imbedded a highly refractive globular lens (*d*). In the *Solaster*, the cones being large and their bases wide, the lenses present a very beautiful appearance, like transparent ova, each in its own scarlet nest. Those cells forming the border of the base of the cone curve inwards, so as to form a ring (*e*), well seen in a front view, which rests upon and screens the margin of the lens. This is admirably likened by Haeckel to an iris. He also mentions that the pigment-

* Plate XIII. fig. 4. † Ibid. fig. 8. ‡ Ibid. fig. 10. § Ibid. fig. 9.
‖ Ibid. figs. 4, 5 & 6. ¶ Ibid. fig. 6. ** Ibid. fig. 7.

cells of the cone become elongated towards the apex; but in this species I could observe no change in their form from base to apex. Several of these were lengthened; but this was evidently the result of injury. On the addition of nitric acid, the vermilion of the cells becomes first purple, then passing rapidly into blue and brown, at last disappears altogether, leaving only the outline of the cone with the unaltered lens at the base. By reflected light the individual eyes appear as opake funnel-shaped red masses, with a dark pit-like centre at the base.

Although Dr. Haeckel mentions his having seen nerve-cells and filaments covering the optic bulb, he could not detect the connexion between the cells and the filaments, nor of the latter with the individual eyes. In the *Solaster*, without any reagent, the nerve-cells may occasionally be distinctly seen, lying above the bulb and sending filaments to the individual eyes*. I have, in several specimens, traced these filaments to the apices of the cones, which they entered; their ultimate termination, however, still remains undecided. Many of these cells are bipolar, one pole being connected with a cone, and the other passing longitudinally towards the proximal end of the cord. What the medium may be which occupies the space from the apex of the cone to the back of the lens, is as yet doubtful, though certainly it is not filled with pigment-cells. The intermediate matrix, within which the cones are imbedded, consists of granules at the base and centre of the bulb (*i. e.* that part nearest the nerve-cells),—these granules becoming smaller the closer they approach the circumference, so that around the bases of the cones it is finely molecular.

The bulb is covered by a transparent homogeneous cornea, whose epithelium consists of very minute transparent polygonal cells†. That it is a modification of the integument, is easily demonstrable by tracing, in profile, the rather opake granular skin along the cord, and noticing, at the base of the bulb, its sudden change to the transparent cornea, to be continued as such over the eye-spot ‡.

The curious foot-like projection, extending beyond the optic bulb, is comparatively small and short in the *Solaster* §. It was only by careful dissection that I was enabled to discover it, as it cannot well be seen when the animal is moving, owing to the bunches of terminal spines, which project considerably beyond it. Probably the large size and mobility of the optic peduncle may account for the poor development of this organ in the *Solaster*. As we find it well marked in *Uraster rubens*, I will describe it more minutely when treating of the latter. From the nerve-cells lying at the base of the optic bulb some filaments pass to the roots of this tactile organ.

The ganglionic enlargement found at the beginning of the ambulacral cord is only small in the *Solaster* ‖. The difficulty experienced in removing it for examination has prevented my detecting, as yet, nerve-cells in its structure. The same arrangement which guards the ambulacral cord also protects the ganglion.

The interambulacral cord (*f*), exceedingly thin and delicate, runs close by the side of a calcareous mass (*d*), the free lower surface of which is convex, and generally supports twelve club-shaped spines. These masses consist of two pieces placed in juxtaposition, and each having six spines. They are modifications of those already described as sup-

* Plate XIII. fig. 11. † Ibid. fig. 7. *c* & *h*. ‡ Ibid. fig. 4. § Ibid. fig. 6. *d*. ‖ Ibid. fig. 3. *e*.

porting the vertebral plates. The first ambulacral arch, however, does not rest directly on these, there being between them two intermediate pieces (*b*, *c*), which are each connected to the corresponding ones of the opposite side by fibrous tissue stretched across. The interambulacral cord either lies below or on a level with the uppermost of these ligaments. I have failed to find nerve-cells in this cord, owing to its extreme delicacy.

2. *Cribella oculata.*

The nervous system of this species is on the whole very distinct, and may be examined with comparative ease; but the great amount of pigment deposited in the integument renders it much less transparent than in *Solaster papposa.*

The ambulacral cord occupies the same position as in the preceding species, lying between the integument and the inferior ligament*. The ambulacral arches do not present such well-marked angles between the vertical and oblique portions of their plates (*a a*); the latter are therefore less irregular in form. The triangular space filled up by the superior muscle (*d*) is well marked; but the fulcrum (*a x*), upon which the plates move as levers, is not so extensive. The tubercles (*c c*), giving attachment to the inferior muscle on each side, are prominent. The muscle itself is thick, and has among its fibres numerous fusiform nucleated cells. The water-vessel (*b*) lies upon it. The vertebral plates rest on two calcareous masses (*e*, *f*) on each side, the innermost of which (*e*) is rounded, and gives articulation to a double row of long club-shaped spines. The outer mass (*f*), more or less triangular, bears on its inferior surface two other rounded pieces. Of these, the innermost (*e'*) affords attachment to spines. The edges of the plates are comparatively thick, but with their intervertebral spaces of less width than in the *Solaster.* Upon the cæcal surface rest the vesicles (*i i*); and to the ambulacral aspect are connected the muscles of the suckers (*k k*). The integument (*h*) covering the nerve-cord is highly coloured by a dark orange-red pigment, with which, when seen in a vertical section, the clear nerve-structure lying immediately above forms a great contrast. The same deep colour persists in the integumentary covering of the plates and the spines.

The nerve-cells occupy the same position, and present an appearance and variations in size similar to those in the *Solaster.* The nerve-filaments resemble in their distribution the corresponding structure in the *Solaster.* The delicate fibrils radiating from the central nerve-mass into the integument are here, owing probably to the amount of pigment, remarkably distinct. In some specimens, where the integument happened to be torn, I observed these fibrils terminate in a rounded nucleus or cellule-like body†. But I have failed, in this case as in the other, to satisfy myself as to whether they are or are not connected with nerve-cells. The transparent lines or streaks on the suckers are also very well marked.

The nerve-cells extend as far as the optic bulb. When the animal is laid on its dorsum and the point of the ray examined, the bulb is found to rest upon calcareous pieces, similar to those in the *Solaster*, and evidently formed of the coalesced ultimate vertebral arches. They bear a great number of spines, which are much shorter than those of the neighbouring arches. Indeed the spines here become so suddenly short, that the ray-point seems at

* Plate XIV. fig. 1. *g*.

† Ibid. fig. 2.

first sight as if tuberculated*; and it is owing to the shortness of these spines that the bulb (*b*) and the tactile organ (*f*) are very easily seen when the animal is in motion. The optic bulb, though having no special protective spines, is nevertheless covered in by those connected to the adjoining vertebræ. These spines are very much tinged, on that side next to the eye-spot, by pigment of the same colour as that of the eye itself.

The bulb is not so distinctly pedunculated, nor so free from the tactile organs, to which it is connected somewhat higher up than its root†. It is altogether much smaller in size than that of the *Solaster*, and its longitudinal diameter proportionately greater than its transverse; so that its shape is more elongated ‡. In profile it is generally slightly convex in outline, sometimes almost flat, and occasionally even saddle-shaped. This variableness in its contour seems to be dependent upon the position of the tactile organ on which it rests.

A bird's-eye view of the surface of the bulb shows the arrangement of the individual eyes to vary, much in the same manner as in the *Solaster*; they seem, however, to be principally distributed in obliquely transverse lines diverging from a mesial one. The longitudinal division of the bulb into two lateral portions is well indicated by the central series of individual eyes. The two last divergent lines of cones, nearest the free end of the bulb, bound a clear triangular portion studded here and there with pigment-points.

The individual cones, smaller than those of the other species, all diverge from a line which bisects longitudinally the ocular mass. The pigment is more of a carmine-red, and the nucleated cells containing it are also smaller and more densely grouped around the cone §. Nitric acid produces effects similar to those already described. The lens (*c*) imbedded in the base of each cone is not so well seen in the *Cribella*, owing to the iris-like ring greatly concealing it. It has the same appearance as in the *Solaster*, differing only in the smallness of its size. Professor Goodsir, years ago, described these eyes as "consisting of a red cushion with pits on its surface ‖." This appearance is especially evident when the bulb is examined by reflected light.

Nerve-filaments pass into the apices of some of the cones; but I have not been able to trace them to any of the cells ¶. The high colour of the integument around the bulb prevents the subcutaneous structures being seen clearly through it. For the same reason, nothing could be distinctly made out regarding the matrix surrounding the cones.

The tactile organ is very long, and projects far beyond the terminal cluster of short spines situated at the ray-point**. It is conical, with a blunted extremity, not very transparent, and orange-brown in colour. If a young specimen be placed in shallow water and watched through a lens whilst it is moving, the tactile organ will be seen protruded from the curved end of the ray, and bearing, on its lower aspect, the eye-spot. By means of it the optic bulb can be turned either laterally or towards the centre of the body. As the bulb is moved from one side to the other, it is very beautiful to notice the lens of each individual eye reflecting, very brightly, for a moment the pencils of light, and then disappearing as another is substituted. The animal never uses this tentacle as a foot. When the ray approaches an obstacle the tactile organ either curves inwards over

* Plate XIV. fig. 3. † Ibid. fig. 6. ‡ Ibid. figs. 3 & 6. § Ibid. fig. 5.
‖ Forbes, E., History of British Starfishes. ¶ Plate XIV. fig. 6. *a*. ** Ibid. fig. 3. *f*, and 6. *c*.

the optic bulb, or contracts, while the slender thread-like suckers are extended forwards and lay hold of the object.

Nerve-filaments are distributed to this organ from the terminal nerve-cells lying above the optic bulb. The cornea differs only in thickness from that of *S. papposa*, and is denser, being with more difficulty injured.

The ganglion at the commencement of the ambulacral cord consists of nerve-cells*; but the relation of the filaments to these requires further observation. In dissecting the animal, this ganglion appears much more distinct than in the former genus, and is situated at a level lower than that of the ambulacral nerve-cord, as the first vertebral arch, on which it rests, projects below the succeeding ones.

The perioral skeleton is formed from the same elements as in the *Solaster*†. Only one intermediate piece (*c*) is found between the vertebral plate (*a*) and the spine-bearing mass (*b*). The interambulacral nerve-cord (*e*), well marked in this species, passes on a level with the ligament which extends between the opposite intermediate pieces (*c*, *c'*).

3. *Uraster rubens*.

I examined this species in 1857–58, choosing it as being the most easily obtained in this locality; but I have since discovered that it is in many respects more complicated than either of the preceding for microscopic investigation. For dissection it answers admirably, as its nervous system is easily seen in all its extent.

The ambulacral cord lies along the centre of the groove, having on either side of it double rows of alternating suckers‡. The vertebral plates (*a a*), forming the ambulacral arches, are comparatively very thin and numerous; they present the same characters as already described in the others. Both muscles are well marked, especially the inferior. The fulcrum (*a x*), upon which the plates move, is also pretty extensive. Immediately above the tubercles (*c*, *e*) of the inferior muscle, an oblique groove (*c' c'*) extends towards the vertical depressions containing the tubes from the vesicles to the feet. These oblique grooves are, probably, for the lodgement of the branches from the water-canal to the vesicles.

The vertebral plates rest upon irregular-shaped calcareous masses (*e e*), bearing each two long spines. These spines are much sharper than the corresponding ones of the other species, and have often at their points slender radiating spinules. They have, almost always, clustered around them bunches of pedicellaria, which are entirely absent in the *Solaster* and *Cribella*. Another mass (*e*), triangular in shape, and separated from the first by an intermediate piece (*f*), gives articulation to three thick, short and bluntly acuminated spines. All these pieces are kept in contact with one another by means of connective fibrous tissue having the characters already enumerated. Externally they are covered by the integument, and give also attachment to the suckers, and internally receive a peritoneal lining and support the double rows of alternating vesicles.

The ambulacral cord (*g*) bears the same relation to the inferior muscle and the integument (*h*) as before stated. The nerve-cells that enter into its formation are chiefly unipolar, though occasionally we meet with bipolar §. They are, to a great extent, opake,

* Plate XIV. fig. 4. *d*.   † Ibid. fig. 4.   ‡ Ibid. fig. 7. *g*.   § Plate XV. fig. 1.

finely granular, and each with a well-marked nucleus. They lie in a coarsely granular matrix, and have one, sometimes two filaments passing off from each.

Some of the filaments run obliquely outwards, while others pass longitudinally along the cord. In Plate XV. fig. 4 we have some of these cells very highly magnified, the fibres from which present the double outline very distinctly. The other branches, before mentioned as passing from these cells, can also be made out in the *Uraster*: some of these are seen in Plate XIV. fig. 9, passing from the cells upwards by the side of the inferior muscle as well as laterally. They, as also the cells, have been coloured with carmine. When more highly magnified, they present a distinct nucleus, deeply coloured, and continuous with the axial cylinder, which is equally tinged (*a*). The radiating integumentary fibrils already mentioned, as well as their connexion with the cellule-like bodies immediately beneath the skin, are very well seen. The nerve-cells extend along the groove as far as the eye-spot; they become smaller and fewer as they approach the point of the ray, but above the optic bulb they again increase in number.

In his Lectures on Comparative Anatomy during the summer of 1857, Professor Goodsir described these cords as "not being mere nerves, but consisting of fine series of ganglionic cords, each cord being beaded or enlarged at the spot where branches pass off." . . . . "They contain a brown pigmental streak extending down their internal surface, are invested by a fine membrane, and consist of delicate filaments, some running longitudinally, others transversely. They have in addition a gelatinous material, which appears to be cellular." In this description he expressed a view homologous with that held by Müller.

The eye-spot of the *Uraster* is large and tolerably pedunculated *. It is connected by means of its peduncle to the root of the tactile organ, from which it projects free. When examined with the ambulacral portion of the ray upwards, it is found to rest partly upon and partly between two calcareous cushions much larger than the corresponding ones of the other species †. The spines placed on these masses for protecting the optic bulb, are best examined along with those guarding the tactile organ.

Like the other bulbs, its longitudinal diameter is greater than its transverse. The unequal distribution of the pigment-cones gives it, in a marked degree, the appearance of being bifid at its free extremity ‡. In profile the contour is saddle-shaped, convex transversely and concave longitudinally §: this form, however, is only seen when a longitudinal section is made through the groove in such a manner as to preserve the calcareous cushion entire; it is immediately lost as soon as the eye-bulb is removed from its position.

The individual cones are very numerous, and so much crowded as to render them difficult to be seen distinctly. When examining them in 1858, I had at first mistaken them for "conical papillæform projections," and described them as such. Shortly afterwards I succeeded in obtaining a front view of the bulb, and, although still ignorant of its compound nature, mentioned its being covered with "irregularly shaped pigment-masses, more or less pointed, and having in the centre a clear space, which, by careful focusing, appeared to be pits similar to those seen by Professor Goodsir in *Cribella oculata*"‖. "This pigmented structure seems to me to resemble the compound eye of insects in ar-

* Plate XV. figs. 3 & 6. † Plate XIV. fig. 10. *d d*. ‡ Plate XV. fig. 6.
§ Plate XV. fig. 3. ‖ Ibid. fig. 5.

rangement; for it may not be improbable that each papillæform projection is equivalent to the simple eye of an insect" *. At that time I was too busily engaged with the nervous system, and paid very little attention to the eye-spots. Their true structure we now know from Dr. Haeckel's accurate observations.

The cones take more generally the obliquely transverse arrangement. The pigment-cells of the individual eyes are nucleated and densely aggregated †. They have a purplish-red colour, undergoing the same changes as already specified on the addition of nitric acid. The lens is small and is very much covered by the iris-like ring of pigment-cells situated around its margin. The apices of the cones all point towards a common mesial plane. Nerve-filaments can be traced into them; but the connexion of these to the cells cannot be distinctly made out. *Solaster* was the only genus in which I observed with certainty a nerve-fibre passing from cell to cone.

The cornea is quite distinct in a profile view. "As the integument runs along the distal portion of the cord it is continued over the pigment-deposit in a modified condition, becoming perfectly clear and apparently denser" ‡. The integumentary cuticle is continued over the cornea as a membrane formed of minute polygonal cells.

The light-purple-coloured Urasters I found the best for the examination of the tactile organ during the animal's movements. The younger the specimen, the longer in proportion is this organ. By carefully watching the animals during life, I observed, as in the *Cribella*, that they never used it as a sucker. Those of the rays fronting the direction of progress, were generally the only ones protruded. They resemble, in shape, a slightly tapering cylinder, contractile and very much thicker than the thread-like suckers surrounding the eye-spot §. Their extremities are more pointed than those of the feet. Their colour is similar to that of the integument over the cord; that is, of a light-brown. That portion, however, against which the eye rests, is in many cases highly tinted with the same pigment as that of the cones.

Although the optic bulb moves, generally, along with the base of the tactile organ, it has in addition an independent motion in its own peduncle. It is interesting to notice the curious manner in which the pigmented, wing-like lateral halves of the eye can be turned in any direction, so that the profile outline of the bulb is constantly changing, the transverse diameter becoming greatly increased or equally diminished.

The protective apparatus for the eye and tactile organ is well marked in the *Uraster*. The elements of the skeleton which enter into its formation are, first, the lateral calcareous masses already noticed as coalesced ultimate vertebral arches ‖; and secondly, obliquely transverse rows of short, thick, bluntly acuminated spines ¶. The latter are serially homologous with the outer row of spines before mentioned in connexion with the ambulacral groove **. Those of the first series, three on each side, rest upon the lateral masses, and lie towards the distal end of the ray. They enclose the eye-bulb ††. The next pair (*b*) also consisting of three spines each, and springing from the distal extremity of the calcareous mass, protects the tactile organ and bars it off from the optic bulb. The tentacle

* The sentences marked by inverted commas are quotations from my Thesis. † Plate XV. fig. 4. ‡ Thesis.

§ Plate XV. fig. 6. *b* represents the comparative size of one of the suckers situated round the bulb.

‖ Plate XIV. fig. 10. *d d*. ¶ Ibid. fig. 11. ** Ibid. fig. 7. *e'*. †† Ibid. fig. 11. *a*.

has on either side a third series (*c*) with two spines each; and filling the intermediate space between the last rows, two central spines are situated, one behind the other (*d*). They gradually diminish in size from the first series onwards, but are much larger than their corresponding neighbours. Those near the eye are tinged with pigment on the ambulacral aspect. When closed, they arch obliquely inwards towards the proximal portion of the ray, and cross one another in the same manner as those of the *Solaster*. In this condition the tactile organ is found to lie within a circle of spines; in other words, these spines form together a tube or sheath within which the tentacle can be withdrawn during contraction, and from which it can be protruded. If these be broken off, the free extremities of the lateral calcareous masses, thus exposed, will be found to arch upwards and inwards, forming an imperfect ring *. The incompleteness is at the ambulacral aspect; and there results from this a deep groove, which contains the lower part or root of the tactile organ. It is around this calcareous bridge that the three terminal spine-rows are arranged. The groove thus resulting from the incompleteness of the calcareous ring is produced by the non-development, centrally, of the coalesced terminal arches. So that the bridge is formed, not by the vertebral plates, but by the calcification of the dorsal integument and the approximation of the calcareous tubercles found on it.

Microscopically, the tactile organ presents an external outer coat of circular contractile fibres, and an internal longitudinal layer. These muscular layers are attached to the free extremities of the calcareous masses (their ambulacral aspect), and probably also to the upper part of the terminal arches. They enclose a cavity having more or less the form of the organ itself, and lined by a delicate homogeneous membrane†. By careful dissection, I have been enabled to trace this cavity beneath the calcareous bridge, and as far as the termination of the water-canal (*c*)‡; whether it possess a vesicle, or not, I have not yet decided, but I could not detect any after repeated searching. The best means of ascertaining this would be by injecting the water-vascular canal. Numerous nerve-filaments pass into its structure from the optic mass of ganglionic cells.

Whether this be the terminal central tentacle described by Müller as seen in the development of some Echinoderms, and also stated by Dr. W. Busch to occur in the young *Echinaster sepositus* §, remains for further investigation to determine. It certainly seems to be a modification of the suckers, and, from its great development and the position it occupies, may probably constitute potentially a pair or more of these. We have already seen that the animal never uses it as a foot. It cannot be an organ for hearing, as the cavity in its interior contains no otolithes, but simply a limpid fluid. Its site, on the other hand, and the abundant supply of nerves it receives, taken together with the important negative conclusions, strongly suggest the hypothesis of its being a tactile organ. In the three specimens I have examined, it presents the same general structure, but only in the *Uraster* was I able to study with more certainty its relation to the surrounding parts.

* Plate XV. fig. 8. *a*. † Ibid. fig. 3. *b*. ‡ Ibid. fig. 8. *d*.

§ "Beobachtungen über Anatomie und Entwickelung einiger wirbellosen Seethiere." 1851. My friend Mr. John Anderson, who lately directed my attention to the above paper, watched the development of several larvæ of *Cribella oculata* a year ago, and states that this long, contractile terminal tentacle was kept constantly in motion, but never used as an organ of prehension.

The ganglion and interambulacral nerve-cords are well-developed. The relation they bear to the skeleton will at once be understood by referring to fig. 8, Plate XII. The perioral spines are only four in number; and the masses (*b b*) bearing them support also the vertebral plates (*a a*) directly, there being no intermediate piece. The integument is firmly connected to the fibrous tissue beneath, as far outwards as the interambulacral cords. These latter have a close relation to the vascular perioral ring connected to the heart.

Microscopically, "the ganglions are a collection of nerve-cells clustered together and forming a union, as it were, between the interganglionic and ambulacral nerve-cords*. Filaments pass outwards, and also to the different cords in connexion with it. Some may likewise be detected passing inwards to the perioral space." Other "small filaments diverge outwards, very soon passing backwards into the interior of the animal, through small foramina in the calcareous plates."†

The interambulacral nerve-cords have each "a series of cells arranged pretty nearly in a line, and sending filaments longitudinally as well as inwards and outwards."

On the Reproduction of lost Rays.

Before concluding, I would offer, though still imperfect, some few observations, made at different times, upon the reproduction of the lost rays in *Uraster rubens.* The specimens I examined were gathered close to Newhaven Pier, and were therefore principally those which had survived the rough handling and ill-treatment of the fishermen. They can be procured of all shapes, from four- to one-rayed, and with the reproduced portions in all stages of development. These stages I have attempted to give in a series of five drawings‡.

After a ray has been torn off or otherwise destroyed, the healing process commences by the disintegration and subsequent rejection of those portions of the integument and skeleton which have undergone fatal laceration. While this is going on, the dorsal skin with its calcareous network curves downwards and slightly inwards upon itself, until it reaches the vertebral arch. Union then begins in the mesial line by the dorsal flap sending inwards a small pointed process, which becomes connected to the integument and the fibrous tissue of the vertebral arch. The lateral portions of the flap next cicatrize, with the skin covering the ambulacral aspect of the vertebral plates. Their broad surfaces, however, remain free,—a distinct cul-de-sac existing between them and the dorsal integument, very well seen in a longitudinal section.

A prolongation from the ambulacral nerve-cord is soon observed, covered, of course, by the skin, and supported on its dorsum by a soft tubercle which is developed simultaneously with it from the dorsal flap. This is followed by the deposit of pigment; but whether it is a perfect eye at this stage, I am still uncertain. It soon, however, presents the characteristic cones, each with the small clear spot at its base. The subsequent stages are the further elongation of the cord and of the dorsal integument, with the development of the vertebral plates and suckers.

* Plate XV. fig. 7. † Thesis. ‡ Plate XV. figs. 10–14.

Whether the prolongation of the axis of the ray be effected by the formation of vertebral plates at the proximal or the distal portion, remains still to be decided. From what I have observed, however, I am inclined to think that the proximate vertebræ are the older. It is a curious fact, that, although the skeleton of the new ray appears very soon after this begins to be reproduced, yet no calcareous deposit takes place, in the fibrous structure connecting it to the remnant of the old ray, for a very long time. Probably this fibrous structure is the result of the cicatrix; and most likely, before any calcification begins, it is entirely absorbed and new tissue developed.

The integument of the young ray remains for a long time quite colourless; so that, on the dorsum of the animal, especially if it have much pigment, the line of demarcation between the old and the new skin is very distinct.

The question now naturally arises, as to how far a Starfish may be mutilated and still retain life, and, therefore, the power of reproducing its lost parts? Amongst the great number I have examined, none have had all the rays destroyed at once, though many have had all but one. None of the rays which reproduced another had the whole of the ambulacral cord destroyed; and none had the stomach injured. Although many rays, separated from the Starfish, are found moving about briskly, and apparently quite lively, nevertheless this apparent life does not continue long, the dorsal skeleton becoming first disintegrated (the suckers still remaining moveable and contractile), and lastly the vertebræ with the feet, &c. Evidently more circumstances than one are essential for the prolongation of the animal's life, the chief of which seem to be, an uninjured stomach, with, at least, one entire cæcal appendage. It would require, however, careful and special investigation of the subject to decide these questions with accuracy.

DESCRIPTION OF THE PLATES.

Tab. XIII.

Solaster papposa.

Fig. 1. Transverse or vertical section of ambulacral arch. *a a.* vertebral plates, resting against each other at the fulcrum (*a x*), upon which they move. *b.* water-canal for the supply of vesicles (*i i*) and feet (*k k*): it rests upon the adductor muscle or inferior ligament which stretches between the tubercles (a' a') of opposite plates. *c.* triangular recess between upper extremities of vertebral plates, filled up by the abductor muscle or superior ligament. *d.* lower end of the vertebral plate: it rests upon a rounded calcareous mass (*e*) bearing a number of spines (*f f*). *g.* ambulacral nerve-cord, consisting of nerve-cells whose filaments may be traced passing through the substance and by the side of the inferior muscle, and extending upwards round the water-vessel. *h.* integumentary covering.

Fig. 2. Fusiform nucleated cells (*a a*) from inferior muscle, found imbedded amongst delicate riband-like fibres (*b b*).

Fig. 3. Diagrammatic view of perioral skeleton. *a a.* modified vertebral plates, the first of the series. *b b*

and *c c*. intermediate calcareous pieces lying between the vertebral plates (*a a*) and the spine-bearing masses (*d d*): the latter are modifications of the rounded mass (*e*) in fig. 1, and support each six spines. *e*. ganglionic enlargement lying below inferior muscle and between the intermediate pieces (*b b*, *c c*). *f*. interambulacral cord running immediately above the spine-bearing pieces (*d d*), and on a level with the ligament which stretches between the masses ($c\,c'$). *g*. integument covering the ganglion and extending laterally over the skeleton.

Fig. 4. Profile view of eye-spot and tactile organ. *a a*. optic bulb, irregularly cylindrical and slightly bent upon itself at its root (*d*), convex in outline (the convexity being greatest at its extremity, *c*). *g g g*. pigment-cones in profile, each having its base directed towards the cornea and containing imbedded in it a lens. Their arrangement is more or less transverse; and the rows of cones nearest the free extremity enclose a space (*c*) having no individual eyes and studded with pigment-dots. *f*. integument covering ambulacral cord and illustrative of its sudden modification to the clear cornea (*e*). *h*. tactile organ.

Fig. 5. Optic bulb and tactile organ *in situ*, taken with the point of the ray lying on its dorsal surface. *a*. ambulacral nerve-cord, resting between the vertebral plates (*c c*) and ending in the optic bulb (*d*): the latter is supported by two calcareous plates (*e e*), divested of all but their terminal bunches of spines (*f f*); the individual eyes are arranged in obliquely transverse lines, and bound, at the free extremity of the bulb, a well-marked space devoid of cones and spotted with pigment-points. *g*. tactile organ.

Fig. 6. Bird's-eye view of eye and tactile organ. The bulb (*a*) has its free end (*c*) slightly indented so as to make it somewhat heart-shaped: the cones appear as irregular pigment-masses with the transparent lens in the centre; the mesial series of cones, from which the others pass off transversely on either side, is well seen. *b*. ambulacral nerve-cord. *d*. tactile organ.

Fig. 7. Individual eye, highly magnified. *a*. pigment-cone formed by irregular-shaped nucleated cells (*b*), vermilion colour; its base is directed towards the cornea (*c*) and has lying in it a large, highly refractive globular lens (*d*), the border of which is partly concealed by the curving inwards, towards its centre, of the marginal pigment-cells of the cone, in the form of an iris-like ring (*e*). *f*. nerve-fibre entering its apex. *c*. the cornea, bounded externally by a cuticular layer (*g*) consisting of polygonal cells (*h*).

Fig. 8. Diagram giving the individual eyes in their probable normal distribution.

Fig. 9. A second, illustrating why the individual eyes sometimes appear in convergent lines.

Fig. 10. A third, accounting for the transversely oblique arrangement occasionally seen.

Fig. 11. Nerve-cells situated above the optic bulb. Some filaments are seen to connect the pigment-cones to these cells; while other fibres pass longitudinally in the direction of the ambulacral cord.

Tab. XIV.

Cribella oculata.

Fig. 1. Transverse section of ambulacral groove. *a a*. ambulacral plates; *a x*. fulcrum; *c c*. tubercles, between which the adductor muscle stretches; *d*. superior or abductor muscle; *e*. round calcareous piece supporting vertebral plates and giving articulation to double row of spines; *f*. intermediate portion, affording attachment to another spine-bearing mass (e'). *b*. water-vessel, lying above inferior muscle. *g*. ambulacral nerve-cord, consisting of nerve-cells, some of whose filaments pass through the substance, others by the side of inferior muscle, and extend upwards round water-vessel; a third set runs transversely outwards. *h*. integument, folded, and dragging downwards in its fold some nerve-cells. *i i*. vesicles. *k k*. suckers.

Fig. 2. *a*. nerve-cells of the ambulacral cord; *b b*. delicate fibrils from the skin towards the nerve-cells;

c c. nuclear or cellule-like bodies lying immediately beneath the cuticle (*d*) and connected to the fibrils.

Fig. 3. Distal end of a ray, its ventral aspect. *a.* ambulacral cord, lying between two rows of suckers (*a' a'*), and ending in the optic bulb (*b*): the cones are arranged transversely, and mark off very distinctly a clear triangular space, situated at the free end (*c*), and having no eyes. *f.* tactile organ partly concealed by terminal rows of spines, which form a protective whorl (*g*).

Fig. 4. Diagrammatic view of perioral skeleton. *a a.* first pair of ambulacral plates. *b b.* spine-bearing pieces, being modifications of that marked *e* in fig. 1. *c.* intermediate piece connecting the spine-bearing mass to vertebral plates. *d.* ambulacral ganglion lying below inferior muscle. *e.* interambulacral nerve-cord, passing above the spine-bearing masses, and on a level with the ligament connecting the intermediate pieces (*c c*). *g.* integument.

Fig. 5. Individual eyes. *a.* bird's-eye view, showing the lens partly covered by the iris-like ring; *b.* profile of the same, exhibiting its conical form; *c.* the lens lying imbedded at the base; *d.* nerve-fibre entering its apex.

Fig. 6. Profile of optic bulb *in situ.* Its outline is slightly convex. Between it and the skeleton lies a mass of nerve-cells (*a*), which send filaments to the cones (*b b*) and tactile organ (*c*).

Uraster rubens.

Fig. 7. Transverse section of ambulacral groove. *a a.* vertebral plates; *a x.* fulcrum; *c c.* tubercles for inferior muscle; *c' c'.* grooves, probably for the reception of the branch from water-vessel (*b*) to vesicles (*i i*); *d.* superior muscle; *e.* calcareous mass, supporting vertebral plates, and bearing two long sharp spines, which have at their apices radiating spinules; *e'.* a second piece, giving articulation to three short thick spines, connected to the other by the intermediate piece (*f*); *g.* ambulacral nerve-cells and their filaments; *h.* integumentary covering; *k k.* suckers.

Fig. 8. Diagram of perioral skeleton. *a a.* vertebral plates; *b b.* spine-bearing masses, each homologous to that marked *e* in fig. 7; *c.* ambulacral ganglionic cells lying below the inferior muscle; *d.* interambulacral nerve-cord passing between the lower ends of vertebral plates and the spine-bearing pieces; *e.* integument.

Fig. 9. Transverse section of ambulacral groove of a specimen treated with carmine; the nerve-cells and their filaments are rendered very distinct by the colouring matter. *a.* some of these more highly magnified, showing the nucleus of the cell and central axis of the fibre highly tinged by the carmine.

Fig. 10. Distal end of ray (its ambulacral aspect), showing the eye and tactile organ *in situ.* *a.* nerve-cord; *b.* optic bulb; *c.* tactile organ, greatly concealed by the spines which spring from the lateral plates (*d d*).

Fig. 11. Diagram of the protective apparatus of the eye and tactile organ. *a, b, c, d.* first, second, third, and central rows of spines as seen when the eye is exposed; E. the same when covering and protecting the eye-bulb and tactile organ.

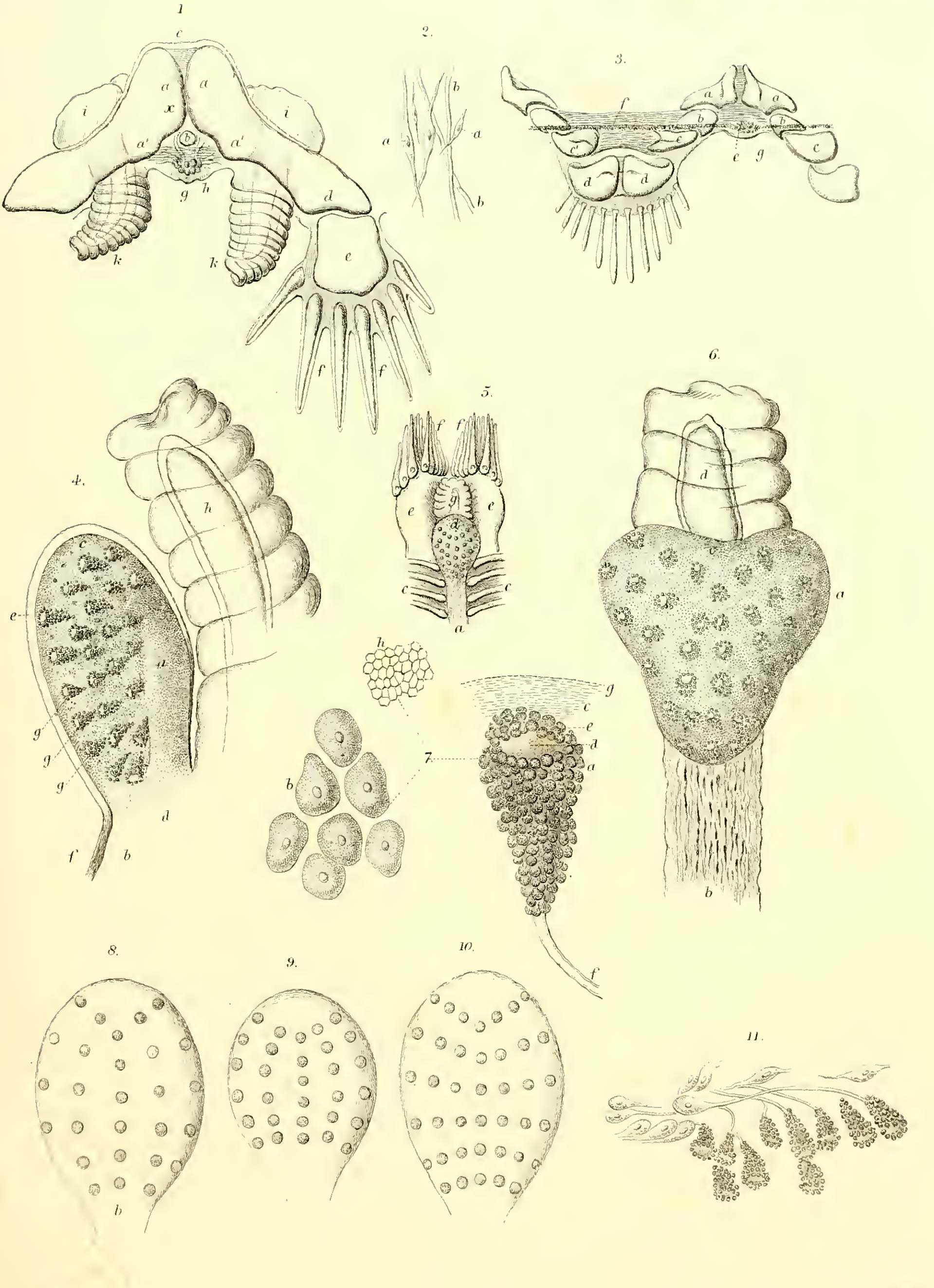
Tab. XV.

Uraster rubens (continued).

Fig. 1. Nerve-cells and filaments from ambulacral cord of a specimen treated with alcohol and acetic acid.

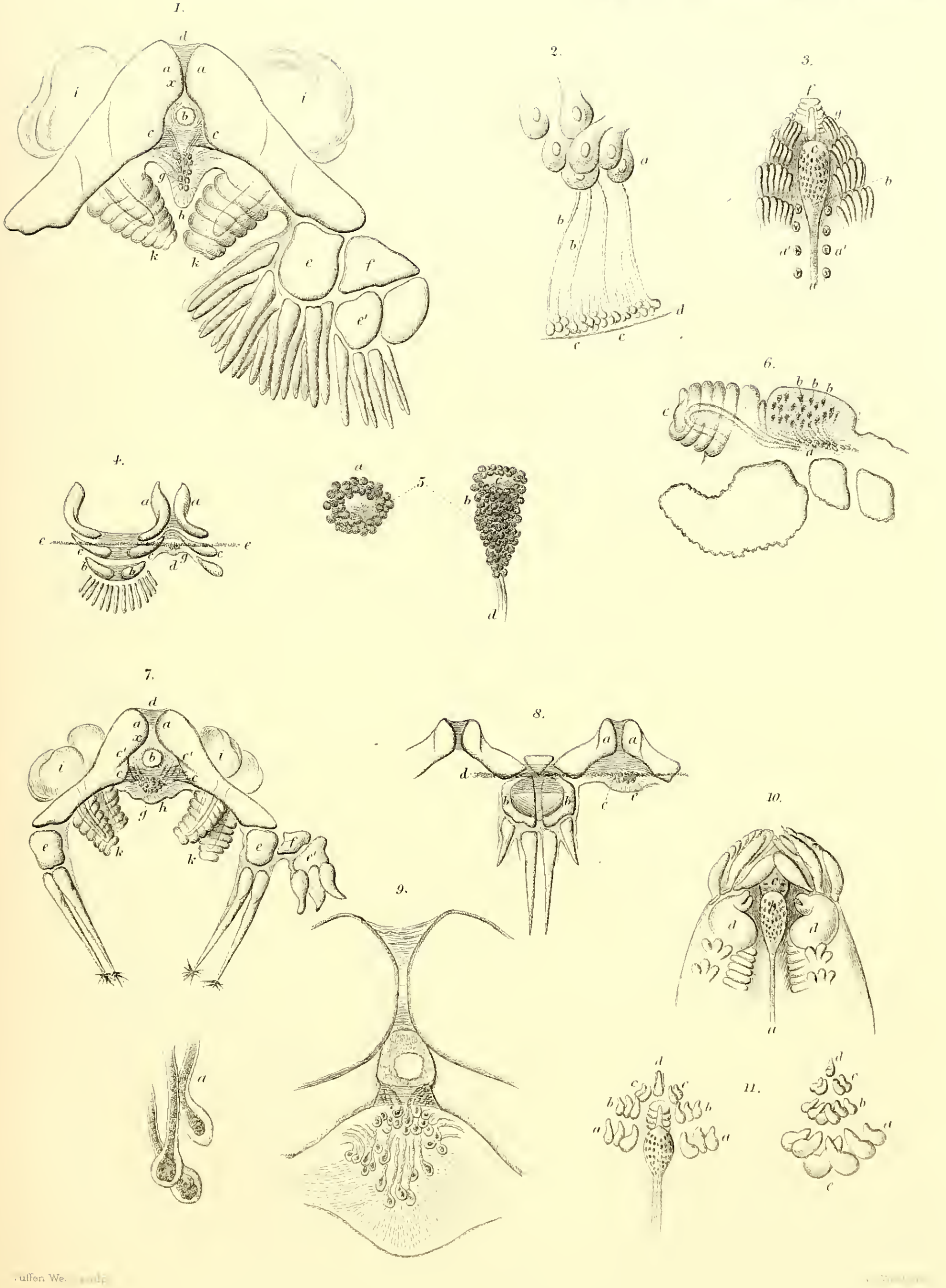
Fig. 2. Other nerve-cells from the same specimen, highly magnified. Their fibre shows the double contour distinctly.

Fig. 3. Profile of optic bulb and tactile organ *in situ,* exhibiting the saddle-shaped outline. *a.* tactile organ; *b.* its cavity, seen to pass towards the termination of the water-canal (*c*).



Tuffen West sculp.

W. West imp.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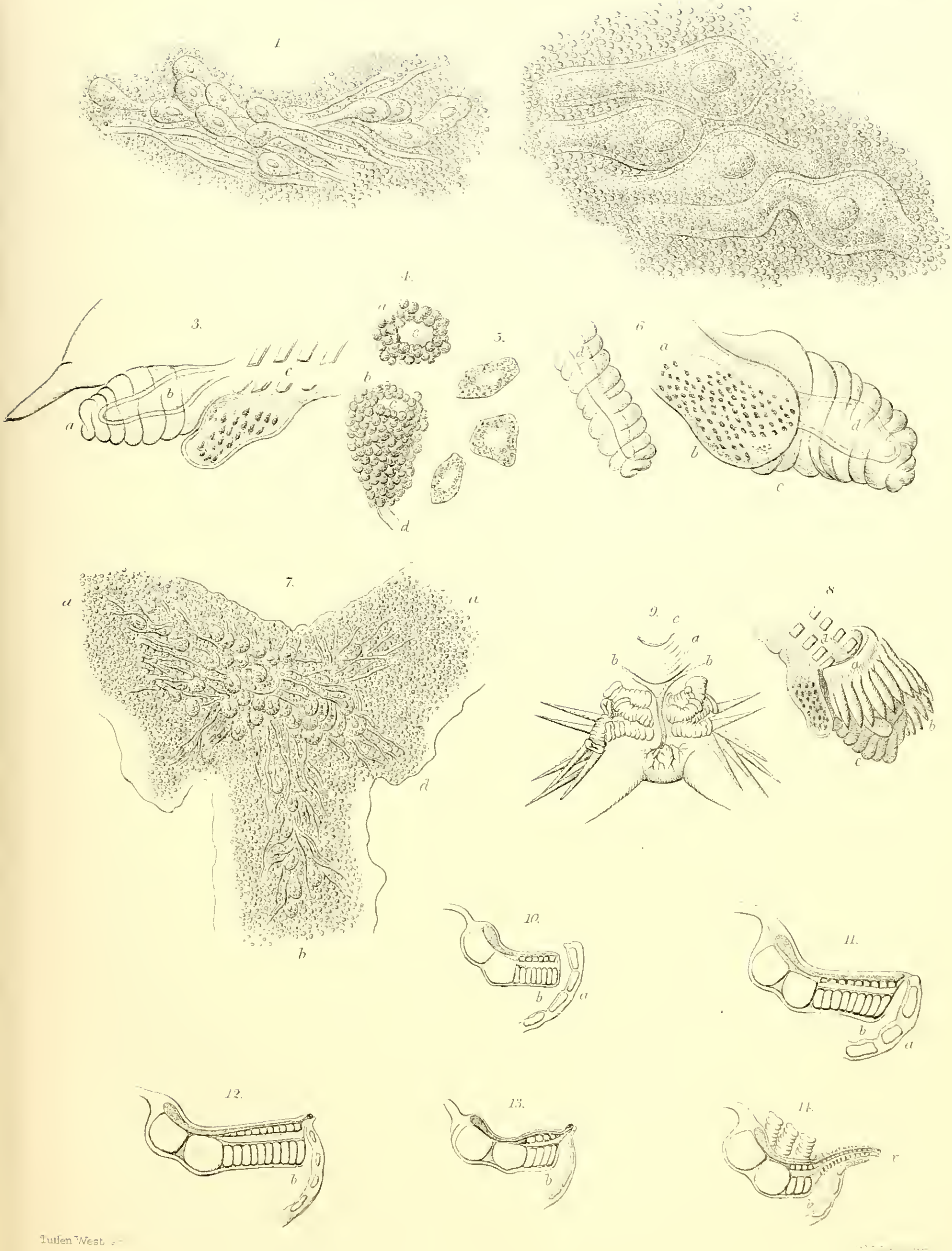


Tuffen West

Fig. 4. Individual cones. *a.* bird's-eye view; *b.* profile; *c.* lens imbedded in the base; *d.* nerve entering the apex.

Fig. 5. Bird's-eye view of individual eyes, with a clear central space.

Fig. 6. Oblique view of optic bulb and tactile organ. *a.* nerve-cord; *b.* optic bulb, showing very distinctly the great number of individual eyes and their arrangement, as well as the clear eyeless portion (*c*), bounded by the distal rows of cones; *d.* tactile organ, very large and with its cavity well marked: the latter may be traced passing onwards behind the bulb.

Fig. 7. Portion of integument, so reflected from the ganglion as to contain parts of the cords passing to or connected with it. *a a.* interambulacral cords; *b.* ambulacral cord; *d.* filaments passing diagonally across to the space between the arms.

Fig. 8. A second profile view of the bulb and tactile organ, showing the calcareous bridge (*a*) bearing the whorl of spines (*b*), underneath which the tactile organ (*c*) passes to communicate with the water-canal (*d*).

Reproduction of a lost Ray.

Fig. 9. Ambulacral aspect of an amputated ray, at the stage in which the newly reproduced arm is just appearing. *a.* ganglion of the old ray; *b b.* interambulacral cords of the same; *c.* dorsal integument, which has curved inwards from behind, in the form of a flap, and united with the skin and other structures of the ambulacral groove.

Fig. 10. Longitudinal section of a ray, illustrating the first stage towards reproduction: the dotted part in the engraving is the ambulacral nerve-cord and ganglion; that shaded with horizontal lines represents the water-canal. *a.* dorsal integument, curving towards the ambulacral groove in the form of a flap; *b.* cæcal cavity or chamber.

Fig. 11. Second stage. Union has taken place between the dorsal flap (*a*) and the ambulacral integument. The cæcal chamber is continued as a *cul de sac* between the surfaces of the vertebral plates and the dorsal flap.

Fig. 12. Third stage. The nerve-cord has sent a prolongation outwards, which is seen resting upon a cutaneous part formed, simultaneously with it, from the dorsal flap. Pigment is deposited at the terminal point of the prolongation; and the water-canal is continued below it.

Fig. 13. Represents the third stage still more advanced. The pigment-deposit is now seen to contain cones with bright specks at their bases.

Fig. 14. Illustrates the last stage. The vertebral arches and the suckers now make their appearance. It will be seen, however, that the vertebræ do not continue regularly up as far as the old ones. The two are separated by the ligamentous structure marked *x*.

Note. Figures 1, 2, 5 & 7 are copied from my Thesis.

XII. *Observations on the Neuration of the Hind Wings of Hymenopterous Insects, and on the Hooks which join the Fore and Hind Wings together in flight.* *By* Miss Staveley. *Communicated by* Dr. John Edward Gray, *F.R.S., F.L.S., V.P.Z.S., &c.*

Read June 21st, 1860.

Considerable attention has been paid to the distribution of the nerves on the fore wings of Hymenopterous insects, and the peculiarities which they offer have been very extensively used in the systematic arrangement of these insects, especially in the separation of nearly allied genera.

After many inquiries of the naturalists best acquainted with the subject, I have failed to discover that any attention has been given to the distribution of the nerves in the lower wings.

The observations which I have been able to make upon these nerves seem to show that they also offer considerable variation, and afford characters which may be valuable for the arrangement of the genera and for the distinction of species.

The existence of a series of hooks on the upper edge of the hind wing, for the purpose of uniting the two wings in flight, has been long known, and the hooks were figured and described as found in the wing of the Bee, and some other insects of the order, in the works of the earlier micrographers; but I cannot learn that any one has particularly studied them, or recorded the peculiarities which they present in different families, or in the genera and species of these groups.

These hooks were generally believed to form a group near the centre of the wing, until the existence of some spines or hooks near the base of the wing, in certain species of *Ichneumonidæ*, was pointed out in a note by the writer, inserted by Dr. Gray, of the British Museum, in the 'Annals of Natural History' for April 1860.

The interest taken in those observations by Dr. Gray has induced me to examine further into the subject than appears to have been done hitherto; and, for the purpose of enabling me to do so, he requested Mr. Frederick Smith, who has paid particular attention to the study of Hymenopterous insects, and who has arranged and described the very extensive collection of this order in the British Museum (perhaps the most extensive which exists), to furnish me with a series of wings of some of the species of the different families and genera, for examination.

These wings were all named by Mr. Smith; and, in the following observations, I have adopted the nomenclature and systematic arrangement used by him in the Museum collections and catalogues.

The wings have been mounted in balsam, and now form part of the collection in the British Museum: they can therefore be consulted by any persons interested in the subject.

The observations have all been made with great care from these mounted wings, which, although they exhibit much which would not be visible in the wings unprepared, are often very deceptive; each observation had, therefore, to be repeated many times to ensure accuracy.

The sketches accompanying this paper were (with the exception of two or three which were traced from the wings themselves) made with the camera lucida, aided by the compound microscope or a simple lens; and this may excuse any artistic defects that they exhibit.

The hooks on the front margin of the hind wings of the Hymenoptera may be divided into two groups: those placed near the middle of the front edge, which may be called the *Distal hooks*, and which appear to occur in the wings of all Hymenopterous insects; and those situated nearer to the base of the wing, which have been called the *Sub-basal hooks*. When the latter are present, they are in general quite distinct from the distal series; but in some few insects the two series seem gradually to pass into each other*.

The disposition, form, and number of these hooks appear to afford, not only good characters for the separation of very nearly allied species, such as the species of the genus *Ophion*, but to afford also excellent characters for the distinction of genera and families; and I have little doubt that when more attention shall have been paid to them, their importance in the economy of the animals will be fully established.

Mr. Frederick Smith, in the notice before referred to, expressed his belief that the hooks would be found to be more developed in those insects which have the quickest flight; but further examination has not confirmed this opinion, as one or two of the insects marked by him as of very quick flight (as *Astata Boops*) have the hooks slightly developed and few in number.

The neuration of the hind wings is somewhat similar to that of the fore wings, and presents variations which fall naturally into three groups, according to the form of the front or costal nerve.

I. *Costal nerve divided near the base.*

A. Upper branch of the costal nerve marginal at least to the centre of the wing, where the upper and lower divisions are re-joined.

VESPIDÆ.	
Vespa maculata	
Polistes (4 species), fig. 43 .	Costal nerve branching at the re-junction. Distal hooks commencing on the re-junction.
Polybia, fig. 44	
EUMENIDÆ.	
Eumenes	
Synagris	

* These hooks are only thus briefly mentioned by Mr. Westwood in his 'Modern Classification of Insects':—"Another character of the order (Hymenoptera) consists in the connexion, during flight, of the two wings on each side of the body by means of a series of minute hooks, along the anterior margin of the posterior wings, which catch the hinder margin of the anterior wings, thus producing one continuous surface on each side." (Vol. ii. pp. 76, 77.)

Dr. Gray has kindly sent me the following observations:—"I do not find that Mr. Westwood anywhere makes use of the hooks in the classification of the insects; and in Curtis's 'British Entomology,' where the wings of the different genera are often figured in considerable detail, I do not find a single instance in which the hooks are either figured or noticed. I have inquired of Mr. Walker if he had ever made use of the hooks on the wings of Hymenopterous insects to distinguish either the genera or the species of these insects, or if he could refer me to any author who had done so; and he said he had not himself, and, after searching in several works where he thought they might have been so used, he was not able to refer me to any."

EUMENIDÆ.	
Rhynchium	Costal nerve branching at the re-junction. Distal hooks commencing on the re-junction.
Odynerus, fig. 42	
SCOLIADÆ.	
Scolia, fig. 29	
SPHEGIDÆ.	
Chlorion (2 species), fig. 33	
NYSSONIDÆ.	
Stizus, fig. 36	
Gorytes mystaceus, fig. 37	Costal nerve branching after the re-junction. Distal hooks commencing after branching.
Gorytes Natalensis, fig. 38	Lower branch of costal nerve branching before the re-junction. Distal hooks commencing on the re-junction.
LARRIDÆ.	
Astata Boops††, fig. 35	
THYNNIDÆ.	
Thynnus, fig. 27	Costal nerve branching at the re-junction. Distal hooks commencing after the re-junction. *Anal nervure* enlarged at the base as if to branch, but not actually branching.

B. Upper branch of the costal nerve marginal, but ceasing before the centre, or becoming very thin. Lower branch rising to the margin (or nearly so) about the centre of the wing.

ICHNEUMONIDÆ.	
Ophion obscurus, fig. 17.	
Ophion combustus *.	
Ophion (N. America) *.	
Paniscus inquinatus †	End of upper branch of costal nerve very distinct.
Paniscus (England), fig. 19	
Paniscus glaucopterus	End of upper branch of costal nerve very indistinct.
Pimpla varicornis ††	Membrane of wing appearing above the costal nerve where the distal hooks are situated, but very narrow.
Pimpla Turionellæ††	
Pimpla (N. America) *	
Pimpla (England)*, fig. 20	
Tryphon *	Has several large and strong hairs irregularly placed near base under costal nerve in externo-medial cell, on membrane of wing.
Ephialtes *	Has four similar hairs more regular and in a row. On membrane as above.
Rhyssa *.	
Osprynchotus†, fig. 22. (2 species)	Membrane of wing appearing above distal hooks. There is a curious appendage (22 *a*) on costal nerve at base in both specimens; it may be accidental, and the nerve certainly is torn, but I think it is worth looking at more specimens for. *Wing brown.*
Trogus *, fig. 23	Membrane of wing appearing above the distal hooks; *wing brown.* This wing and *Osprynchotus* closely resemble each other in colour and veining, and in having two clear, colourless spots in the same situation. The chief difference is between † *and* *.
Mesostenus †, fig. 16	Membrane of wing appearing above the distal hooks.
Cryptus, (1) (Europe), fig. 14	Membrane of wing appearing above the distal hooks. Upper branch very distinct. Upper margin of wing turned over *accidentally*?

†† A short or faint branch from the base of the anal nervure. † A decided branch from the base of the anal nervure. * A slight indication of branch from the base of the anal nervure.

ICHNEUMONIDÆ.
Cryptus (2), fig. 14. . . . . Membrane of wing appearing above the distal hooks. Upper branch very indistinct.

SPHEGIDÆ.
Sphex, fig. 34.

POMPILIDÆ.
Pompilus (5 species), fig. 30.
Macromeris violaceus, fig. 31.
Pepsis (6 species), fig. 32.

I do not know how to describe the hind wing of the *Chrysididæ*. The nerve divides (fig. 25), and the division and re-junction are very indistinct, while there is merely an indication of a branch, and the only other nerve ends nowhere in particular. Perhaps some larger foreign species (if there are any) would be more decided.

ICHNEUMONIDÆ.
Hemiteles . . . . The wing of my specimen is torn at the base; and I think the nerve is displaced. I cannot describe it, or be sure if it should be in this division.

II. *Costal nerve not divided at the base; single; not marginal till about the centre, but margin of wing thickened above it.*

APIDÆ.
Xylocopa (2 species) . . .
Melecta armata . . . . .
Melecta, sp. . . . .
Anthidium manicatum . .
Anthidium, sp., fig. 46. . .
Panurgus Banksianus . . .
Chrysanthedra smaragdina .
Lestis muscaria . . . . .

} Costal nerve branching about the centre, where it becomes marginal or nearly so.
Distal hooks commencing on or before the branching. On costal nerve.
Membrane of wing near base deeply cleft, and again nearer the centre.

ANDRENIDÆ.
Dasypoda hirtipes, fig. 45 . . . As above, but costal nerve not marginal.

FORMICIDÆ.
Formica, fig. 26. . . . .
Œcodoma . . . .
DORYLIDÆ.
Dorylus . . . .
CRABRONIDÆ.
Trypoxylon, fig. 41 . . . .
Mimesa . . . .
Pemphredon, fig. 40 . . .
NYSSONIDÆ.
Mellinus sabulosus, fig. 39 .

} Distal hooks commencing beyond the branching.
(In *Mimesa* and *Pemphredon* the anal vein is enlarged at the base as if to branch, but without actually branching.)

TENTHREDINIDÆ.
Cephus pygmæus, fig. 2 . . As above, but costal nerve becoming marginal sooner than in the others.

MUTILLIDÆ.
Mutilla, fig. 28 . . . . . Costal nerve rising to the margin about the centre. Dipping below the margin at the commencement of the distal hooks (which grow on the membrane of the wing above it), and, when they cease, rising again and becoming marginal. Costal nerve branches at the point where it dips.

CHALCIDIDÆ.

Chalcis, fig. 24 . . . . One vein only, simple; ceasing at centre of wing. Distal hooks on end of vein.

III. *Costal nerve not divided at the base*; *marginal*; *joined about the centre by the nerve below.*

A. The two nerves continued after the junction as one, no longer marginal. Distal hooks commencing before the junction on costal nerve.

Row of hooks single.

XYPHIDRIIDÆ.

Xyphidria, fig. 12 . . . . } *Tip of wing* as in *Tenthredo*, &c. below.

TENTHREDINIDÆ.

Perga, fig. 7 . . . . . . }

Pterygophorus (2 species), fig. 8. The costal nerve is divided at the base—the lower branch bent down and ceasing, whilst the upper is continued and joined by the nerve below, and the two become one nerve no longer marginal.

Costal nerve and nerve below both reaching nearly to the margin at the *tip of the wing* without meeting there.

N.B. All the other characters of *Pterygophorus* corresponding with this section, I have placed it here, notwithstanding the division in the costal nerve, this division being totally unlike that in section I., and, indeed, as far as I have observed, being peculiar to *Pterygophorus*.

Row of hooks double.

UROCERIDÆ.

Sirex, fig. 13 . . . . Costal nerve and nerve below not joining *at the tip*.

B. A loop formed at the junction of the nerves, by their separation and re-junction. The two nerves continued after the re-junction as one, no longer marginal. Distal hooks commencing before the junction on costal nerve.

Row of hooks double.

TENTHREDINIDÆ. . . . . . *Tip of wing*: the costal nerve and nerve below join, and one is continued for a short distance; never quite to the margin.

Tenthredo (3 species), figs. 9, 10.

Allantus (2 species), fig. 1.

Abia.

Sciapteryx, fig. 11.

Hylotoma (7 species), figs. 3 to 6. In some of the *Hylotomæ* the costal nerve is interrupted, rendering the loop exceedingly indistinct; sometimes it is even lost, but there is always an indication of it.

I now proceed to describe the two groups of hooks found on the wings.

The *Distal hooks* are present on all the hind wings of Hymenopterous insects that I have examined.

In the ICHNEUMONIDÆ they are long and re-curved (sometimes losing the re-curve towards the tip of the wing), and are situated on the lower division of the costal nerve after that has branched and become marginal. They are generally largest towards the base of the wing.

The number on various species is as follows :—

Ophion combustus, 7.
Ophion obscurus, 8 (fig. 17).
Ophion (America), 6.
Paniscus (England), 6.
Paniscus inquinatus, 7.
Paniscus glaucopterus, 15.
Tryphon, 8.
Pimpla Turionellæ, 7.
Pimpla (England), 6.
Pimpla varicornis, 10.

Pimpla (N. America), fig. 21, has 2 strong upright hairs at the commencement of the row of hooks; 12 follow regularly; but between the 6th and 7th and the 9th and 10th, and in a line with the hairs, is a small hook standing up and not re-curved. In all these species of *Pimpla*, there are rather upright and strong hairs at the commencement of the row of hooks.

Rhyssa, 13–14.
Ephialtes, 6.
Osprynchotus, 20, preceded by 2 upright hairs.
Trogus, 21.
Mesostenus, 11.
Cryptus (England), 6.
Cryptus (Europe), 14.
Hemiteles, 4.

The distal hooks are of similar form, and begin before, on, or after the branching of the costal nerve in SPHEGIDÆ (*Sphex*) and POMPILIDÆ.

Sphex (Brazil) has	36, beginning on branching of costal nerve (7 ? sub-basal hooks).
Pompilus bicolor	24, beginning on branching of costal nerve (no sub-bas.).
Pompilus	44, beginning before branching of costal nerve (no sub-bas.).
Pompilus nitidulus	21, beginning after branching of costal nerve (no sub-bas.).
Pompilus Bretonii	23, beginning on branching of costal nerve (7–9 ? sub-basal hooks).
Pompilus	35, beginning on branching of costal nerve (2 sub-basal hooks ?).
Macromeris violaceus	32, beginning after branching of costal nerve (14 sub-basal hooks).
Pepsis cærulea (Brazil) . . .	24, beginning before branching of costal nerve (no sub-bas.).
Pepsis speciosa	23, beginning on branching of costal nerve (no sub-bas.).
Pepsis pretiosa	26, beginning on branching of costal nerve (1 sub-basal hook).
Pepsis apicalis	19, beginning on branching of costal nerve (8 sub-basal hooks).
Pepsis viridisetosa	22, beginning on branching of costal nerve (5 ? sub-basal hooks).
Pepsis limbata (fig. 32 *a*) . . .	30, beginning on branching of costal nerve (7 ? sub-basal hooks).

They are of similar form, and begin where the upper and lower divisions of the costal nerve unite and again branch, in VESPIDÆ, EUMENIDÆ, SCOLIADÆ, and SPHEGIDÆ (*Chlorion*).

VESPIDÆ.	
Vespa maculata	33
Polistes	22
Polistes	21
Polistes	27
Polistes	27
Polybia	14, fig. 4 *a*.
EUMENIDÆ.	
Eumenes	26
Odynerus	23
Rhynchium	23
Synagris	23
SCOLIADÆ.	
Scolia	17
SPHEGIDÆ.	
Chlorion (1)	36
Chlorion (2)	31, fig. 33 *a*.

In *Thynnus* they commence after the branching and junction, and are 15 in number.

In *Astata Boops*, fig. 35 *a*, they commence after the branching and on the junction, and are 8 in number.

In NYSSONIDÆ both the veining and the situation of the hooks vary.

Stizus (fig. 36 *a*) has 25 distal hooks, commencing on junction before branching.
Gorytes mystaceus (fig. 37 *a*), 12, commencing on junction after branching.
Gorytes Natalensis (fig. 38 *a*), 25, commencing on junction after branching.
Mellinus sabulosus, 14, on costal nerve after branching (no junction).

They commence on or immediately before the branching of the costal nerve in ANDRENIDÆ and APIDÆ, and are large and recurved. They occasionally differ from the preceding families in increasing in size after they commence at the centre of the wing.

APIDÆ.	
Xylocopa	49 ? largest in the centre of the row; very close together.
Xylocopa	27, first two or three simple, the rest re-curved, diminishing in size towards the apex of the wing.
Melecta	22, largest in the centre.
Melecta armata	17, diminishing towards the apex.
Anthidium, fig. 46 . . .	29, largest in the centre, *broader* and *sharper* towards the base of the wing.
Anthidium manicatum . .	33 ? the wing too broken to be described.
Panurgus Banksianus . .	11, diminishing towards apex.
Chrysanthedra.	
Lestis muscana	20, diminishing towards apex.
ANDRENIDÆ.	
Dasypoda hirtipes, fig. 45 *a*.	15, largest in the centre.

They commence after the branching in FORMICIDÆ, DORYLIDÆ, and CRABRONIDÆ.

FORMICIDÆ.
Formica, 24 ?
Œcodoma, 25.

DORYLIDÆ.
Dorylus, 22.

CRABRONIDÆ.
Pemphredon lugubris, 9.
Mimesa unicolor, 9.
Trypoxylon figulus (fig. 41), 13, in two rows (of 7 & 6), *growing in a line*, with an interval between them of the length of one row.

In *Mutilla*, fig. 28 *a*, they grow on the membrane of the wing, above the costal nerve, which appears to dip down to make room for them. They are 17 in number, and commence before the branching.

In the TENTHREDINIDÆ and two allied families of XYPHIDRIIDÆ and UROCERIDÆ, they are in a single or a double row (one below the other), commencing on the costal nerve before the first junction with the nerve below, with occasional indications of a third series between the two principal rows.

They are in a single row in

XYPHIDRIIDÆ.
Xyphidria, which has 11.

TENTHREDINIDÆ.
Perga, 10. } Radiating wrinkles above the base of each hook.
Pterygophorus (fig. 8 *b*), 10. }

And in a double or treble row in

UROCERIDÆ.

Sirex has 46, *i. e.* $\begin{Bmatrix} 28 \\ 3 \\ 15 \end{Bmatrix}$.

TENTHREDINIDÆ.

Tenthredo viridis (fig. 9 *a*), 15 ($\frac{10}{5}$).

Tenthredo viridis ??, 16, growing too irregularly to divide.

Tenthredo Nothus, 13 ($\frac{5}{8}$).

Allantus (N. America) (fig. 1 *a*), 16.

Allantus scrophularius, 18 ($\frac{6}{12}$).

TENTHREDINIDÆ.

Abia sericea, 16.

Hylotoma cærulea, 13.

Hylotoma cyan. croc., 11.

Hylotoma ustulata (fig. 5), 15 or 16.

Hylotoma Rosæ, 12?

Hylotoma (England), A. (fig. 3 *a*), 15.

Hylotoma femoralis, 12, 13?

Hylotoma (England), B. (fig. 4), 15?

Sciapteryx costalis, 13.

Cephus pygmæus has a single row of 6, beyond the branching of the costal nerve.

CHALCIDÆ, fig. 24 *a*. I have only one species of this family; it has three hooks on the termination of the only nerve.

CHRYSIDIDÆ.

Chrysis ignita, 13 ♀, 12 ♂ ?

Chrysis bidentata, 13.

Chrysis (England), 11.

Sub-basal hooks are found in the families of ICHNEUMONIDÆ, SPHEGIDÆ, CHRYSIDIDÆ, POMPILIDÆ, LARRIDÆ, CRABRONIDÆ, ANDRENIDÆ, NYSSONIDÆ, TENTHREDINIDÆ, and THYNNIDÆ. In some families, as ICHNEUMONIDÆ, I have seen no species without. In others, as POMPILIDÆ, they are sometimes present or absent in different species of the same genus; and I have found no trace of them in the families APIDÆ, VESPIDÆ, EUMENIDÆ, SCOLIADÆ, DORYLIDÆ, MUTILLIDÆ, FORMICIDÆ, and CHALCIDIDÆ. Of these, however, I have (with the exception of VESPIDÆ and APIDÆ) seen very few, in some cases only one species.

The sub-basal hooks vary much in situation, arrangement, form and number, being sometimes on the nerve and sometimes on the membrane of the wing. They occur at the base of the wing, or midway between the base and the distal hooks; or a long row *begins* midway between the base and the distal hooks, ending only at the commencement of the distal row. Sometimes (as in some species of *Hylotoma*) there are one or two at the commencement of the row of distal hooks which can only be classed as sub-basal from their slightly differing in form from the distal hooks, while they agree with the sub-basal of other species which do not commence so near the distal.

They are generally smaller and straighter than the distal hooks, being sometimes quite fine and straight (though still, in most families, quite distinguishable from the hairs, which they then resemble), sometimes strong and straight almost to the end, where they curve suddenly—as in *Paniscus*.

In the following species of the family ICHNEUMONIDÆ they are strong, curved at the end, and situated on the upper division of the costal nerve, near its termination.

Ophion obscurus (fig. 17 *b*) has 2.

Ophion combustus (fig. 18) has 3.

Ophion (America) has 6. 5 grow together in a row, and 1 about the length of that row distant from them, towards the base. There is something like the scar of a missing hook in the interval.

Paniscus inquinatus has 1.

Paniscus glaucopterus has 1.

Paniscus (English) (fig. 19 *a*) has 1, with a few very strong short hairs in a line on either side, differing from the fringe of hairs which cease when these begin. They seem intermediate in form between the hooks and hairs.

Tryphon has 1.

Pimpla (N. America) has 1, 2?

Pimpla (England) has 1.

Pimpla Turionellæ has 1 } nearly straight.
Pimpla varicornis has 1 }

Rhyssa has 1 (hook lost).

Ephialtes has 1.

Osprynchotus has 6.

In *Trogus* (fig. 23) there is one; fine and quite straight, on the margin of the membrane of the wing, beyond the end of the upper division of the costal nerve, about midway between the base of the wing and the distal hooks.

In *Mesostenus* there are 3–4? on the membrane as above, but not quite at the margin; rather nearer to the base than to the distal hooks.

In *Cryptus* (fig. 14) they are on the membrane, not marginal, midway between the base and the distal hooks, slightly curved. In another species there are 4, large and strong, with a double curve, nearer the base than the centre of the wing. The margin of the wing is bent (accidentally?); and I cannot tell whether they are on the nerve or the membrane. There are strong hairs on either side of the hooks in a line with them.

In *Hemiteles* there is one; fine, straight, and erect, nearly on the margin of the membrane of the wing, above the costal nerve, rather nearer to the base than to the distal hooks.

In the following species of the tribe Fossores they are large, strong, and curved at the tip, and situated on the upper branch of the costal nerve.

In Pompilidæ, out of five exotic species of *Pompilus*, two have sub-basal hooks (2?, 7–9? in number); but, owing to the darkness of the wings and the dense covering of hair, it is not easy to ascertain the number.

Macromeris violaceus has 14.

Pepsis (Brazil). Of six species, four have sub-basal hairs: *pretiosa* has 1; *apicalis* 8; *viridisetosa* 5? *limbata* 7? (fig. 32 *b*).

In Sphegidæ they are of the same form as in Pompilidæ.

Sphex (Brazil) has 7 or more, close together, on the margin of upper branch of costal nerve, near base.

Chlorion (India, 1) has 17, near margin of wing, commencing further from the base than in *Sphex*, growing at irregular intervals.

Chlorion (India, 2) (fig. 33 *b*) has 22–23? near margin of wing, commencing further from the base than in *Sphex*, at irregular intervals.

In *Astata Boops* (Larridæ) (fig. 35 *a*) they are 7 in number, growing on the costal nerve, at rather wide intervals, near the distal hooks. Very strong. Those nearest the base almost straight; those towards the distal hooks sharply curved at the tip. A row of strong straight hairs grows in a line with them on either side, and between them.

Gorytes Natalensis (fig. 38 *b*) (NYSSONIDÆ) has 12, and *G. mystaceus* 8, strong sub-basal hooks on upper branch of costal nerve, nearer the base than the centre of wing.

Mellinus sabulosus (NYSSONIDÆ) has 7–9 small sub-basal hooks on the membrane of the wing, above the costal nerve.

Stizus (NYSSONIDÆ). I have only one specimen, much torn at the base, and an unnamed wing (? *Stizus*) (fig. 36) with rather similar veining, which has the appearance of nine partitions in the cell, formed by the divided costal nerve. These may be sub-basal hooks lying down; but if so, the manner of growth must be peculiar. They are perfectly straight.

In the three following species of CRABRONIDÆ (which are all that I have seen) they are on the membrane of the wing, above the costal nerve, placed at rather wide intervals, about midway between the base and the distal hooks in

Mimesa unicolor, which has 6, and

Pemphredon lugubris, which has 4–6 ?

Trypoxylon Figulus has 2, nearer the distal hooks.

Dasypoda hirtipes (fig. 45 *a*) (ANDRENIDÆ) has 2 large and slightly curved hooks on the membrane of the wing, above the costal nerve and near the distal hooks.

In *Chrysis ignita* (fig. 25 *a*) and *bidentata* (CHRYSIDIDÆ), they are large and situated on the upper division of the costal nerve. *Ignita*, 8 (♀ ?) and 7 (♂ ?); *Bidentata*, 8 ?

The TENTHREDINIDÆ appear generally to be furnished with sub-basal hooks; but it is not always easy in this family to distinguish them from the hairs, or from the distal hooks.

I do not see them in *Hylotoma rosæ*, *H. cærulea*, *H. cyaneo-crocea*, *H.* "A.," or *H.* "B.," nor in *Perga*, unless one minute erect marginal hair close to the base of the wing on the otherwise hairless costa is to be called a "sub-basal hook," which I should be inclined to admit, from the fact that *Sirex Juvencus* has four or five similar hairs—the first nearly in the same situation, and the last quite at the commencement of the distal hooks—resembling the sub-basal hooks in many of the TENTHREDINIDÆ. In this wing, however, there is a scar, not quite marginal, on the costal nerve, between the base and the distal hooks, which may have been the site of a more marked sub-basal hook. In *Abia sericea* there are about 7, as above, but more nearly approaching the character of sub-basal hooks.

If in the above the sub-basal hooks are difficult to distinguish from the hairs, in some of the following it is as difficult to draw a line between them and the distal hooks. In some cases a distinction may be made by the form; for, as the sub-basal hooks are, in nearly all families, straighter and smaller than the distal, and as the distal in nearly all families are largest and most decided in form towards the base * (diminishing in size, and in some

* This fact does not always hold good with the *Tenthredinidæ*, the distal hooks of which are sometimes smaller towards the base; so that the distinction appears inapplicable in this family—the only one I have yet seen which requires it. I put it forward only as a quite arbitrary rule, which may be useful if it is necessary to divide the hooks into two series; but I believe that in some species there is no real division.

The hind wings of the *Tenthredinidæ* seem to be, both in the veining and in the arrangement and form of the hooks, entirely irregular. The termination of the veins at the tip of the wing seems to me the most certain character of the group.

cases losing the re-curve as they approach the apex of the wing), I should, in ill-defined cases, call any straight hook at the commencement of the distal a sub-basal hook. Thus in *Pterygophorus* I should reckon three (fig. 8), although there is nothing but the form of that nearest the distal, and the fact of the scars beginning nearer the base than is usual with distal hooks, to separate them.

Allantus scrophularius has 5, on the costal nerve, at wide intervals, nearer the distal hooks than the base.

Allantus (N. America) (fig. 1 *a*), 6 or 7.

Tenthredo Nothus, 5 well-marked sub-basal hooks, beginning near the distal; but the series is continued almost to the base in the form of a deflexed hair, with a large scar on the lower edge of the costal nerve. The other hairs have not such "scars."

Tenthredo viridis (fig. 9 *a*), 12.
Tenthredo viridis? 2.
Sciapteryx, 4.
Hylotoma ustulata, 3.
Hylotoma femoralis, ?

Cephus pygmæus, 6, about midway between the base and the distal hooks.

Xyphidria Dromedarius has 7 prominences (fig. 12 *a*), close to the base of the wing, on one of which is a large sub-basal hook. Probably 6 others have fallen off.

Fore Wings.—The folding over of the lower margin of the fore wing, for the reception of the *hooks* of the hind wing, varies much in different insects, in form, size, arrangement, and in texture, that part of the wing often differing greatly from the rest of the membrane, as in *Pelecinus polycerator*, where the principal roll is thick and dark, and thickly studded with short stiff spines or hairs, while the membrane of the wing is clear and thin, having large fine hairs at wide intervals. It is frequently serrated, or edged with short stiff hairs, along the upper part; sometimes it takes a second fold, when the serration usually ceases (as in *Astata Boops*).

In some insects, as in all the TENTHREDINIDÆ which I have seen, in *Scolia*, *Mutilla*, and *Stilbum*, there is but one roll; and in some (as *Mutilla*) it becomes very narrow, and extends almost to the base of the wing.

In *Vespa* the roll for the distal hooks is very broad, and doubled, and there is a second and narrower roll, nearer to the base, for the sub-basal hooks.

In *Chlorion* the roll is broad at the centre of the wing, diminishes and widens again as it approaches the base, and there is a short broad turning up of the wing quite at the base.

In *Pimpla*, *Paniceus*, *Tryphon*, *Mesostenus*, and *Pelecinus* there are two separate rolls.

In *Ophion* two, or one prolonged roll.

(Query.—Is it always *a roll*?)

Xyphidria Dromedarius has some hairs on the costa, near the base of the fore wing, much resembling in appearance the sub-basal hooks in the same part of the hind wing.

The only genus of four-winged insects, not Hymenopterous, on the hind wings of which I have observed a hook, is *Aphis* * (Tab. XVI. fig. 13 *a*). It is found in all the British species of that genus described by Mr. Walker, of which there are specimens mounted by him in

* Mr. Westwood having suggested to Dr. Gray that the hook of the *Aphides* was figured and described by Messrs. Ratzeburg and Curtis, he consulted their works, and has kindly furnished me with the following observations :—

"Ratzeburg, in his 'Die Forst-Insecten,' figures four species of *Aphides* in their various states, but he does not the Museum collection, though I do not find it mentioned in the descriptions of that author. I may also observe that it is not represented in any of the 370 very much enlarged drawings of the species of this genus engraved in Koch's 'die Pflanzenläuse, Aphiden, getreu nach dem Leben abgeleitet und beschrieben.' Nor are they mentioned in the work of MM. Amyot and Serville, 'Hist. Nat., Hémiptères,' Paris, 1843.

The wing of *Aphis* is figured with a group of hooks, in a paper by Mr. John Tyrrell, in the 'Journal of Microscopical Science,' vol. iii. p. 230. This does not agree with anything that I have seen, nor does his third figure, which represents the fore and hind wings as *joined costa to costa*.

In all the species of *Aphides* that I have examined, there is only a single hook placed near the middle of the front edge of the hinder wing; and the hinder edge of the front wing is turned up for a considerable distance to receive it.

In general the hook is simple, subcylindrical, tapering to a point, with an enlarged base; but in one or two species it looks as if it were compressed or flattened, and is slightly striated longitudinally.

It is not to be observed in the wings of *Livia*, *Psyllæ*, or any of the neighbouring genera Homoptera which have come under my observation. In most of the other genera of this order of insects, the fore wings are more coriaceous or horny than in *Aphis*, and are to be regarded as much in the light of covers to the other wings as organs of flight.

In some Lepidopterous insects there is an appendage thus described by Mr. Westwood :— " Another peculiarity consists in the apparatus by which the two wings on the same side are retained together in the same line during flight, composed of a loop in which a strong bristle plays (fig. 102. 8). The loop is formed either by an elevated portion of the membrane of the strong central vein of the upper wing on its under surface, or by a tuft of raised hairs. This appears to have been first noticed by De Geer (tom. i. tab. 10. f. 4) and Harris (in his Essay upon the membrane of the wings), and afterwards by Giorna (Lin. Trans., vol. i. p. 135) in greater detail. M. Poey (Ann. Soc. Ent. France, tom. i.) has observed that the bristle is simple in the males but multiplied in the other sex, in which, according to Kirby and Spence, there is no annulus, and consequently these individuals are less fitted for flight. See also Hoeven in Férussac's Bul. Sci. Nat., March, 1828. It is chiefly among the *Spingidæ* and Moths that we find this apparatus, the butterflies being destitute of it." ('Modern Class. of Insects,' vol. ii. p. 317.) And he adds as a foot-note at page 332 : " From the observation of Mr. Haworth (Lep. Brit. p. 19) upon the strong flight of the males of the Purple Emperor (*Apatura Iris*), it would appear that the males of that species possess this socket and spring, as he terms this apparatus, and of which the females, which fly but little, are destitute."

represent the hook on the wing in any, although his figures of *A. platanoides* and *A. piniphila* are of a large size. He has observed and figured the hooks on the hind wing of the genus *Chermes* in two species, viz., *Chermes coccineus* (t. 12. f. 1. *o*. 9), *Chermes laricis* (t. 13. f. 5).

" Mr. Curtis, in vol. xi. of the 'British Entomology,' divides the *Aphides* into two genera, and figures as the types *Cynara roboris* (p. 576), *Aphis tiliæ* (p. 577). He does not describe the hooks in his generic characters, nor represent them in his figures: this is the more remarkable, as he figures the hind and fore wings of *Cynara roboris* in the relative position, of an enlarged size, to show the nerves."

I have examined this apparatus in different genera of Lepidoptera. The bristle is usually not only double or divided and forked from the base, instead of single, but also is much weaker in the females than in the males.

It has no affinity in its structure with the hooks on the hind wings of Hymenoptera and *Aphides* here described; and from its situation at the base of the wing, its flexible and elastic character, and from the imperfection of the loop, it can have little effect in keeping the wings "in the same line during flight," or at least an effect very different from that produced by the hooks on the margin of the wings of Hymenoptera and *Aphides*, which, wherever they may commence, always reach to near the middle of the wing, and are thus able to act with considerable power in connecting the two wings and keeping them in place.

I cannot believe that the use of this apparatus in the Lepidoptera has yet been discovered, or that it is of the same nature with that of the hooks here described. Perhaps the name of "spring," which Mr. Haworth gives to it, may best illustrate its use.

EXPLANATION OF THE PLATES.

Tab. 16.

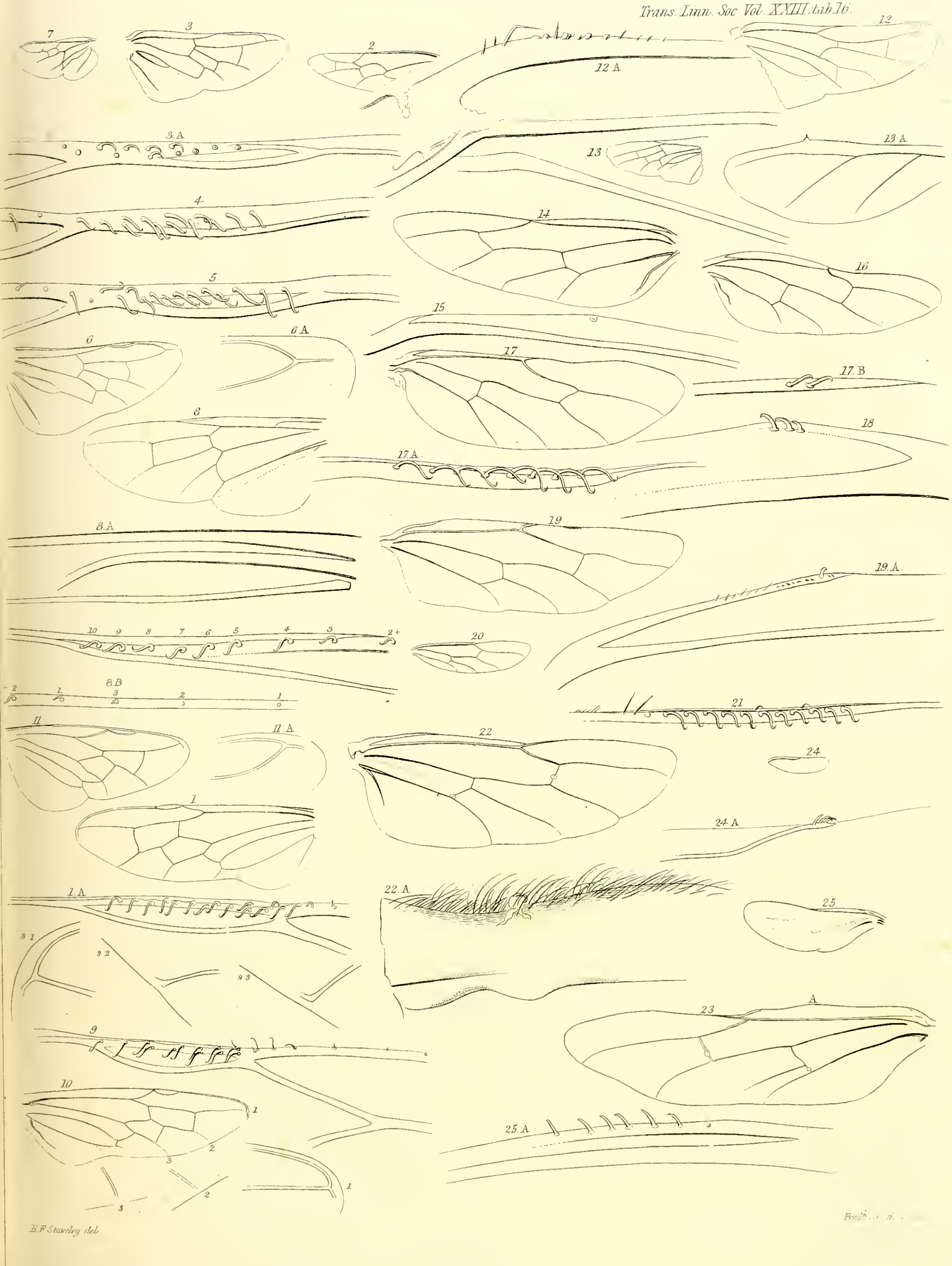
Hind Wings of Hymenoptera Terebrantia, *Latr., and* Aphis.

Fig. 1. *Allantus* (N. America). *a.* the 16 distal hooks and the first sub-basal.
Fig. 2. *Cephus pygmæus.*
Fig. 3. *Hylotoma,* A. *a.* the distal hooks.
Fig. 4. ——, B. The distal hooks.
Fig. 5. —— *ustulata.* Distal hooks, and, 1 and 2. ? sub-basal hooks.
Fig. 6. —— *femoralis.* *a.* tip of wing.
Fig. 7. *Perga.*
Fig. 8. *Pterygophorus.* *a.* base of wing: *b.* 1, 10. distal hooks; 1, 3. sub-basal hooks.
Fig. 9. *Tenthredo viridis.* *a.* the distal and three first sub-basal hooks; 1, 2, 3. end of nerve.
Fig. 10. *Tenthredo,* sp. n.? 1, 2, 3. end of nerves.
Fig. 11. *Sciapteryx costalis.* *a.* end of costal nerve.
Fig. 12. *Xyphidria Dromedarius.* *a.* sub-basal hooks.
Fig. 13. *Sirex Juvencus.*
Fig. 13 *a.* Wing of *Aphis hieracii.*
Fig. 14. *Cryptus,* Europe.
Fig. 15. *Cryptus,* England. Scar of sub-basal hook.
Fig. 16. *Mesostenus.*
Fig. 17. *Ophion obscurus.* *a.* the distal hooks; *b.* sub-basal hooks.
Fig. 18. —— *combustus.* sub-basal hooks.
Fig. 19. *Paniscus* (England). *a.* sub-basal hooks.
Fig. 20. *Pimpla,* England.
Fig. 21. ——, N. America. distal hooks.
Fig. 22. *Osprynchotus.* *a.* base of costal nerve.
Fig. 23. *Trogus.*
Fig. 24. *Chalcis.* *a.* distal hooks.
Fig. 25. *Chrysis.* *a.* the sub-basal hooks.

Tab. 17.

Hind Wings of Hymenoptera Aculeata, *Latr.*

Fig. 26. *Formica.*
Fig. 27. *Thynnus.*
Fig. 28. *Mutilla.* *a.* distal hooks.
Fig. 29. *Scolia.*
Fig. 30. *Pompilus.*
Fig. 31. *Macromeris violaceus.*
Fig. 32. *Pepsis limbata.* *a.* distal hooks; *b.* sub-basal hooks: highly magnified.
Fig. 33. *Chlorion* (No. 2). *a.* the distal hooks; *b.* the sub-basal hooks.
Fig. 34. *Sphex* (Brazil).
Fig. 35. *Astata Boops.* *a.* some of the distal and sub-basal hooks.
Fig. 36. *Stizus.* *a.* some of the distal hooks.
Fig. 37. *Gorytes mystaceus* *a.* some of the distal hooks.
Fig. 38. —— *Natalensis.* *a.* some of the distal hooks; *b.* a sub-basal hook.
Fig. 39. *Mellinus sabulosus.*
Fig. 40. *Pemphredon lugubris.*
Fig. 41. *Trypoxylon Figulus.* The distal hooks.
Fig. 42. *Odynerus.*
Fig. 43. *Polistes.*
Fig. 44. *Polybia.* *a.* distal hooks.
Fig. 45. *Dasypoda hirtipes.* *a.* the distal and the sub-basal hooks.
Fig. 46. *Anthidium.* *a.* the distal hooks.
Fig. 47. ——?



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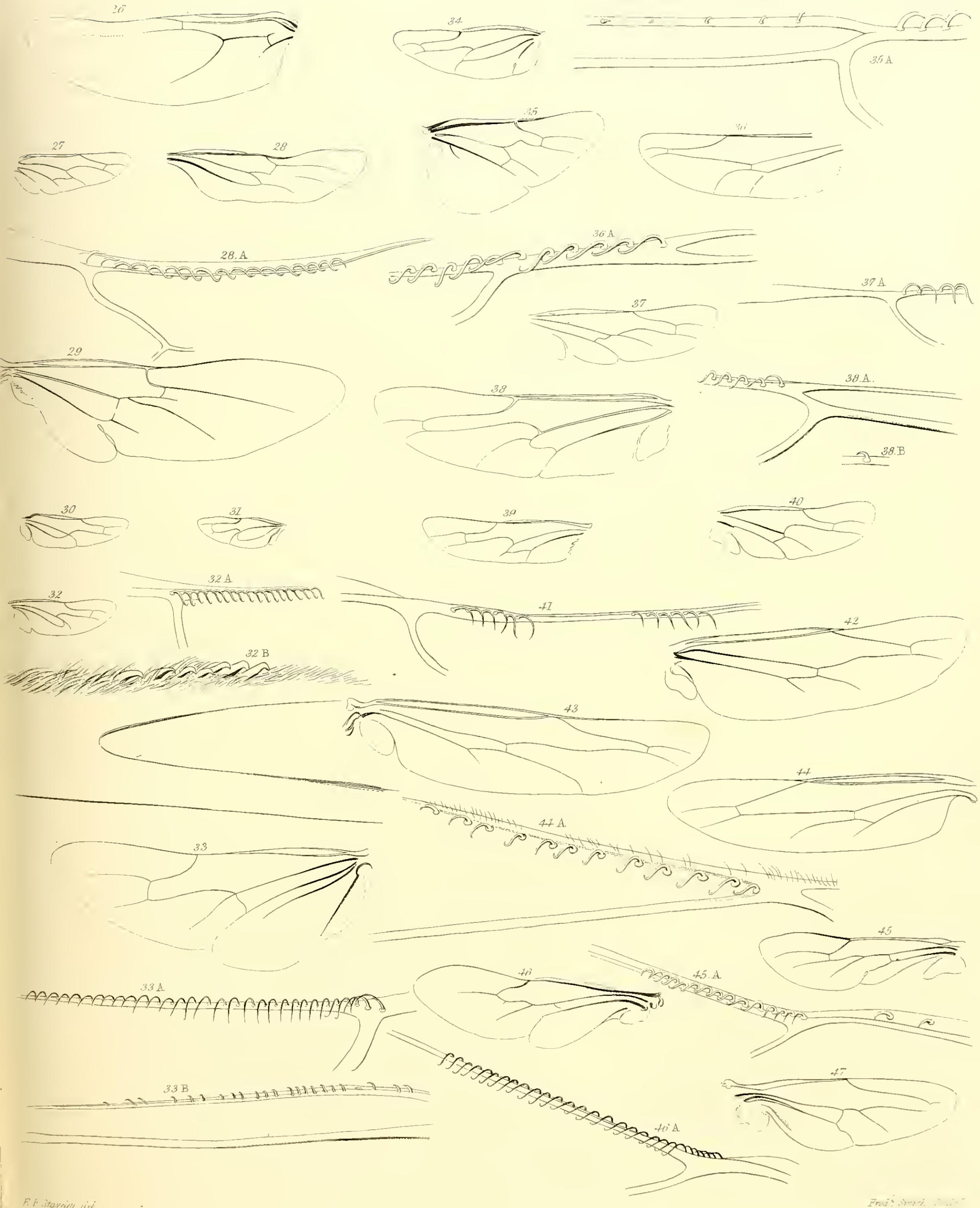
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38. B
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44 A.
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45. A.
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46 A
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XIII. *On certain Sensory Organs in Insects, hitherto undescribed*.*

By J. Braxton Hicks, *M.D. Lond., F.L.S.*

Read May 3rd, 1860*.

Before proceeding to the details of the following communication, it will be well to remind this Society of the structures I have already pointed out as existing in the Insect tribes, the consideration of which will serve to explain the nature of the new organs about to be described.

In a paper read before the Linnean Society on the 17th June, 1856†, I called attention to groups of hemispherical vesicles, disposed in rows, very regularly arranged, situated at the base of the *halteres* in all Diptera. These vesicles are apparently formed of cuticle, beneath which the ordinary chitine-layer is deficient, whereby a longer or shorter tube is formed, according to the thickness of that layer at the part. I showed that the number of these vesicles in some Diptera was great—sometimes as many as 360 on each *halter*. I also pointed out that a very considerable nerve (the largest in the body except the optic) proceeded to the *halter*. I then, as also subsequently (Linn. Trans. vol. xxii. p. 144), showed that similar structures were to be found extending along the subcostal nervure of the wings both of Diptera and of the 4-winged tribes; more numerously in that of the posterior wings and on the upper aspect.

To these organs also nerves were clearly seen to pass from the thoracic ganglia.

At the same time I showed that the elytra of the Coleoptera formed no exception in consequence of their peculiar structure, but that the nerve, entering their base, branched into numerous filaments, which ultimately terminated in vesicles pretty uniformly scattered on the upper surface.

At the time of reading that paper I had not found these organs on the under surface of the elytron, but I now furnish a drawing of the under surface of that of *Aromia moschata* (Musk Beetle), in which the vesicles are distributed in the course of the nervure, the nerve giving off branches to each vesicle (Pl. XVIII. fig. B).

Although I had distinctly perceived the branches of the nerves passing to the vesicles on the subcostal nervure of the wings and on the elytra, I had not, at the time of my first notice of the subject, seen the nerves actually distributed to those more elaborate groups on the base of the *halteres*.

I now, however, am able to show this point most clearly in the *halteres* of *Œstrus Equi* (Pl. XVIII. fig. A). It will be seen that a branch passes directly to each of the three principal groups at the base, while a small nerve only proceeds up to the head of the organ. Thus it is proved that, whatever the function of these organs may be, the largest nerve, except the optic, is distributed to them.

Having pursued these investigations into the different members of insects, I beg now

* It should be stated, that this paper was originally presented to the Royal Society, where it was read on the 26th May, 1859; and an abstract of it was published in the Proceedings Roy. Soc., vol. x. p. 25.

† Journ. of Proceed. Linn. Soc., vol. i. p. 136.

to draw attention to another somewhat similar group of organs observed about the joint of the trochanter and femur, chiefly on the former, and which I have found in all the insects I have examined.

The organs in question consist, as in the structures above described, of a thin delicate membrane, probably the cuticle, stretching over, and closing in from the air, a tubular aperture in the chitine-layer of the part. This aperture may be circular or oval, the tube varying in length according to the thickness of the integument, curved as in the Hornet, or forming a globular cavity as in *Silpha*. The delicate membrane which covers over this aperture is generally level, sometimes having a ridge or a minute papilla in its centre, as in *Meloë* (Pl. XVIII. fig. G).

In some rare instances, as in *Formica rufa* (Pl. XVIII. fig. M), I have found that a few occur about the next joint (the tarso-femoral).

The following are those which I have selected to exemplify these structures:—

They are remarkably well shown in the genus *Hippobosca*. Fig. C, 1, represents the trochanter-femoral joint of *H. Hirundinis*. The organs are found on both sides of the limb, and occur in groups of one or two rows of vesicles, each of which has a diameter of $\frac{1}{3750}$ inch, the rows being either straight or curved.

Fig. C, 2, shows those of *H. Ovis*; they are rather more numerous than in *H. Hirundinis*, and of the same diameter.

Those of *H. equina* are similar.

Those of *Musca domestica* are represented at fig. D. In all the Diptera I have examined they are alike; they are concentrated into a group of about ten to twelve on the femoral portion of the joint. The diameter of each is $\frac{1}{3000}$ inch.

In *Pulex* these organs can be seen, of a small size, about three in number, on the concave side of the trochanter. They are best shown in the Swallow-Flea.

In *Silpha* (Pl. XVIII. fig. E) they are well marked, being about eight on one side of the trochanter and six on the other, the centre of the tube being of much greater diameter than either the covering-in membrane or the internal opening, thus being of a globose form. The diameter of the covering-in membrane of the largest is $\frac{1}{1420}$ inch.

In the female of *Lampyris noctiluca* (Glow-worm) (Pl. XVIII. fig. F) they are found in a row of six to eight, extending transversely across the trochanter on each side. The branches of the nerve proceeding to them can be plainly seen (fig. F, 1 *c*).

In *Meloë* I have found these organs on the femur, close to the trochanter; they are about twenty in number; the covering-in membrane has a central prominence (Pl. XVIII. fig. G, 2 *b*, 3 *b*), on which the branch of the nerve (fig. G, 1 *a*, 3 *a*) ends, after passing up the tube in the integument. The diameter of this covering-in membrane is about $\frac{1}{2720}$ inch; that of the papilla is $\frac{1}{7500}$ inch, whilst that of the nerve is still smaller.

In *Forficula auricularis* (Pl. XVIII. fig. H) they are found on each side of the trochanter, near the joint, on one side rather scattered and large, and on the other in a group of about six or seven. They are oval in form, and rather prolonged at one end. The diameter of the longest is $\frac{1}{1700}$ inch.

These structures are found in the Grasshoppers (*Tetrix*) on both trochanter and femur, as shown in Pl. XVIII. fig. I, 3; they are oval, and in the common Grasshopper measure about $\frac{1}{1500}$ inch. They are found on the same parts in *Acheta* and *Blatta*, of the form of those of the Scorpion-fly, as below.

In the Scorpion-fly (*Panorpa communis*) they are found in a group of ten to twelve on each side of the trochanter (Pl. XVIII. fig. I, 1) each one is oval; and has on one side a ridge running in the direction of the longest diameter (fig. I, 2 *a*). They are also found in *Libellula* in the same parts.

In the genus *Gerris* (Hemiptera) the organs are found in two groups on the trochanter, about four in each group, and their shape is different from those hitherto described, being oval, with a point at each end and a papilla in the centre (Pl. XVIII. fig. K, *a*). The same organs are found in the Water-Scorpion (*Nepa cinerea*).

In the genus *Vespa* they are found in a group on both the trochanter and femur, near the joint, and a few scattered over the trochanter. I have represented those of *Vespa Crabro* at Pl. XVIII. fig. L, 1; they are circular at the surface. The tubes leading to the surface are curved; the nerve proceeding to them can be plainly seen, as is shown at fig. L, 2.

In the Hive-Bee these organs are not so numerous, but are situated in the same part.

In *Formica rufa*, or the Wood-Ant (Pl. XVIII. fig. M, 1), the organs are very numerous, and exist both on the trochanter and femur (fig. M, 1, *a a*). The nerve can be seen passing to the different groups. On the femoral end also of the tibia are to be found a few small groups, to which the nerve can be traced (fig. M, 2). Their diameter is about $\frac{1}{3780}$ inch.

In the various Tenthredines the same organs are to be seen (Pl. XVIII. fig. N, 1), larger than the foregoing, and their form, which is shown at fig. N, 2, is somewhat conical. They exist in two groups—one small, on the coxa; and the other larger, on the trochanter.

The organs on *Grylla viridissima* are represented at Pl. XVIII. fig. O, 1. They exist on the first and second legs, but not on the third leg; they are in three groups, two on the trochanter and one on the femur.

At this place I may mention that I have examined the dilatation on the fore leg of *Gryllus* and *Locusta*, considered by Siebold* as the "organ of hearing," and I have arrived at the same conclusion as M. Lespés in the 'Ann. des Sci. Nat.' 1858, namely, that there is no special nerve proceeding to the dilatation, but that within it there is a swelling of the tracheæ, which principally occupies the space, and that the nerve passes deeper down behind this tracheal swelling, being continued through the joint to the extremity of the leg. I have bleached the integuments, and have been able to see quite through the leg by adjusting the focus suitably.

The next portions of the Insect to which I wish to direct attention are the palpi, both maxillary and labial. If we examine, with $\frac{1}{4}$ to $\frac{1}{8}$-inch objective, the palpus of the common Blow-fly (*Musca vomitoria*), it will be seen to be studded with a number of small transparent dots over more than half its surface, more thickly towards the apex (Pl. XVIII. fig. P, 1). Their true nature it is difficult to tell, but it is probably something similar to that which I shall describe in *Vespa Crabro*. I have drawn them enlarged (fig. P, 2), with the minute hair-like cuticular projections between them. Their diameter in this Fly is $\frac{1}{5000}$ inch.

* Wiegm. Archiv, 1844, vol. i. p. 52.

In the palpi of all Diptera formed on the same plan as in *Musca*, I have found these structures existing, varying indeed in number and size. I have also found them in *Eristalis tenax*.

In many of the Diptera (*Musca*, *Mesembrinum*, for instance, and Flies of similar construction), a group of organs of a somewhat similar character is to be found on the tips of the piercers; in some there are as many as twenty on each side of the middle line, two large ones generally being situated at the apex. In *Tabanus bovinus* the tip of the central portion or piercers possesses as many as twenty, apparently having the same structure as those in the Hymenoptera, to be immediately described.

I have found similar organs on or about the palpi of some of the Hymenoptera, as *Vespa*, *Odynerus*, *Apis*, *Bombus*, *Megachile*, *Nomada*, &c. I have, in Pl. XVIII. fig. Q, 1, figured these in *Vespa Crabro*. They are situated at the basal joint of the labial palpi, about twelve in number, and in the same joint of the maxillary palpi, but fewer and more scattered. In *Vespa vulgaris* their diameter is $\frac{1}{1870}$ inch. In fig. Q, 2, I have given an enlarged view of one,—(2) showing a section in which the nerve (*a*) is seen expanding on the inner surface of the covering-in membrane, (3) as seen from above.

In *Odynerus muraria* and *O. Antilope*, for instance, they are found also on the centre of the base of the labium.

In *Apis mellifica* these organs, instead of being placed on the first joint of the labial and maxillary palpi, are close to the origin of the palpus. I have shown these at Pl. XVIII. fig. R, 1 *a*, 2 *a*. If we examine the apex of the labial palpi of this Bee, we shall find three or four structures somewhat similar, but having a few papillæ at the surface. They are situated among the hairs, and are represented at Pl. XVIII. fig. R, 3 *a*. In the *Megachile* (Leaf-cutting Bee) they are very similarly situated, but on the base of the tongue, and on the basal joint of its palpus, and a few scattered over the second joint (Pl. XIX. fig. A, 1).

In *Nomada succincta* I can find them only on the base of the labial palpi, and one on the distal end of each segment of the same palpi, which latter are of much larger size (Pl. XIX. fig. B, *a*).

This will suffice to point out the kind of structure to be found on or about the palpi; to all of them a bundle of nerves can be seen proceeding.

In *Dyticus marginalis* I have observed a few organs on the maxillary palpi, situated in an oblique row (Pl. XIX. fig. E, 1 *a* & 3), of apparently similar nature to the structures which I have observed on the antennæ of that insect (in the second paper read before the Linnean Society, May 1859). They are shown enlarged at fig. E, 3.

A group of similar structures is to be found in some of the Arachnida, as *Arania*, *Tegenaria*, on the under surface of the maxillæ, extending lengthwise along the middle on a space nearly devoid of hairs. They are the only organs which I have been able to meet with in that tribe; but as the habits of the Arachnida show them to be chiefly dependent on sight for their guidance in obtaining supplies of food, we probably might not expect to find a large development of these organs, or others I am about to mention.

In the palpi of Lepidoptera I have observed a peculiar structure, which I cannot find noticed by any one, and which differs much from the other I have described.

The structure in question consists of a depression on the apex of the terminal joint, the depth of which varies extremely—from a mere depression, as in the Lacquey-moth (*Clisiocampa Neustria*), to a tube extending inwards to half, or more, of the length of the joint. Sometimes the tube is of the same diameter throughout, or even dilated at the innermost end. What the nature of the inner surface of this tubular depression is, it is very difficult to ascertain from its position. It certainly possesses numerous hairs, and apparently there are some circular markings between them at the deepest part. However, upon one point there is no doubt, viz. that a nerve proceeds distinctly to it alone, and spreads out upon the apex of this cavity (Pl. XIX. fig. C, 1 *b*, 2 *b*). It is held in its position by two or three bands which are attached to the interior of the wall of the palpus. The aperture of this structure when tubular (which is its most frequent form) is shown at fig. C, 1 *a*, 2 *a*. I have given figures of it in *Argynnis Paphia* and in a Geometer-moth. In a large number of different species examined, I have never found this structure absent.

In *Acherontia Atropos* (Death's-head Moth) there is no depression, the part being merely marked by a circular yellow spot.

I have found something similar to this in the first joint of the palpus in *Bibio Marci* (Diptera), which I have drawn at Pl. XIX. fig. D, 1. There are about twenty-four irregularly-shaped hollow cells or compartments on the floor of the cavity, each of which is divided from its neighbours by a rather stout septum; and a number of hairs spring up from the floor of each cell, and from the sides of the walls dividing them (See Pl. XIX. fig. D, 2). I have not as yet met with this condition in any other dipterous insect.

I shall now pass to a class of structures quite dissimilar to those already mentioned. They are to be found on the palpi and those parts about the mouth whose function is that of touch, as the apex of the palpi, proboscis of Lepidoptera and of Diptera, and also on the apex of the antennæ, being peculiar modifications of true hairs, and not processes of the cuticle. It is requisite to bear in mind the true nature of the hair in Insects,—namely, that it is situated in a depression caused by the absence of the inner layers of the integument, into which the cuticle is continued. In the centre of this cuticular depression a small elevation or papilla arises, which is the true root of the hair, and which rises from it of various length. By means of this arrangement, the hair itself is capable of some degree of motion. The interior of the root of each hair is in connexion with the internal parts of the member on which it is situated; commonly fibres run to it, probably always including a branch of a nerve; and this is decidedly the case in those hairs situated near the prominent parts and extremities of the various members, as, for instance, the tips of the antennæ, the palpi, pads of tarsi, &c.; and this branch of the nerve does not run into the interior of the hair, but only to the inner aspect of the root, which separates it entirely from the interior. The difference between this structure (true hairs) and cuticular processes must be particularly borne in mind: the latter, having no *root*, and not being situated in a depression, evidently only spring from the surface. The spine must also be distinctly separated from the true hair, being a tapering process of the whole integument, into the interior of which the contents of the body can freely pass.

The palpi have been considered by most naturalists as the organs of touch, both from observations upon the habits of insects, and also from the palpi having, in those instances where they are particularly used in the investigation of food, &c., an apparently thin, delicate, bladder-like membrane at their extremities. Now, although I shall be able to show that they are endowed with a very delicate sense of touch, yet that function depends on a condition very different from that simply of a delicate membrane; for, in the numerous palpi which I have examined, the thin bladder-like membrane, instead of being perfectly smooth, is in most, if not in all instances, furnished with numerous bodies, which I shall be able to show are but modified hairs, sometimes of extreme minuteness and delicacy. But even the palpi of the Orthoptera (*Gryllus*, *Locusta*, *Tetrix*, for instance) bristle all over with hairs, as will be shown below. Proceeding to each of these modified hairs, in every instance, can be plainly observed a branch of the palpal nerve; indeed, in some Beetles, which have the extremities of the palpi dilated, the palpal nerve seems to undergo an extraordinary development, which perhaps may be only from the multitudinous subdivision to which it is subjected in order to supply each hair, or from the formation of a ganglionic enlargement of the nerve itself. This latter supposition does not seem to me improbable, as I think I have seen such a condition on the antennal nerve. The subject, however, is one of difficulty. The palpus of *Timarchus* (Pl. XIX. fig. H) is well-fitted for examination.

The palpi of many Insects are covered with large stiff hairs, such as the palpi of most of the Diptera, Hymenoptera, &c., which evidently can possess only a general sense of feeling; but in those Insects which are remarkable for the use they make of their palpi, as the Coleoptera, Orthoptera, &c., the integument becomes more delicate towards the apex, and the large scanty hairs found on the shaft become much smaller, and altered in general appearance near the apex, while on the delicate tip itself they are further modified, and are sometimes exceedingly minute and very numerous. Sometimes, however, the shaft of the palpus is almost destitute of hairs, while those on the apex are largely developed, as in the larva of *Melolontha*. The antennæ themselves are frequently used as supplemental organs of touch, and in those Insects which use them largely for that purpose, a certain modification of the hairs takes place, but not so completely as in the palpus; also the antenna-wall undergoes considerable reduction in thickness gradually as it approaches the apex, which is well observed in the antennæ of *Myrmica*, *Formica*, *Vespa*, *Apis mellifica*, and *Sirex gigas*; but in no instance have I found the change of hair so well marked, and so easily observed, as in *Dyticus marginalis* both in the antenna and palpus; and by watching the habits of this insect we see that it uses the antennæ in the same manner as *Hydrophilus piceus* does its palpi, which organs they much resemble. The form and position of these modified hairs, to which I propose to give the name "tactile hairs," will be best understood by the investigation of the different drawings here given; and first I will call attention to the palpi of *Dyticus marginalis* (Pl. XIX. fig. E).

On the prominent portions near the joints the largest tactile hairs are to be found, as shown in Pl. XIX. fig. E, 4, which may be described as follows: a tube passes through the wall, becoming narrower in the centre, across which stretches the cuticle, which dips down the tube as far as this point and forms a conical septum; in the centre of this septum is a point or papilla, which is the root of the hair, which springs from it, not long and tapering, but oval like a ninepin, its apex scarcely reaching beyond the general level of the exterior. To the inner surface of the root a nerve passes.

If we look with a higher power ($\frac{1}{4}$ or $\frac{1}{8}$ inch objective) at the delicate membrane at the extremity of the apex of this palpus, it will seem to be studded all over with minute bodies, as shown in Pl. XIX. fig. E, 1 *b b*. These upon careful examination will be seen to be but modified hair-follicles, the space between each being depressed (fig. E, 2). The principal part of the palpal nerve proceeds to these, sending a branch to each. Compare this palpus with that of another Water-Beetle, *Hydrophilus piceus* (Pl. XIX. fig. F, 1, 2), where, in the centre of the bladder-like apex, a small depression occurs, in which are seen two shortened hairs, whose apices just appear above the general level (fig. F, 3 *a*). Besides these is a multitude of very delicate hairs (true) which seem to be collected into two groups, those towards the middle of each group being the tallest. To these, as in all others, the nerve is plainly seen proceeding.

The labial palpi of *Melanotus* (Pl. XIX. fig. G) present a similar structure, the smaller hairs being shorter and more distinct, as shown at fig. G, 2. Their diameter is $\frac{1}{7000}$ inch. The surface of the maxillary palpi has nothing but the short sunken hairs over the whole surface of the bladder-like membrane (fig. G, 1 & 3).

In *Timarchus*, the last segment of whose palpus is much dilated, the apex is covered by a very thin membrane, which is thickly covered by a more elongated form of hair, as shown in Pl. XIX. fig. H, 1, 2. The nerve (1 *a*), as before remarked, becomes so enormously enlarged or expanded on reaching the roots of these hairs, that it seems not improbable that it is increased by the addition of some ganglionic matter; certainly among the expanded nerve-threads globular bodies very much like ganglion-cells may be noticed.

In Pl. XIX. fig. I, 1, 2, I have shown another slightly different form of tactile hairs covering the whole membrane of the palpi of a *Carabus*. Some of them are similar to those of *Dyticus marginalis*.

In another species of *Carabus* may be seen (at Pl. XIX. fig. J, 1 & 1 *a*) only a few tactile hairs; these, however, are long and well-marked; while in a third species they are reduced to a very small size (fig. J, 2). A similar condition is observable in the maxillary palpus of the Glow-worm (*Lampyris noctiluca*) (Pl. XIX. fig. K, 1 & 2), the numerous fine delicate hairs being seen at the edge.

But sometimes the termination of the nerves in the surface is so delicate and minute as to have the appearance of mere points even under a $\frac{1}{8}$-inch objective. This is shown in the palpi of *Cychrus rostratus* (Pl. XIX. fig. L, 1 & 2). Some of them, however, are a little larger; but it is impossible to decide if they possess any hair-like structure, such as appears in *Goerius olens* (Pl. XIX. fig. L, 3), where they are shown as rounded elevations of the membrane. However, between these delicate tactile hairs and the large long hairs on some palpi, there are various grades more or less approaching to the condition of tactile hairs. For instance, on the apex of the antennæ and palpi of the larva of *Melolontha vulgaris* (Pl. XIX. fig. M, 1, 2, 3) are found from fifteen to eighteen stiff hairs, which diverge from each other at the apex, and have their extremities rounded off, being especially blunted on the antennæ. In the perfect insect these are altogether altered in the antennæ; but in the palpi they retain their features perfectly, as is shown at Pl. XIX. fig. M, 4. There is also another peculiarity in these antennæ, that on each side is an oval space where the integument is very thin, and covered closely by a great number of very delicate hairs, and to this part a large portion of the palpal nerve can be traced. The larva of *Dyticus marginalis* presents extremities somewhat on the same plan (Pl. XIX. fig. N, 1, 2, 3): on the apex of each of the three palpi are short conical hairs; on the external maxillary there are only two, on the internal maxillary three, and on the labial palpi four.

Many of the Orthoptera possess palpi, the apical segment of which is dilated, and is described by many to be terminated by a white, transparent, distended bladder, upon which the main nerve of the maxilla and tongue spreads, and distributes itself upon its superior surface, with the finest branches (Burmeister). This bladder, however, instead of being smooth, is furnished all over with numerous hairs, which differ from the others on the palpi in being much smaller and more delicately formed and evenly distributed, as is represented in the palpi of *Tetrix* (Pl. XIX. fig. O, 1). An enlarged view of the hair is shown at fig. 2. The length of each hair is about $\frac{1}{1000}$ inch, the diameter at the base is $\frac{1}{5000}$ inch, while the diameter of the elevation from which it grows is $\frac{1}{2700}$ inch. If the hair is compared with the smaller palpal hairs of *Dyticus marginalis* (Pl. XIX. fig. E, 2), a strong resemblance will be seen. This condition exists in all the Orthoptera I have examined, the hairs being as strong and well-marked as in *Tetrix*; they are well shown in *Gryllus*, *Acheta*, *Blatta*, &c.

A common form of the termination of palpi is shown in the Hive-Bee (Pl. XVIII. fig. R, 4), and in the *Megachile* and *Nomada* (Pl. XIX. fig. A, 2, and fig. B), in the Scorpion-fly (*Panorpa communis*) (Pl. XIX. fig. P, 1, 2, 3), in *Formica* (Pl. XIX. fig. Q, 1). In these the hairs are shorter than the general form of hairs,—still not so much so as those above described, but they are placed on the most prominent points of the apex, evidently for the purpose of touch.

Some palpi have no rounded bladder-like membrane, but simply a pointed extremity; this, I believe, exists chiefly in the larval state. I have figured the internal maxillary palpi of the larva of *Colymbetes striatus* at Pl. XIX. fig. R, 1 *a*. On the apex of the maxillary and labial palpi are a number of small papillæ, as at fig. R, 2 & 3. The nerve can also be seen running up to these papillæ (fig. R, 3 *a*); the diameter of each papilla is $\frac{1}{10,000}$ inch. These papillæ are so exposed and unprotected by any hairs that doubtless they are used as instruments of touch. Compared with those of the perfect insect, they are very different, the latter being very similar to those of *Dyticus marginalis* at Pl. XIX. fig. E.

A very peculiar form of palpus is that of *Forficula auricularis*, in which there is no such delicate membrane; but the centre of the apex rises up in a cylindrical form, as in Pl. XIX. fig. S. The apex of this cylinder is closed across by a very thin membrane, the centre of which again is elevated, so as to form a large papilla; around this latter there can be discerned very delicate hairs. To it also the nerve passes, as at fig. S, 2. Both palpi are alike.

In those palpi with a delicate bladder-like termination, the membrane commences abruptly, so as to give the edge in most cases the appearance of a ridge running round the palpus. This is well shown in *Tetrix*, &c., and in the Coleoptera.

Closely resembling these tactile hairs, we find on the proboscis of *Musca*, *Mesembrinum*, and many dipterous genera, as *Eristalis*, &c., on the delicate under surface of that suctorial organ, some nipple-like bodies, which apparently are hairs in origin (Pl. XIX. fig. T, 3), but which are, with their follicles, much firmer than the membrane from which they spring; in *Musca vomitoria* and *domestica* they are well-marked, as in Pl. XIX. fig. T, 1; while in *Eristalis*, &c. the hair itself is much abbreviated, although the integumental tube is long, lying obliquely in the membrane (Pl. XIX. fig. T, 2). Their minuteness renders it difficult to ascertain whether a branch of the nerve proceed to them; but, from their position on the *under* surface, which is that used for touching, it is probable that such is the case. And as the proboscis of the Diptera is certainly in part used for the same purposes as the palpi in other insects, it seems also highly probable that these bodies have a similar function, particularly when we consider that the palpi of the Diptera are generally devoid of those peculiar hairs which I have called "tactile."

Now these "tactile hairs" are found not only in Insecta, but also in Myriapoda and Arachnida, and probably in all the Articulata. In the common Wood-louse the apex of the feeler is depressed, from the centre of which spring three shortened hairs, the tips of which appear only just above the edge of the depression. In the Grass-tick (*Ixodes*) there are two cup-shaped depressions close together near the end of the fore leg, from the centre of which three or four hairs arise, whose apices extend just beyond the level of the margin. These I have shown at Pl. XIX. fig. U.

While considering the relation of these hairs to the sense of touch, it seems proper here to mention that on other parts of insects also, hairs, much altered from their usual form on the general integument, are to be found on those parts of the members which necessarily come into contact with bodies in the natural movements; as, for instance, the pads of the tarsi, &c. That these are used as instruments of touch, some have denied; still I am sure that careful investigation would lead to the conclusion that such is their vocation. On examining the tarsal pads, we shall find that they have shortened, conical and delicate hairs, sometimes closely crowded, as in the Wood-Ant (Pl. XVIII. fig. M, 3); sometimes sparingly so, as in the *Tetrix*. To these hairs I have observed in every case a nerve proceeding, giving off branches to their roots. This is well marked in *Formica rufa* (Wood-Ant). (Pl. XVIII. fig. M, 3, *a*.)

As the pads on the last joint of the tarsus of the Diptera have been closely investigated by others, I have not pursued their anatomy.

Finding thus that these modified hairs are situated on those parts that are used for touching, and that they become most modified in form in those parts that are employed more particularly for delicate touch, and are supplied with nerves proportionately to their altered form, I think we are justified in concluding that the highest form of feeling, viz. touch, resides in them, especially in those of such extreme delicacy as are found on the terminal membrane of the palpi, while those on the pads of the tarsus, &c. we may suppose to possess the sense of touch also, but in a less degree,—and further, that the hairs of the general surface possess the function of common feeling. To follow the nerve into the hairs of the general integument is a matter of much difficulty, compared with that of the members where the nerve can be easily traced throughout its course.

I now wish to call attention to the anatomy of the "barrel-shaped" organs (as they are called) on the proboscis of the Lepidoptera. They are found in almost all genera of English Butterflies and Moths. The genera *Pontia*, *Pieris*, *Gonopteryx*, and the *Sphingidæ*, are free from them, as is also the rudimentary proboscis in the *Bombycidæ* and Tiger Moths. Perhaps they are shown best in *Argynnis Paphia* and *Vanessa Atalanta* among the Diurna, whilst among the Noctua *Mormo* and *Tryphæna* possess them exceedingly well marked. In those species where they are not present, dwarfed hairs are found, in rows on the proboscis; but whether they are in the same position as the barrel organs would have been in, I cannot decide.

The form of the barrel organs is very variable; but they may be divided, so far as I have had the opportunity of examining in British Lepidoptera, into two divisions—the simple and the winged; the latter I have found only in the Moths, whilst the simple are confined to the Diurna. The simple form is shown at Pl. XIX. fig. V, 1, which represents that of the *Argynnis Paphia*. They are flattened in one direction. The winged are shown at Pl. XIX. fig. V, 5, being those of *Mormo Maura* (Moth). The section at 6 indicates the position of the wings on the body of the organ.

The essential part of the barrel organs is a tube more or less dilated towards the middle, contracting again towards the apex, and terminating in a nipple-like point,—the membrane of this papilla and for some distance around its base being very thin and delicate; and, at the point where this thinning commences, a very delicate tissue stretches across the interior of the organ. A nerve can be traced up to this membrane for that certainty, as is shown at figs. V, 1 & 4, in *Argynnis Paphia*. I am tolerably certain that a delicate filament passes to the apex of the papilla (fig. V, 2); or if that is not the true interpretation of the appearance, then I think it must be produced by a very delicate tube passing from the apex of the papilla into the interior of the barrel organ. This point is difficult to settle on account of the delicacy of the parts to be investigated. In the *Vanessæ* and many other Diurna, there is a ring of eight spines around the papilla, which spring from the part where the thinning commences; and in the Moths there are seven or eight rings springing from the whole length of the barrel organs, ending at the point just mentioned. The upper points of the rings and of the spines, as in *Vanessa*, do not, I believe, ever extend to the length of the papilla. That these organs, where they exist, are used for some refined sense, one can hardly doubt, but of what nature it is very difficult to decide. Whether it is to the sense of touch that they confine that highly-developed variety of it which we call *taste*, we are not at present competent to judge. The anatomical resemblance of these organs to that on the palpus of *Forficula* will be apparent to all.

In considering what functions we are to assign to the various structures I have just described, we have to bear in mind that a too strong dependence on analogy of position of the different parts of Insects, and of the Invertebrata in general, to those of the higher animals will tend to mislead us; for as the ganglionic nervous system is itself diffused far beyond the state it is in the Vertebrata, so we may possibly find that the special sensations are also; and this view is certainly strengthened by the fact that the respiratory organs and their accompanying nerves are distributed in a diffused manner throughout the whole length of the Insect's limbs, instead of being concentrated anterior to the extremities, as in the Vertebrata. Reasoning from analogy, therefore, will clearly not hold in this case; indeed there can be little doubt (and this view is held by some of our best naturalists) that the true homological relations of the various organs in the Vertebrata and Invertebrata are to be decided rather by the analogy of their form, structure, and evident functions, than by that of their position.

These circumstances should guide us in determining the functions of the structures I have now brought under notice; but at present I think it would be premature to attempt finally to assign a particular function to any of these organs, excepting those of the antennæ, which I have described on two former occasions; still I may venture to throw out a few hints for further investigation in the matter.

That there is every reason to think that the antennal organs are those of hearing, I have stated in my papers above mentioned; at all events I do not think it possible to suppose they can be olfactory organs, according to our present ideas of the essentials of that organ. It is difficult to understand how odorous particles can pass through, as in some Coleoptera, a hard spine-like membrane, then a fluid, thirdly, through a thin membrane to reach the extremity of the nerve, while a wave of sound can readily be conceived to be capable of thus impressing upon the nerve the required impulse. The non-existence of an otolith within these sacs cannot, I think, be considered as conclusive against their being auditory organs,—and for this reason, that as every Invertebrate hitherto described as having an auditory organ is aquatic, so it does not seem a necessary consequence that, should an air-breathing Invertebrate be discovered to have an auditory apparatus, such structure requires an otolith. The conditions of the transmission of the waves of sound are totally altered, and it is possible that the multitudinous repetition of these organs on the antennæ in some Insects may preclude the necessity of such an addition within the auditory sac.

Regarding the function of the organs so liberally supplied with nerves on the nervure of the wings, base of *halteres*, and elytra, I have already expressed my opinion in the Journal of the Linnean Society (*l. c.* p. 139): namely, as in the Vertebrata we find the olfactory organ near the respiratory aperture, so that, by the process of breathing, a constant supply of fresh odorous particles can be brought to it, we may, I think, expect from analogy to find, in those animals where the position of the respiratory organ is altered, that the olfactory sense will accompany it: and I may ask, where should we find it more suitably placed than at the base of the wings, which are so frequently in motion and so near the large thoracic spiracle, through which the air is continually passing.

I think we may reasonably conclude that the organs I have above described on the palpi in Diptera and Hymenoptera are in some measure connected with the sense of taste, being situated around the mouth, perhaps supplemental to other organs; and one can scarcely deny a similar function to the tube running inwards from the apex of the palpi in Lepidoptera. That they are in a position where the air is the only medium by which impressions can be conveyed to them, can easily be seen in Diptera, Hymenoptera, and Lepidoptera.

The same must be said of those on the legs, which I have described above. If we observe an Insect, that joint around which the organs are placed does not touch the surface over which it is running, but remains at some distance above it: in this also the air must be the medium of communication.

The delicacy with which odours are perceived by many insects argues an olfactory apparatus of considerable perfection; and it seems to me not improbable that these latter-named organs may be in some way connected with the sense of smell, or perhaps with some sense not to be found in the Vertebrata.

In conclusion, I again venture to recommend the process of bleaching by chlorine, to which I have already called attention in my former papers. It is easily managed, always efficacious, and invaluable in researches of this nature, and equally adapted to decolorize Crustacea, Arachnida, and Insecta. Without it, I should have been unable to arrive at the results here detailed.

DESCRIPTION OF THE PLATES.

Tab. XVIII.

Fig. A. *Halter* of *Œstrus Equi*.

1. Showing the groups of organs (*a a*) at base on one side; *b b*, nerves to them.
2. Section of base: *a a a*, organs in section; *b b b*, nerves proceeding to each group.
3. Magnified view of the lateral groups: *a*, seen from above; *b*, seen in section.
4. Magnified view of the lower group: *a*, seen from above; *b*, seen in section.

Fig. B. Under surface of nervure in elytron of *Aromia moschata*: *a a*, vesicles; *b b*, nerve proceeding to them.

Fig. C. Organs on legs of *Hippobosca* (*a a a*).

1. Of *H. Hirundinis*. Diameter of each vesicle $\frac{1}{3750}$ inch.
2. Of *H. Ovis*.

Fig. D. Organs on trochanter-femoral joint of *Musca domestica* (*a*). Diameter of each $\frac{1}{3000}$ inch.

Fig. E. Organs on trochanter of *Silpha* (1 *a a*).

2. Enlarged view from above. Diameter of largest $\frac{1}{1420}$ inch.

Fig. F. Organs on trochanter of *Lampyris noctiluca* (Glow-worm).

1. Under surface: *a*, organs; *b*, main nerve of leg; *c*, branches to organs.
2. Upper surface.

Fig. G. Trochanter of *Meloë*.

1. *b b*, organs *in situ*; *a*, nerves proceeding to each.
2. Section of wall, showing the nerve (*a*) passing to the papilla (*b*).
3. Magnified view of organs and papillæ from above: *a a*, nerve; *b*, papilla.

Fig. H. Trochanter-femoral joint of *Forficula auricularis* (common Earwig).

1. Under surface. } *a*, *a*. organs. Diameter $\frac{1}{1700}$ inch.
2. Upper surface. }

Fig. I. Trochanter-femoral joint of *Panorpa communis* (Scorpion-fly).

1 & 2. Both surfaces: *a a*, organs.

3. Trochanter-femoral joint of *Tetrix*: *a a*, organs. Diameter of each, $\frac{1}{1300}$ inch.

Fig. K. Trochanter of *Gerris*: *a a*, organ.

Fig. L. Trochanter of trochanter-femoral joint of *Vespa Crabro*.

1. Organs *in situ*.
2. Nerve proceeding to them.

Fig. M. Leg of *Formica rufa* (Wood-Ant).

1. Trochanter-femoral joint, showing organs (*a a*), and nerves passing to them (*b b*). Diameter of organs $\frac{1}{3750}$.
2. Femoral-tibial joint: *a a*, organs; *b b*, nerves.
3. Tibio-tarsal joint, showing the nerve (*a*) proceeding to the numerous hairs on under surface of first tarsal joint.

Fig. N. Organs on trochanter-femoral joint of *Tenthredo* (Saw-fly).

1. Organs *in situ*.
2. Section of them.

Fig. O. Trochanter-femoral joint of *Gryllus viridissimus*.

1. Of fore leg: *a*, organs.
2. Organs enlarged.

Fig. P. Palpus of *Musca vomitoria* (Blow-fly).

1. Organs *in situ*. Diameter $\frac{1}{5000}$ inch.
2. Organs magnified.

Fig. Q. Organs on palpus of *Vespa Crabro*.

1. *a*, organs *in situ* on basal joint. Diameter in *Vespa vulgaris* $\frac{1}{1870}$ inch.
2. Enlarged section of one organ: *a*, nerve expanding at termination.
3. Organ magnified, seen from above.
4. Apex of the palpi.

Fig. R. Organs in *Apis mellifica*.

1. Labium and ligula, &c.: *a*, organs at base of labium and mandible.
2. Enlarged view of base of labium.
3. Lip of labial palpi: *a*, papillæ.
4. Lip of maxillary palpi.
5. *a*, end of ligula, covered with compound hairs, enlarged at *b*.

Tab. XIX.

Fig. A. *Megachile lignisecans*.

1. Organs on base of tongue (*a*); on base of palpi (*b*).
2. Apex of labial palpi.

Fig. B. Palpus of *Nomada succincta*: *a a*, organs.

Fig. C. Apex of palpi of Lepidoptera.

1. Of *Argynnis Paphia*: *a*, aperture of tube; *b*, nerve expanding on apex of the tube.
2. Of a Geometer-moth: *a*, aperture of tube; *b*, nerve expanding on apex of the tube.

Fig. D. Palpus of *Bibio Marci*.

1. Second segment, showing cavity (*a*).
2. Enlarged view of portion of cavity.
3. Apex of palpus.

Fig. E. Maxillary palpus of *Dyticus marginalis.*

1. Apex of palpus: *a*, organs similar to antennæ; *b*, tactile organs; *c c*, nerves.
2. Enlarged view of tactile organs.
3. Enlarged view of 1 *a*.
4. Largest tactile hairs.

Fig. F. Palpi of *Hydrophilus piceus.*

1. Maxillary palpus.
2. Labial palpus.
3. Enlarged view of 1, with the two larger tactile hairs in centre.

Fig. G. Palpi of *Melanotus.*

1. Apex of maxillary palpus.
2. Apex of labial palpus.
3. Portion of apex of maxillary palpus magnified.

Fig. H. Palpus of *Timarchus.*

1. Shows the nerve (*a*) enlarged in last joint, going to the tactile hairs in apex.
2. Tactile hairs of apex magnified.

Fig. I. Palpus of a *Carabus.*

1. Showing the distribution of the nerve.
2. Enlarged view of apical membrane.

Fig. J. Palpi of *Carabus.*

1. Apex: 1 *a*, enlarged view of tactile hairs.
2. Apex of another; hairs very small.

Fig. K. Palpi of *Lampyris noctiluca.*

1. Apex of labial palpus, showing delicate hairs on membrane.
2. Apex of maxillary palpus.

Fig. L. Palpus of *Cychrus rostratus.*

1. Shows the distribution of the nerve.
2. Enlarged view, a branch of nerve passing to each papilla.
3. Apex of palpus of *Goerius olens.*

Fig. M. Palpi and antennæ of *Melolontha vulgaris.*

(1–3. Of the larva.)

1. Apex of antenna.
2. Apex of maxillary palpus.
3. Apex of labial palpus.
4. Apex of palpus of perfect insect.

Fig. N. Palpi of larva of *Dyticus marginalis.*

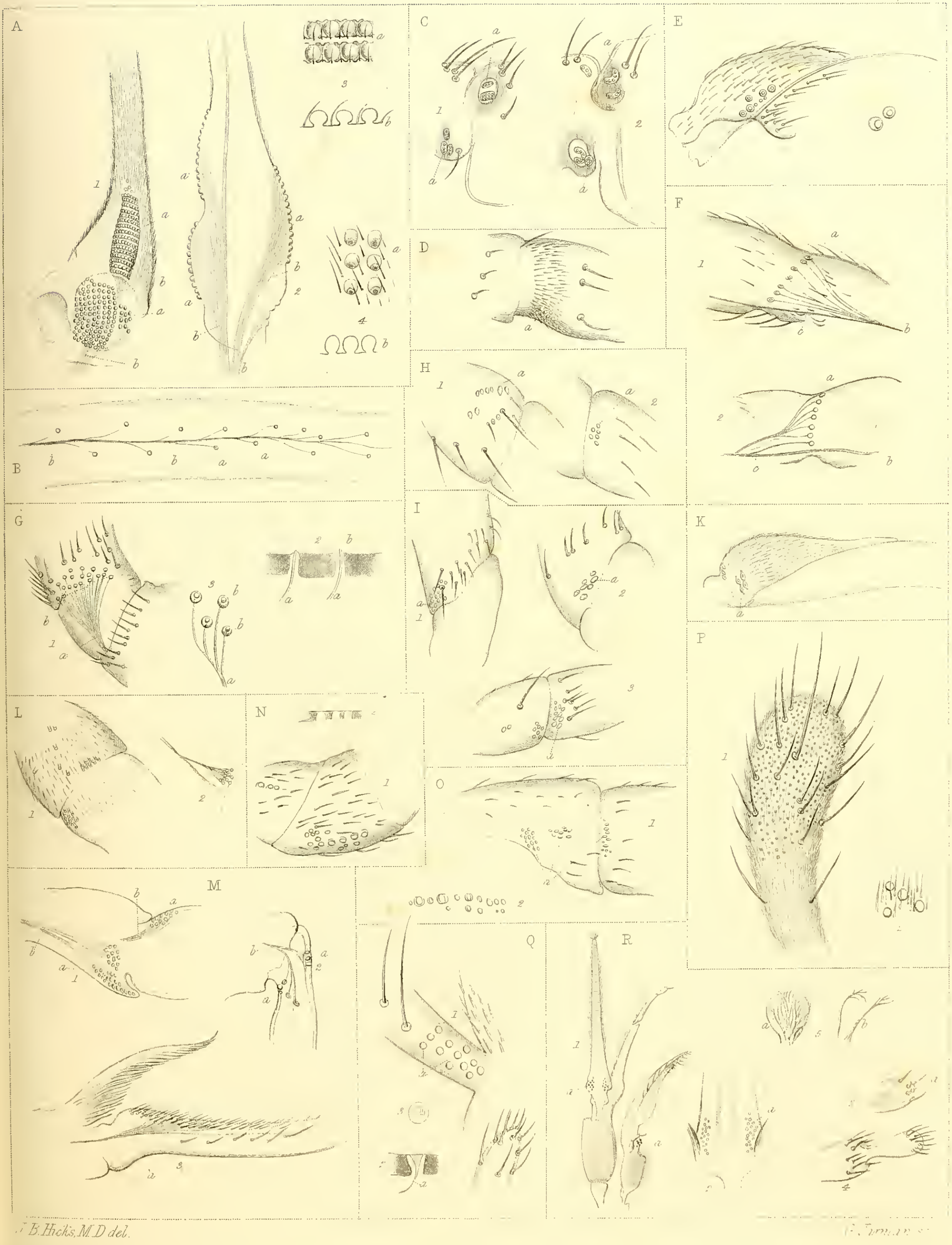
1. Apex of maxillary palpus.
2. Apex of internal maxillary palpus.
3. Apex of labial maxillary palpus.

Fig. O. Apex of palpus of *Tetrix.*

1. Shows the bladder-like membrane covered with tactile hairs (*a a*).
2. Shows one of the hairs magnified.

Fig. P. Palpus of *Panorpa communis.*

1. Apical segment of palpus, showing the nerve within and its branches.
2. Exterior view of apex.
3. Sectional view of apex.



J. B. Hicks, M.D. del.

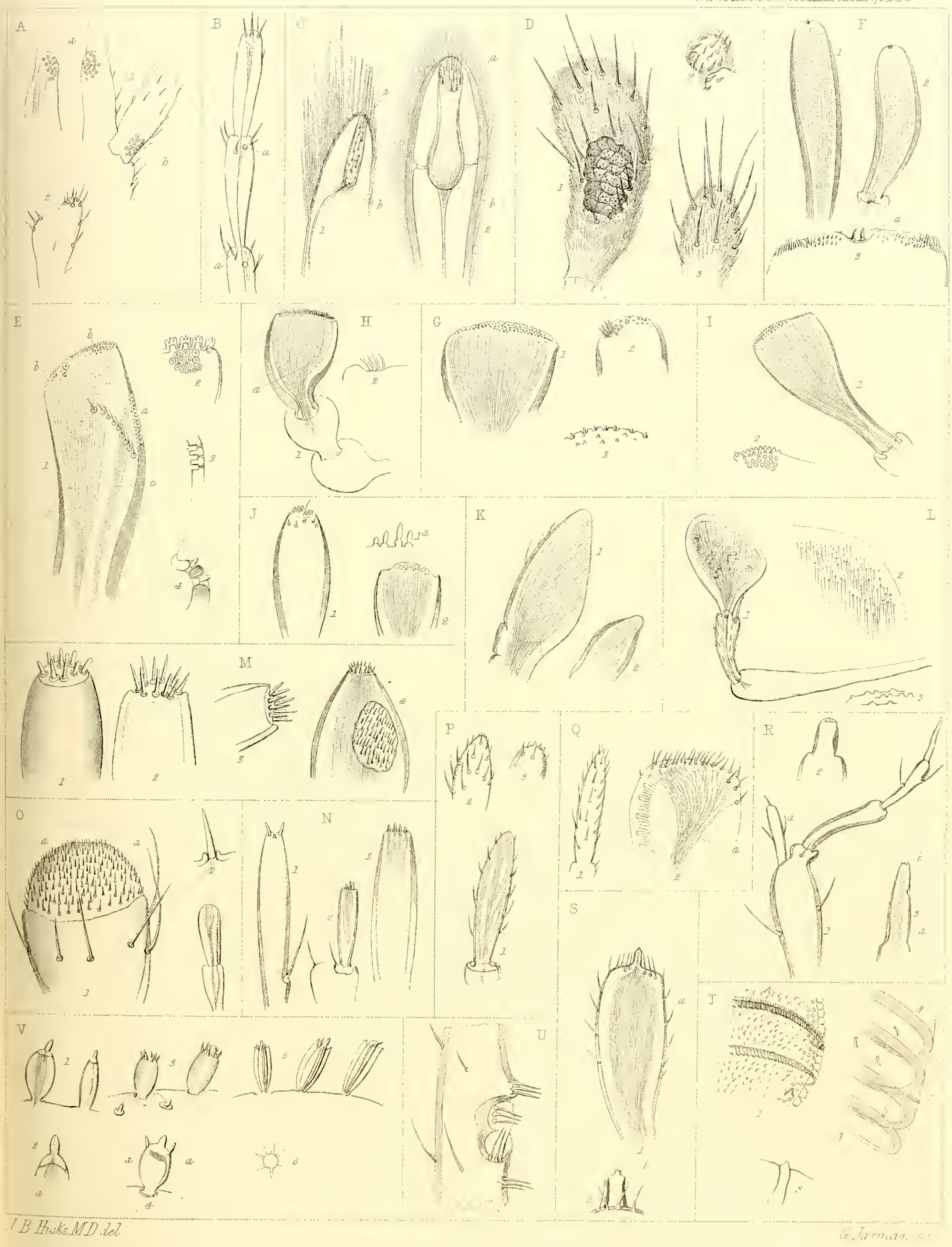


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Fig. Q. *Formica rufa.*

1. Apical joint of palpus.
2. End of maxilla. The nerves (a) are distributed to the numerous hairs on the edge.

Fig. R. Palpi of larva of *Colymbetes striatus* (Striped Water-Beetle).

1. Maxillary palpus: a, internal maxillary palpus.
2. Apex of labial palpi with papillæ.
3. Apex of maxillary palpus, with papilla at apex (b); the nerve supplying them is distinct (a).

Fig. S. Palpi of *Forficula auricularis.*

1. Last segment, with elevation in centre, supplied by the nerve (a).
2. Enlarged view of section of elevation, having a papilla in centre (b).

Fig. T. Tactile hairs on under surface of proboscis of Diptera.

1. In Blow-fly.
2. In *Eristalis* (Drone-fly).
3. Enlarged view of latter.

Fig. U. Tactile hairs in *Ixodes Dugesii*, on the fifth joint of the tarsus.

Fig. V. Barrel-organs of Lepidoptera.

1. In *Argynnis Paphia.* A side- and end-view.
2. Enlarged view, showing nerve (a).
3. In *Vanessa Atalanta.*
4. Enlarged view, showing nerve (a a).
5. In *Mormo Maura.*
6. Transverse section, showing position of wings.

XIV. *Illustrations of the Floras of the Malayan Archipelago and of Tropical Africa.* By JOSEPH D. HOOKER, *Esq., M.D., R.N., F.R.S., L.S. & G.S.* (With Nine Plates.)

Read June 21st, 1860.

THERE are few countries which possess so many new and imperfectly understood genera of plants as the Malayan Islands and Western Africa; and the researches of recent travellers have added largely to our collections of them. The herbaria of the late Mr. Griffith, collected in the districts around Malacca, Singapore, and Mergui; of the late Mr. Motley, in the northern and southern parts of Borneo; of Mr. Hugh Low, on the same island, and especially on the lofty mountain of Kini Balou; and of Mr. Thomas Lobb, in Sarawak and Labuan, contain many obscure tropical forms of plants, together with interesting new genera and species of better understood families. In Tropical Africa the researches of the late indefatigable Mr. Barter, on the banks of the Niger river, during Dr. Baikie's expedition, have procured the most extensive and perfect collections ever formed in those countries, which also contain many singular and interesting unpublished forms. Mr. Barter's successor, Mr. Gustav Mann from Kew, has been no less successful in Fernando Po, where he has ascended the Clarence Peak, and procured the first types of a temperate elevation that have hitherto been found in West Tropical Africa*. Other unpublished materials exist from the Gulf of Guinea, collected at Abeokuta by the late Dr. Irving, R.N.; and still more recently a most valuable and extensive collection of drawings, with analyses, of Eastern Tropical African plants have been received from Dr. Kirk, the accomplished and indefatigable companion of Dr. Livingstone; and the collections of that gentleman, which are shortly expected in England, will no doubt supply many more novelties of the greatest scientific importance. From these and other sources I propose to offer to the Linnean Society a series of papers illustrating the most interesting discoveries they contain.

Nat. Ord. ANONACEÆ.

1. OXYMITRA MOTLEYANA (H. f.); ramulis pedunculis petiolis costaque foliorum superne ferrugineo-tomentosis v. villosis, foliis oblongo-lanceolatis acutis, sepalis abrupte acuminatis, petalis coriaceis sericeo-villosis, exterioribus ovato-oblongis acutis, interioribus late spathulatis.

Hab. In ora septentrionali insulæ Borneo ad Labuan, *Motley*.

Rami crassitudine pennæ corvinæ, tomento patente induti. *Folia* 6–10″ longa, $2\frac{1}{2}$–$3\frac{1}{2}$″ lata, sicca superne fusca v. brunnea subtus pallidiora, venis numerosis lente arcuatis, costa venisque pubescentibus. *Flores* solitarii, extra-axillares, pedunculis crassis, sepalis petalisque dorso dense ferrugineo-villosis. *Petala* suberecta, $\frac{1}{2}$″ longa.

* These comprise species of *Thalictrum, Hypericum, Rubus,* and *Erica,* generally very closely allied to Madagascar and Bourbon species.

Nov. Gen. Disepalum, H. f.

Sepala 2, ampla, ovata, concava, valvata. *Petala* 4, anguste lineari-spathulata, incurvo-ascendentia, inter se remota, ad marginem tori depressi adnata et persistentia! *Stamina* numerosa, multiseriata, connectivo apice truncato vix dilatato. *Torus* latissimus, medio leviter concavus. *Carpella* 10–15, strigosa, stylo brevi conico tereti, stigmate terminali, ovulo solitario? prope basin loculi. *Fructus* deest.—Frutex 5-*pedalis, glaberrimus, Borneensis, ramis gracilibus.* Folia $2\frac{1}{2}$–$3\frac{1}{2}''$ *longa, bifaria, elliptico-obovata v. lanceolata, utrinque angulata, apice caudato-acuminata, creberrime pellucido-punctata.* Pedunculi *terminales, solitarii, graciles, elongati, uniflori.* Flores *sub* $\frac{1}{2}''$ *diam., virides.*

1. Disepalum anomalum, H. f.

Hab. In insulæ Borneo locis humidis depressis prope Sarawak, *T. Lobb.*

Of this very remarkable plant, in some respects quite as anomalous as *Eupomatia*, I have only two small specimens. It differs in habit from any Anonaceous plant known to me, and approaches *Schizandreæ* in texture and some other respects. The minute punctation of the foliage is peculiar; the stamens and ovaries are typically Anonaceous; but the two valvate sepals, and four organs which appear to represent the petals, are quite unlike anything else in the Order. Technically it will rank in the tribe *Unoneæ*; but I know of no genus to which it is at all nearly allied.

Tab. XX. A. fig. 1. flower; 2. the same, cut vertically; 3 and 4. front and back views of stamens; 5. carpel; 6. vertical section of the same: *all magnified.*

Nov. Gen. Sphærothalamus, H. f.

Sepala 3, maxima, orbiculata, rigide membranacea, subfoliacea, erecta, imbricata. *Petala* 6, biseriata, elongato-spathulata, crasse coriacea, imbricata? 3 interiora angustiora. *Torus* globosus. *Stamina* valde numerosa, dense imbricata, obcuneata, connectivo ultra loculos dilatato truncato. *Carpella* numerosa, oblonga, strigosa, stylo brevissimo obtuso; ovulis 2? superpositis, ventralibus. *Fructus* deest.—Frutex 10-*pedalis, Borneensis, pulcherrimus.* Folia *magna, subsessilia, elongato-lineari-lanceolata, acuminata, glaberrima,* $1\frac{1}{2}$–2-*pedalia, basi subcordata apice acuminata.* Flores *speciosi, rubro-aurantiaci,* $3''$ *longi.*

1. Sphærothalamus insignis, H. f.

Hab. In sylvis insulæ Borneo ora septentrionali, *T. Lobb.*

I have seen only a flower, leaf, and coloured drawing of this remarkable and beautiful plant. It belongs to the tribe *Uvarieæ*, and apparently to the section with more than one ovule, and will thus rank near *Uvaria* itself. The ovaria are very minute indeed; and I have further had great difficulty in analysing them, on account of the dense consistence of their walls: these are full of indurated wood-cells above, which it is difficult to discriminate from ovules after both have been dried.

Tab. XX. B. leaf; and XX. C. flower: fig. 1. outer, and 2. inner petal; 3. torus, with a few of the lower series of stamina below, and ovaries at the apex; 4. stamen; 5. ovary; 6. long vertical section of the same: *all,* but 1, 2, and 3, *magnified.*

Nat. Ord. MYRISTICEÆ.

1. Myristica (Pyrrhosa) grandis (H. f.); foliis obovato-oblongis oblongo-lanceolatisve acutis supra scaberulis, subtus lacunoso-venosis ferrugineo-tomentosis, paniculis ferrugineo-lanatis, sepalis glandulosis.

Hab. In ora septentrionali insulæ Borneo, *Low.*

Arbor vasta. *Folia* 12–15″ longa, coriacea, rugosa, supra profunde impresso-venosa, secus costam puberula, subtus pilis rigidiusculis tomentosa, costa crassa, venis 12–16 lente arcuatis, margine tenuiter recurva, petiolo brevi crasso. *Panicula* composita, 6–8″ longa, ramis ramulisque dense ferrugineo-lanatis. *Flores* ♂ minimi, globosi, pedicellis gracilibus glabris; *Sepala* 3, glabra. *Antheræ* in globum connatæ.

A magnificent timber tree, with leaves a good deal like those of *Rhododendron Falconeri.*

Nat. Ord. NYMPHÆACEÆ.

1. Barclaya Motleyi (H. f.); pedunculis petiolis foliisque subtus pubescenti-tomentosis, foliis cordato-rotundatis.

Hab. In ins. Borneo australis rivulis arenosis umbrosis prope Banjoerang, *J. Motley*; Sarawak, *Lobb.*

The genus *Barclaya* has hitherto consisted of but one species, a native of Pegu and the Tenasserim provinces, where it was discovered by Wallich, who has given an excellent detailed description of it in the Linnean Transactions (vol. xv. p. 441, t. xviii.), and which has further been figured in the 'Icones Plantarum,' t. 809–10. The present species is very much larger than the original one, and differs in its tomentose parts, very broad leaves, fewer stamens, longer, narrower sepals and outer petals, more oblong seeds, and other characters. I am indebted to the late lamented Mr. Motley for the excellent drawings and dissections given here, which, together with a detailed description of the plant, were the last botanical labours of that admirable observer and collector. Shortly after their receipt at Kew, the news of his murder, and that of all his family, by the Mahommedan settlers in Southern Borneo, was received in England; and I have therefore replaced the name of *rotundifolia*, which he had given to this species, by that of its ill-starred discoverer.

Tab. XXI. fig. 1. back, and 2. front view of sepal; 3. flower with sepals removed; 4. flower with outer series of petals removed; 5. vertical section of flower, showing the inner recurved petals, stamens, and styles; 6, 7, and 8. three views of the stamens; 9. transverse section of anther; 10. ovary; 11. stigmatic rays; 12. transverse section of ovary; 13. transverse section of ripe fruit; 14. seed; 15. transverse section of seed: *all magnified.*

Nat. Ord. SAUVAGESIEÆ.

1. Schuurmansia angustifolia (H. f.); foliis angustissime lanceolatis longe acuminatis obtuse serrulatis, racemo interrupto, floribus fasciculatis, sepalis æqualibus, antheris rimis lateralibus dehiscentibus.

Hab. In insula Borneo ad Sarawak, *T. Lobb.*

Frutex 10-pedalis, glaberrimus. *Ramuli* tenues. *Folia* versus apices ramulorum subconferta, utrinque lucida, 5–8″ longa, $\frac{3}{4}$″ lata, petiolo brevi. *Racemus* terminalis, 8″ long., erectus. *Fasciculi florum* basi bracteolis subulatis cincti. Pedicelli graciles, $\frac{1}{2}$″ longi. *Flores* flavi? $\frac{1}{3}$″ expansi. *Sepala* parva, oblonga, obtusa. *Petala* subæqualia, sepalis quadruplo longiora, oblonga, obtusa, concava. *Staminodia* numerosa, subulata, cum staminum filamentis brevibus in tubum connata. *Ovarium* anguste ovoideum in stylum attenuatum, placentis 3–4. *Capsula* coriacea, $\frac{3}{4}$″ longa.

This differs from Blume's character of the genus in the sepals and petals not being unequal, and in the dehiscence of the anthers being lateral and a little anticous; otherwise it appears to be congeneric with the Amboyna plant of that author.

1. Neckia lancifolia (H. f.); caule simplici stipulis setaceis incurvis, foliis lanceolatis duplicato-serratis, sepalis capsulam superantibus.

Hab. Borneo septentrionali, *T. Lobb.*

N. humili affinis, differt foliis duplo latioribus et sepalis capsulam superantibus.

2. Neckia humilis (H. f.); caule simplici, stipulis setaceis, foliis anguste lanceolatis obtusiusculis duplicato-serratis, sepalis capsulam æquantibus.

Hab. In insula Labuan, Borneo septentrionali, *T. Lobb, Motley.*

Caulis simplex, basi lignosus, gracilis, teres, 3–8″ longus. *Stipulæ* strictæ, $\frac{3}{4}$″ longæ. *Folia* patentia, 2–4″ longa, $\frac{1}{3}$–$\frac{1}{2}$″ lata, petiolo brevi. *Pedunculi* capillares, striati, gracillimi, 1–2″ longi. *Flores* nutantes, $\frac{1}{4}$″ expansi. *Sepala* lanceolata, serrata. *Petala* inæqualia, oblonga, obtusa, petalis vix longiora. *Staminodia* ad basin tubi staminei pauca parva subulata, exteriora apice clavata. *Antheræ* fertiles 5, oblongæ, simplices, tubo insertæ. *Capsula* oblonga, stylo terminata. *Semina* minima, oblonga, fusca, impresso-punctata.

In the venation of the foliage all the above *Sauvagesieæ* present a remarkable similarity to *Euthemis.*

Nat. Ord. POLYGALEÆ.

1. Epirhizanthus tenella (H. f.); caule filiformi, calyce 5-partito.

Hab. In sylvis umbrosis Borneo australis, *Motley.*

Plantula 2–3″ alt., simplex v. ramosa. *Spicæ* $\frac{1}{2}$–1$\frac{1}{2}$″ longæ, apice florentes et basi fructus maturos simul gerentes. *Filamenta* in tubum connata, antheris 5.

I have an excellent drawing, with dissections, of this curious little plant, by Mr. Motley, who remarks that it further differs from its described congeners in its calyx cleft to the base.

Nat. Ord. BUETTNERIACEÆ.

1. Buettneria lancifolia (H. f.); scandens, ramis teretibus glabris, foliis brevi-petiolatis lanceolatis longe acuminatis integerrimis subtus puberulis, pedunculo gracili, fructu globoso, spinis patenti-recurvis.

Hab. In insulæ Borneo ora septentrionali, *Lobb.*

Rami crassit. pennæ corvinæ, cortice atro. *Folia* 4–6″ longa, coriacea, 1–1$\frac{1}{2}$″ lata, utrinque venosa, petiolo breviusculo robusto puberulo. *Fructus* 1″ diametro, pilosulus, spinis viridibus laxiusculis $\frac{1}{4}$″ longis, pedunculo pollicari.

Nat. Ord. DIPTEROCARPEÆ.

Nov. Gen. Pachynocarpus, H. f.

Calyx 5-partitus, laciniis oblongis obtusis, tubo demum cum fructu adnato. *Petala* 5, linearia, obtusa, libera. *Stamina* 10, brevia, hypogyna, alterna longiora, filamentis brevibus incurvis, antheris oblongis, loculis discretis, valvis inæqualibus, connectivo in conum brevem obtusum producto. *Ovarium* late depresso-ovatum, stylo brevi columnari, stigmate trilobo, loculis 3, ovulis geminis ex apice loculi pendulis. *Fructus* crasse coriaceus, brevi-urceolatus, ultra medium tubo adnato calycis incrassato 5-lobo margine tumido inclusus, apice umbonatus, unilocularis, evalvis, 1-spermus. *Semen* pendulum, testa tenui endocarpio adhærente, cotyledonibus convoluto-lobatis.—Arbor *elata, Borneensis.* Rami *teretes, lignosi, cortice sulcato pallido.* Folia *petiolata, oblonga ovato-lanceolatave, obtuse acuminata acutave, integerrima, coriacea, glaberrima,* 4–6″ *longa,* $1\frac{1}{2}$–3″ *lata, venis sub* 6 *lente arcuatis, venulis exemplarium floriferorum prominulis reticulatis, fructiferorum obsoletis.* Paniculæ *axillares terminalesque,* 1–3″ *longæ, laxe ramosæ, ramis gracilibus, pedunculis pedicellisque cinereo-pubescentibus.* Flores $\frac{1}{2}$″ *longi.* Sepala $\frac{1}{8}$″ *longa, pubescentia.* Petala *sepalis quadruplo longiora, dorso puberula.* Ovarium *obscure* 5-*lobum, pubescens.* Fructus *singularis,* $\frac{3}{4}$″ *diam., pericarpio resinæ albæ scatente.*

1. Pachynocarpus umbonatus, H. f.

Hab. In insula Labuan, ora septentrionali Borneo, *Motley. Nom. vern.* "Rasak bunga" v. "Rasak ranga."

Mr. Motley states this to be a large tree with soft white wood, and deliciously fragrant flowers, and that the fruit yields a fragrant oil. The habit and inflorescence of *Pachynocarpus* resemble *Vatica* very closely; but the fruit is very different, being surrounded by the adnate 5-grooved tube of the calyx.

Tab. XXII. A. flowering, and B. fruiting specimen, of the nat. size; fig. 1. unexpanded, and 2. expanded flower; 3. the same, with petals and two calyx-lobes removed; 4 and 5. stamens; 6. transverse section of ovary; 7. vertical section of one half of ovary; 8. vertical section of fruit with seed removed: *all magnified.*

Dipterocarpus, Gaertn.

1. D. lamellatus (H. f.); ramulis petiolisque gracilibus dense tomentosis, foliis oblongis acuminatis subtus dense stellatim tomentosis, fructu crebre lamellato lamellis undulatis, calycis lobis foliaceis late linearibus apice rotundatis.

Hab. In insula Labuan, ora septentrionali ins. Borneo, *Motley.*

D. Baudii, Korth., affinis, differt fructu lamellato.—*Folia* juniora 3″ longa, petiolo gracili 1″ longo, densissime fulvo-tomentoso, margine sericeo-piloso, pagina superiore pilosa, demum glabrata, inferiore pilis stellatis præsertim ad venas operta. *Fructus* purpureus, 6″ longus. *Calycis* tubus globosus, $\frac{3}{4}$″ diam.; laciniæ duæ, venosæ, fere 1″ latæ.

2. D. Motleyanus (H. f.); ramulis validis, ultimis pulvereo-puberulis, foliis longe gracili-petiolatis ovatis basi rotundatis late cuneatisve acuminatis obscure undulatis glaberrimis, venis utrinque sub 16, costa subtus sericea, calyce oblongo tetraptero, petalis dorso cinereo-pubescentibus.

Hab. In ins. Labuan, ora septentrionali ins. Borneo, *Motley.* Ins. Philippinens., *Cuming* (No. 1073).

Ramuli crassit. pennæ olerinæ, apicibus cinereis v. fulvis. *Folia* rigidiuscula, 8–10″ longa, 4″ lata, venis primariis cum costa rectangulum formantibus. *Pedunculi* 2–3-flori, flexuosi, 3–4″ longi, graciles, glaberrimi, flexuosi. *Calyx* glaberrimus, fere 1″ longus. *Corolla* $1\frac{1}{2}$″ longa, petalis $\frac{1}{2}$″ latis.

3. D. Lowii (H. f.); ramulis crassis crebre annulatis ultimis velutino-tomentosis, foliis coriaceis ovatis integerrimis transverse undulatis, petiolo crasso, costa venisque subtus prominentibus dense tomentosis, pedunculo brevi crasso fulvo lanato, calyce dense tomentoso tetraptero, alis undulato-crispatis.

Hab. In ora septentrionali ins. Borneo, *Low*. *Nom. vern.* "Kaga kruning."

Ramuli ob stipulas delapsas annulati, crassit. digiti majoris, internodiis $\frac{1}{2}$–$\frac{3}{4}''$ longis, ultimis demum glabratis. *Petioli* 1'' longi. *Folia* dura, 8–10'' longa, venis cum costa fere rectangulum formantibus, basi rotundata v. obscure cordata, apicibus obtusis. *Pedunculi* 2'' longi, crassi, 3–4-flori. *Calyx* 1' longus. *Corolla* dense tomentosa.

1. Dryobalanops aromatica, Gærtn. fil.

Hab. Labuan, in ora septentrionali insulæ Borneo, *Motley* (85).

1. Anisoptera? melanoxylon (H. f.); ramulis teretibus glabris, foliis ovatis oblongisve apice angustato obtuso basi rotundata utrinque glabris, venis inconspicuis, paniculis folio brevioribus paucifloris, pedunculis pedicellis calycibusque dense fulvo-tomentosis, staminibus sub 12, connectivo apice breviter uncinato, stylo gracili.

Hab. Borneo septentrionali, in insula Labuan, *Motley*. *Nom. vern.* "Rapak."

Rami teretes, crass. pennæ anserinæ. *Folia* coriacea, 3'' longa, petiolo $\frac{1}{2}$–$\frac{2}{3}''$ longo, utrinque glaberrima, supra vix lucida, subtus venis primariis tenuibus. *Inflorescentia Elæocarpo* subsimilis. *Flores* nutantes, $\frac{1}{3}''$ expansi, pedicellis gracilibus. *Sepala* lanceolata, dense tomentosa. *Petala* oblonga, basi contracta (non imbricantia). *Stamina* brevia, filamentis brevibus late triangularibus, antheris oblongis. *Fructus* globosus, basi calycis tubo cinctus, stellato-tomentosus, $\frac{1}{3}''$ diametro. *Calycis* fructiferi lobis omnibus accrescentibus stellato-pubescentibus, duobus maximis lineari-oblongis, 2'' longis, $\frac{3}{4}''$ latis, 3-nerviis, pubescentibus, apicibus obtusis, cæteris $\frac{1}{2}''$ longis lineari-lanceolatis.

This plant differs from *Anisoptera* in the short hooked apex to the anther, and slender style, and from *Hopea* in the petals not imbricating at the base. Motley describes it as being a second-class tree. *Trunk* almost invariably divided at a great height into two heads. *Bark* scaly, studded with tears of clear yellow resin. *Sap-wood* thin and white. *Duramen*, first yellow; when seasoned, black; bitter, and when chewed yielding flakes of white resinous substance; easily worked and taking a beautiful polish. Next to the *Dryobalanops*, this is perhaps the most valuable wood in Labuan.

1. Vatica oblongifolia (H. f.); ramulis robustis puberulis, foliis longe petiolatis lineari-oblongis oblongo-lanceolatisve abrupte acuminatis coriaceis utrinque glaberrimis, paniculis erectis axillaribus terminalibusque folio brevioribus, floribusque ferrugineo-pubescentibus, petalis linearibus.

Hab. In Borneo ora septentrionali, *Low*.

V. Rassak, Bl. (*Retinodendron*, Korth. Verhandl. t. 8), similis, differt ramis robustis, foliis latioribus magis oblongis abrupte acuminatis longius petiolatis, paniculis plurifloris ferrugineo-pubescentibus, petalisque linearibus.—*Petioli* $2\frac{1}{2}''$ longi. *Folia* valde coriacea, 7–9'' longa, 3'' lata, subtus pallida, vix glauca. *Flores* fere $\frac{1}{2}''$ longi.

V. Rassak and *V. venulosa*, Bl. (Mus. Bot. Lugd. Bat. ii. 32), are the only other described Bornean species.

1. Hopea micrantha (H. f.); minute lepidota, ramulis nigris, foliis coriaceis elliptico-ovatis ovato-lanceolatisve caudato-acuminatis, subtus petiolis pedunculisque parce puberulis, paniculis brevibus axillaribus terminalibusque, floribus densis secundis, calycibus cereis, petalis dorso sericeo-tomentosis.

Hab. In ora septentrionali Borneo, ad insulam Labuan, *Motley*. *Nom. vern.* "Dammar mata Kuching" (or "cats'-eye resin") and "Dammar Batu."

Folia 2–$2\frac{1}{2}''$ longa, subgrisea, subtus cinerea, petiolo $\frac{1}{4}$–$\frac{1}{3}''$ longo. *Racemi* $\frac{3}{4}$–$1''$ longi. *Flores* $\frac{1}{10}''$ longi. *Petala* oblonga, basi connata. *Stamina* sub 12.

Motley's specimens vary a little in the breadth of the leaf. He sends them under two names, viz., as the "Rock Dammar," a very large tree with furrowed bark, hard wood turning brown when cut, yielding sparingly a white resin, and one of the best timbers; also as the tree yielding "Dammar mata Kuching," "of no great diameter, but tall, with smooth buttresses, deeply fissured bark on the trunk, wood hard, light yellowish-brown, durable, easily worked; the resin exudes in large lumps from the trunk and branches."

Of other Bornean *Dipterocarpeæ* there are—

1. A small-leaved *Dipterocarpus*? described by Motley (Labuan, No. 143) as a hard heavy oily wood, much valued for masts and otherwise in ship-building. The branches are rather slender, covered with a minute ashy pulverulent tomentum; the leaves 3 inches long, on long petioles, glabrous, elliptic-lanceolate acuminate, obscurely waved at the margin, veins straight, 6–8 on each side of the costa, forming an angle of 45° with it, and joined by fine transverse veinlets.

2. Vatica sp.?? "Dammar frutik," from Low, quite indeterminable.

3. Vatica? A handsome plant sent by Low, with elliptic-oblong coriaceous leaves 6–8 inches long, scattered stellate hairs on the ramuli and panicle, and fruit with three linear-oblong wings 5 inches long.

4. Vatica? "Bunk Tansaman," Low; yields a useful oil. A noble species with stout annulate branches; linear-oblong leaves a foot long, cuneate or cordate at the base, minutely pubescent on the costa and veins below; branching, flexuous, pubescent panicles a span long.—*Bracts* oblong, pubescent, $\frac{3}{4}$ inch long. All the sepals of the young fruit are enlarged.

5. Vatica? Labuan, *Motley* (204).

6. Hopea? Labuan, *Motley* (116). Common "Dammara hitam." Yields a dark resin. Is apparently the same as 115, Labuan, *Motley*, "Salangan Putik."

7. Hopea? *Motley* (37). "Dammar Tritain" or Black Dammar. Yields most of the Dammar of the Malay countries.

There is further enumerated, in Blume's 'Mus. Bot. Lugd. Bat.,' *Shorea ovalis*, Bl. (*Vatica*, Korth.), a native of Borneo.

Nat. Ord. TERNSTRŒMIACEÆ.

1. Saurauja Planchoni (H. f.); ramulis petiolis inflorescentiaque dense appresse setosis squamatisque, foliis (amplis) elliptico-lanceolatis caudato-acuminatis margine inte-

gerrimis spinuloso-ciliatis membranaceis, supra glaberrimis, subtus viridibus, ad nervos setulosis, paniculis elongatis erectis multifloris, floribus parvis, sepalis sparse strigosis oblongis subacutis, petalis sepala vix excedentibus.

Hab. In ora septentrionali ins. Borneo, *Low*; Sarawak, *T. Lobb.*

Frutex 6-pedalis (*Lobb*). *Ramuli* crass. pennæ anserinæ, squamulis a basi ovata subulatis ferrugineis. *Petioli* $1\frac{1}{2}''$ longi. *Folia* pedalia et ultra. *Racemi* 8–10″ longi, suberecti, multiflori, angusti. *Sepala* $\frac{1}{6}''$ longa, submembranacea, vix acuta. *Petala* sepalis paulo longiora, oblonga, obtusa. *Stamina* 10, filamentis brevibus. *Stigmata* 3, villosa.

2. Saurauja horrida (H. f.); ramulis petiolis pedunculisque patentim setulosis squamosisque, squamis patenti-incurvis rigidis, foliis elliptico-lanceolatis longe acuminatis integerrimis, subtus ad nervos setulosis, corymbis longe pedunculatis, sepalis paleatis ovatis obtusis.

Hab. Borneo septentrionali, *Motley.*

Species e paleis elongatis patenti-incurvis facile nota.—*Folia* brevi-petiolata, 5–8″ longa, 2–3″ lata, ad insertionem petioli subcordata, supra glabra, subtus ad costam venasque longiuscule setosa. *Pedunculus* 1–2″, suberectus, robustus. *Flores* $\frac{3}{4}''$ expansi, corymbosi, pedicellis breviusculis calycibusque paleaceis. *Sepala* oblongo-ovata obtusiuscula, marginibus late glabratis. *Petala* sepalis duplo longiora. *Stamina* sub 30. *Styli* glaberrimi.

1. Gordonia Lobbii (H. f.); ramulis petiolisque basi sericeo-pilosis (demum glabratis), foliis ellipticis utrinque acuminatis coriaceis integerrimis subtus glaucis, pedunculis axillaribus solitariis 1-floris, sepalis parvis orbiculatis, petalis late orbiculatis concavis dorso puberulis, staminibus numerosissimis tubo corollæ insertis glaberrimis, antheris late didymis.

Hab. In insula Borneo ad Sarawak, *Lobb.*

Arbor 50-pedalis (*Lobb*), perulis sericeis, ramulis crass. pennæ corvinæ. *Petiolus* crassiusculus, $\frac{1}{3}''$ longus. *Folia* $3–3\frac{1}{2}''$ longa, $1\frac{1}{2}–2''$ lata, valde acuminata, nervis utrinque vix conspicuis. *Pedunculi* glabri, pollicares, substricti, erecti. *Flos* $\frac{3}{4}''$ expansus. *Sepala* ciliata, $\frac{1}{8}''$ longa. *Petala* subcoriacea, valde concava. *Filamenta* carnosula. *Ovarium* globosum, basi sericeum, 5-loculare, stylo brevi, stigmate capitato 5-lobo.

2. Gordonia brevifolia (H. f.); foliis brevi-petiolatis late ovatis obovatis v. rotundatis obtusis v. abrupte acuminatis coriaceis integerrimis, pedunculis robustis curvis, sepalis ciliatis.

Hab. Monte Kini Balou insulæ Borneo, alt. 8000 ped., *Low.*

Arbuscula 4–14-pedalis, floribus amplis suaveolentibus (*Low*). *Rami* crassi, ramulis pilosulis, foliis subimbricatis, 1-2″ longis, ima basi subcordatis. *Pedunculi* subclavati, $\frac{2}{3}''$ longi. *Flores* $1\frac{1}{2}''$ expansi. *Sepala* parva, orbicularia, intus sericea. *Petala* pilosula. *Stamina* glabra, antheris brevibus. *Ovarium* dense velutino-tomentosum. *Capsula* globosa, $\frac{1}{2}–\frac{3}{4}''$ diam., columna centrali brevi apice capitata.

The capitate central receptacle of the capsule accords with Blume's character of Reinwardt's genus *Schima.*

1. Adinandra dumosa, Jack.

A. Jackiana, Korthals.

Hab. In ora septentrionali insulæ Borneo, *Motley.*

I have three different-looking plants from Borneo which may all be referable to Jack's *A. dumosa*, or some of them to Korthals's Bornean *A. trichocarpa* and *excelsa*; but I have failed to distinguish these by good characters. Motley's best specimens are identical with Malayan and Sumatran ones.

1. Eurya, sp. ?

Hab. In monte Kini Balou insulæ Borneo, *Low.*

Resembles *E. Wightiana*, Wall. I have only a fruiting specimen, in which the large rounded sepals differ much from those of *E. nitida*, Korth., the only described Bornean species.

Nat. Ord. OCHNACEÆ.

1. Euthemis robusta (H. f.); ramis robustis, foliis lineari-oblongis oblongo-lanceolatisve obtusis margine spinulosis, stipulis oblique oblongis acutis, paniculæ ramulis puberulis, bracteolis oblongis acutis, sepalis obtusis margine fimbriolato-spinulosis.

Hab. Sylvas in ora septentrionali insulæ Borneo, *Lobb.*

Ab *E. leucocarpa*, Jack, differt omnibus partibus duplo majoribus, ramulis robustis, foliis obtusioribus, &c. *Folia* 8″ ad pedalia, in petiolum 1–2″ long. angustata, 2–3″ lata, stipulis oblique ovato-oblongis acutis. *Panicula* 4″ longa, ramis robustis. *Bracteolæ* $\frac{1}{3}$″ longæ. *Flores* sub $\frac{3}{4}$″ expansi. *Stamina* 5, oblique lagenæformia, longe attenuato-rostrata. *Fructus E. Jackianæ,* sed duplo major.

2. Euthemis obtusifolia (H. f.); foliis anguste obovato-oblongis oblongo-lanceolatisve obtusis apiculatis serrulatis, stipulis longe subulatis.

Hab. In ora septentrionali insulæ Borneo, *T. Lobb.*

Rami teretes, crass. pennæ corvinæ. *Folia* 3–4″ longa, in petiolum brevem angustata, $\frac{3}{4}$–$1\frac{1}{4}$″ lata.

I have no flower of this very distinct species, which may readily be known by its blunt leaves and subulate stipules.

Nat. Ord. GUTTIFERÆ.

1. Calophyllum Lowii (H. f.); foliis 6–8″ longis anguste oblongis oblongo-lanceolatisve acuminatis nervis creberrimis tenuibus, paniculis axillaribus folio brevioribus floribusque cano-pubescentibus, sepalis 2, petalis 5.

Hab. In ora septentrionali insulæ Borneo, *Low.* *Nom. vern.* "Kayuk Bintangur."

Arbor 100′ (*Low*). *Ramuli* robusti, teretes, ultimi tetragoni, nigri. *Folia* coriacea, petiolo 1″ longo. *Paniculæ* 3″ longæ, sub 20-floræ. *Flores* subglobosi, fere $\frac{1}{2}$″ expansi. *Sepala* oblonga, valde concava, valvata. *Petala* late obovata v. orbicularia. *Stamina* perplurima, filamentis ima basi connatis, antheris breviter oblongis. *Ovarium* subglobosum, stigmate late bilobo. *Pedicelli* fructiferi 1″ longi, curvi, robusti. *Drupa* late ovoidea, $\frac{1}{2}$″ longa.

Mr. Low remarks that this forms a straight tree, used for masts and in boat-building.

2. Calophyllum hexapetalum (H. f.); foliis 3″ longis elliptico- v. oblongo-lanceolatis acuminatis, petiolis brevibus, ramulis racemisque ferrugineo-pubescentibus, paniculis foliis æquilongis v. longioribus, pedunculis pedicellisque gracilibus, floribus parvis globosis, sepalis 2, petalis 6.

Hab. In ora septentrionali insulæ Borneo, *Low.* *Nom. vern.* "Kaya Utah."

Rami teretes, cortice albo, ramulis et inflorescentia pube ferruginea subhispidula opertis. *Petioli* $\frac{1}{4}''$ longi. *Folia* basi acuta v. rotundata, venis lateralibus inconspicuis distantibus. *Alabastra* globosa, $\frac{1}{6}''$ diam. *Sepala* valvata v. paulo imbricata, rotundata, valde concava, extus puberula. *Petala* late orbicularia. *Stigma* 3-furcatum.

Nat. Ord. SAPINDACEÆ.

1. SCHMIDELIA TOMENTOSA (H. f.); ramis petiolis costis nervis et inflorescentia velutino-tomentosis, foliis 3-foliolatis, foliolis ovato-lanceolatis longe acuminatis subrepandis, racemis subramosis.

Hab. In insulæ Borneo ora septentrionali, Labuan, *Motley*.

Ramuli crass. pennæ corvinæ. *Petioli* graciles, 3–4″ longi. *Foliola* 6–8″ longa, 2–3″ lata, membranacea, pallide viridia, supra glabra, ad costam et subtus pubescentia. *Racemi* 2-3″ longi, stricti, ramis paucis divaricati. *Flores* parvi, fasciculati, $\frac{1}{16}''$ diam., pilosuli. *Sepala* 4, subæqualia. *Petala* parva, squama villosa. *Fructus* obovoideus, $\frac{1}{3}''$ longus.

1. NEPHELIUM ACUMINATUM (H. f.); arboreum, ramulis petiolisque hic illic fulvo-villosis, foliis pinnatis, pinnis 5–10-jugis oblongo-lanceolatis longe acuminatis grosse remote serratis glabris infimis parvis oblique recurvis, paniculis axillaribus et terminalibus tomentosis, ramis elongatis multifloris, floribus in pedicellis brevibus fasciculatis minutis, petalis subæqualibus, squama petalo adnata.

Hab. In ora septentrionali insulæ Borneo, *Low*. *Nom. vern.* "Buptut Manok."

N. eximio, Thwaites (En. Pl. Ceyl. 75), simillimum, differt præcipue foliis longe acuminatis et costa glaberrima. *Flores* tomentosi. *Calycis* lobi obtusi. *Petala* intus squama adnata, villosa. *Stamina* 5, elongata. *Discus* in fl. ♂ pulviniformis.

2. NEPHELIUM MULTIJUGUM (H. f.); petiolo elongato superne tetragono, pinnis 15–25-jugis elongato-lineari-lanceolatis acuminatis sessilibus integerrimis basi cordatis utrinque glaberrimis costa superne puberula, panicula ampla laxa rachi ramisque ascendentibus angulatis, floribus ♂ apetalis monoicis, sepalis 5 concavis gradatim majoribus, staminibus villosis, filamentis brevibus, ovario 3-lobo.

Hab. In ora septentrionali insulæ Borneo, ad Labuan, *Motley*.

Folia 3-pedalia, petiolo inferne tereti superne angulato, angulis puberulis. *Pinnæ* alternæ, 4–6″ longæ, infimæ stipulæformes, supra punctulatæ, subtus lucidæ, venosæ. *Panicula* 2-pedalis, ramis alternis, apicibus ramulorum puberulis. *Flores* fasciculati, globosi, brevi-pedicellati, glaberrimi. *Sepala* coriacea, extima duplo minora quam intima, omnia suborbiculata concava. *Stamina* 8, subsessilia, pilis albis dense villosa, filamentis brevibus, antheris elongatis acutis incurvis inter se compactis. *Ovarium* profunde 3-lobum, stylo recto, stigmate 3-lobo.

Nat. Ord. MELIACEÆ.

1. MILNEA EDULIS, Roxb. Fl. Ind. i. 637, var.? foliolis latioribus, floribus majoribus.

Hab. var.? In ora septentrionali insulæ Borneo, ad Labuan, *Motley*.

This appears identical, in the structure of the flower, with Wallich's specimens of *M. edulis*, R.; but the leaflets are rather broader, and the flowers rather larger. I have seen no fruit. There are several very similar Philippine Island plants, but with scattered lepidote scales on the under surface of the leaf. The staminal cup is broader than long, sinuate rather than toothed at the broad orifice; the stamens are quite included, inserted half-way down in Wallich's and the Bornean specimens (not at the base as described by Roxburgh); the petals are quite free. An extremely similar Malacca species, from Griffith, has the stamens inserted towards the mouth of the cup. There are many undescribed species in India; but without fruit, and very careful dissection of the flowers, it is impossible to distinguish them.

2. Milnea lancifolia (H. f.); ramulis petiolis foliis junioribus subtus paniculisque puberulis lepidotisque, foliolis 6–10-jugis 6–8″ longis anguste lanceolatis longe attenuato-acuminatis, petiolo $\frac{1}{2}$″ longo, paniculis elongatis angustis ramosis gracilibus, floribus parvis, petalis connatis, tubo stamineo disciformi 5-lobo, antheris lobos disci terminantibus.

Hab. In ora septentrionali insulæ Borneo, *T. Lobb*, *Low*.

Dioica? *Folia* pedalia, pinnis alternis submembranaceis utrinque costa sub 15-nerviis. *Panicula* pedalis, rachi gracili, ramis $1\frac{1}{2}$–2″ longis. *Flores* numerosi, globosi, sicci rufo-brunnei, $\frac{1}{16}$″ diam. *Calyx* tomentosus, parvus, lobis obtusiusculis. *Petala* late oblonga v. orbicularia, fere ad tertiam partem connata. *Urceolus stamineus* vix concavus, sed stellatim expansus, radiis 5 brevibus incurvis. *Ovarium* punctiforme.

There are three other Bornean *Milneæ* in the Herbarium, but all in too imperfect a state for satisfactory description.

Nat. Ord. AMPELIDEÆ.

1. Vitis Motleyi (H. f.); caule gracili, ramulis paniculis petiolisque albo- v. rufo-lanatis, foliis pedato-5–6-foliolatis gracile-petiolatis oblongo- v. obovato-lanceolatis acuminatis ultra medium serratis supra glabris, spicis elongatis racemosis, floribus sessilibus oblongis, calyce cupulari 5-lobo, petalis erectis.

Hab. In ora septentrionali insulæ Borneo, ad Labuan, *Motley*.

Caules crass. pennæ corvinæ, omnesque partes præter folia petalaque lana alba v. rufa molli opertæ. *Petioli* 2–3″ longi, petiolulis $\frac{3}{4}$–1″ longis, 2 lateralibus 2-foliolatis, 3 v. 4 intermediis 1-foliolatis. *Foliola* 3–5″ longa, $1\frac{1}{4}$–$1\frac{3}{4}$″ lata, abrupte acuminata, basi obliqua, superne glabra, subtus parce tomentosa v. glabrata. *Paniculæ* laxæ, 6–8″ longæ, ramis alternis. *Flores* in ramis sessilibus spicatis $\frac{1}{8}$″ long., oblongis obtusis. *Calyx* glabratus, brevissimus, 5-lobus. *Petala* 5, oblonga, simul secedentia, erecta. *Stamina* erecta, filamentis anthera ter longioribus. *Ovarium* truncatum, stylo brevissimo conico. *Baccæ* siccæ obovatæ, glabræ, $\frac{1}{2}$–$\frac{2}{3}$″ longæ. *Semen* oblongum, obtusum, compressum, dorso convexum, antice utrinque excavatum.

This and the following species belong to the same section of the genus as *V. cinnamomea*, Wall.

2. Vitis Lowii (H. f.); tota tomento dense lanuginoso brunneo velata, ramis crassis, foliis pedato-5–6-foliolatis, stipulis magnis foliaceis, spicis racemosis breviusculis, floribus tomento velatis, alabastris globosis, calyce membranaceo.

Hab. In ora septentrionali insulæ Borneo, *Low*.

Ramuli crass. digiti minoris, tomento e pilis septatis. *Cirri* et *petioli* crass. pennæ corvinæ. *Petioli* 6″ longi, petiolulis 1″ longis. *Foliola* 2 lateralia valde inæquilateralia, latere extimo subcordato; intermedia oblonga v. oblongo-lanceolata; omnia 5–8″ longa, dentata, utrinque rufo-pilosa. *Stipulæ* 1″ longæ, sessiles, late cordatæ, glabratæ. *Paniculæ* (v. spicæ) rami pollicares, crassi. *Flores* sessiles, in lanam immersi. *Calyx* cupularis, 5-lobus. *Petala* brevia, glabra. *Filamenta* brevia. *Ovarium* depressum, stigmate conico.

My specimen of this magnificent plant is, I regret to say, in a very imperfect state. The great size, stout habit, dense tomentum, large persistent stipules, and short woolly branches of the panicle well distinguish it from all others of this section with spicate flowers.

Nat. Ord. OXALIDEÆ.

1. Connaropsis glauca (H. f.); ramulis glaberrimis, foliis 1-foliolatis glaberrimis oblongis obtusis supra lucidis subtus glaucis, racemis contractis pubescentibus ramulis brevibus multifloris subsecundis.

Hab. In collibus prope Bruni, in ora septentrionali insulæ Borneo, *T. Lobb.*

Arbor 20-pedalis (*Lobb*). *Petioli* graciles, $\frac{3}{4}$″ longi, ad $\frac{1}{4}$″ infra folium articulati. *Folia* coriacea, 2–2$\frac{1}{2}$″ longa, basi obtusa, apice subangustata, dein obtusa, subtus pallide glauca, reticulatim venosa. *Panicula* 3–9″ longa, erecta, $\frac{3}{4}$–1″ lata, ramis confertis alternis ferrugineo-pubescentibus. *Pedicelli* graciles, 1″ longi, subfasciculati. *Flores* suberecti, $\frac{1}{3}$″ longi. *Sepala* 5, lineari-oblonga, subacuta, glabra, basi pubescentia. *Petala* 5, lineari-spathulata (sicca purpurea), sepalis duplo longiora, versus mediam partem inter se connata. *Stamina* 10, alterna longiora, filamentis basi monadelphis, tubo basi annulo tenui cincto. *Ovarium* hirsutum, stylis 5 brevibus, stigmatibus subrecurvis, 5-loculare, loculis 2-ovulatis, ovulis pendulis superpositis. *Fructus* edulis.

The genus *Connaropsis* was proposed by Planchon in the Hookerian Herbarium on two Malacca plants of Griffith, of which one (*C. monophylla*, Pl. Cuming, 2324) has tomentose panicles and simple (unifoliolate) elliptic-ovate long-acuminate leaves, and the other (*C. Griffithii*, Pl.) has impari-pinnate leaves with one pair of leaflets. The *C. monophylla* differs from *C. glauca* in the form of the leaves, and in the very long styles, which project beyond the stamens.

Nat. Ord. XANTHOXYLEÆ.

1. Evodia alba (H. f.); ramulis petiolis pedunculisque pubescenti-tomentosis, foliis 3-foliolatis, foliolis late ellipticis abrupte acuminatis integerrimis multinerviis subtus niveo-tomentosis, floribus capitellatis, capitulis in corymbum ramosum dispositis.

Hab. In ora septentrionali insulæ Borneo, *Lobb.*

Rami crassiusculi. *Petioli* 5″ longi, teretes. *Foliola* sessilia, 5–7″ longa, 3–4″ lata, supra viridia, subtus tomento appresso molli nivea, nervis prominulis fulvis. *Corymbus* 3″ latus, pedunculo 2″ longo, ramis pollicaribus pedicellisque furfuraceo-pubescentibus, *capitulis* $\frac{1}{3}$″ latis. *Flores* $\frac{1}{10}$″ longi, oblongi. *Calyx* 4-lobus, brevis, tomentosus. *Petala* oblongo-lanceolata, obtusa, glabra. *Stamina* petala duplo superantia, antheris magnis sagittatis. *Ovarium* 4-lobum, sericeo-villosum, stylo brevi, stigmate oblongo 4-sulco. *Ovula* loculis 2.

Nat. Ord. SIMARUBEÆ.

Nov. Gen. Irvingia, H. f.

Flores hermaphroditi. *Calyx* 4–5-partitus, parvus, imbricatus. *Petala* 4–5, patentia, late oblonga, imbricata. *Discus* crassus, pulviniformis, elevatus. *Stamina* 10, basi disci extus inserta, filamentis nudis filiformibus. *Ovarium* ovoideum, apice depresso disci insertum, biloculare, stylo 1 curvo, stigmate simplici, ovulis loculis solitariis, axi medio insertis. *Drupa* magna, crassa, lignea, lineari-oblonga, leviter compressa, abortu 1-locularis, 1-sperma. *Semen* lineare, prope apicem loculi appensum, testa subcrustacea, embryone axi albuminis copiosi recto, cotyledonibus planis, radicula brevi supera.—Arbores *Africæ* tropicæ occidentalis, *glaberrimæ, insapidæ*, ramulis *ad nodos annulatis, gemmis squamis convolutis obtectis.* Folia *alterna, simplicia, petiolata, exstipulata, integerrima, nitida, membranacea v. coriacea.* Paniculæ *axillares et terminales, ramosæ, ramulis ad nodos annulatis.* Flores *parvi, flavi, odori.* Drupæ *magnæ, edules.*

This singular genus I refer to the *Simarubeæ* as modified by Planchon, and to a division of the Order with 2–5-celled ovaries, 1-ovuled cells, and simple leaves; it thus ranks near *Soulamea* and *Amaroria*, differing from these in the very large disk, in habit, and many other characters. The annulation of the branches is very remarkable. I have named the genus in honour of the discoverer of one species, Dr. Irving, R.N., for some months resident at the Missionary Station of Abeokuta, where he fell a victim to the climate.

1. Irvingia tenuifolia (H. f.); foliis membranaceis oblongis obovato-oblongisve obtusis, paniculis laxe ramosis ramis divaricatis tenuibus, floribus brevi-pedicellatis subcymosis, stylo brevi.

Hab. Abeokuta, *beat. Dom. Irving, M.D.*

2. Irvingia Barteri (H. f.); foliis coriaceis ovato-oblongis ovato-lanceolatisve obtuse acuminatis obtusisve obliquis utrinque nitidis, paniculis parvis paucifloris subfasciculatis, stylo filiformi.

Hab. Prince's Island, *beat. Dom. Barter.* "Wild Mango," ab Anglis dicta.

Arbor 40-pedalis. *Fructus* edulis (*Barter*).

3. Irvingia Smithii (H. f.); foliis coriaceis ovatis ovato-cordatisve acutis obtusisve sæpissime obliquis pallidis superne nitidis, paniculæ ramis elongatis pedicellisque divaricatis, floribus racemosis, stylo brevi.

Hab. Ad ripas fluminis Congo, *beat. C. Smith*; et flum. Niger, prope Nupe, *Barter.*

Arbor 40-pedalis, ad ripas fluminum. *Flores* pallide flavi, odori. *Fructus* magnus, drupaceus, ab simiis valde dilectus (*Barter*).

Nat. Ord. TEREBINTHACEÆ.

Subordo Anacardieæ.

Mangifera Kamanga (Blume); foliis petiolatis obovato-lanceolatis apice subacutis basi angustatis 6–12″ longis 2–5″ latis rigidis, nervis crebris validis patentibus utrinque prominulis, panicula terminali elongata ramis suberectis crassis puberulis, floribus angustis, calyce parvo, petalis suberectis anguste lanceolatis enerviis basi secus costam incrassatis, staminibus hypogynis basi liberis non incrassatis, unico fertili elongato, cæteris ad squamulas subulatas reductis.

M. Kemanga, Blume, Mus. Lugd. Bat. i. 202; Miquel, Flor. Ind. Bat. i. 634. *M. fœtida*, Bl. (non Loureiro), Bijd. 1153; Hassk. in Flora, vel Bot. Zeit. 1844, p. 622. excl. synon.

Hab. Borneo septentrionali, *Low* (*nom. vern.* "Binjue"). Java v. Moluccas, *fide Miquel*. In cultis archipelagi Indici, *fide Blume*.

I have called this fine species *Mangifera Kemanga* of Blume, on the faith of a specimen so named received from Dr. Miquel, from which it differs only in the rather longer petiole; but it is extremely unlike the plate of Rumphius (i. p. 99), quoted by Dr. Miquel in his 'Flora Indiæ Batavæ,' i. p. 634, as belonging to this plant. It accords well with Blume's description and Hasskarl's quoted above.

There are several very distinct modifications in the insertion of stamens in *Mangifera*. In the present plant they are all free and absolutely hypogynous, the gynophore, which is prolonged in the closely allied genus *Gluta*, being here so short as to be almost obsolete. In *M. fœtida* and *Horsfieldii*, on the other hand, the filaments are all connected at the base into a thickened fleshy ring, quite distinct from the calyx, and forming a hypogynous tube or cup. In *M. Indica* and its allies, the ovary is seated within a very thick, deeply 5-lobed sub-perigynous disk, from the inner margin of which the stamens rise; this disk may, however, be equally well considered to be the very much incrassated bases of the filaments, which are connate at their insertion. In all these the flower is much shorter than in *M. fœtida* and *M. Kemanga*, the petals more spreading from the base, and furnished with several thickened veins.

A third modification is presented by a small-flowered and leaved Malacca species (*M. Griffithii* *), in which the disk is hypogynous, very large, oblique, unequally lobed, and bearing one short perfect stamen within its mouth, and no imperfect ones.

TAB. XXIII. fig. 1. unexpanded, 2. expanded flower; 3. petal; 4. stamen, staminodia, and pistil; 5. pistil: *all magnified.*

NOV. GEN. PENTASPADON, H. f.

Flores hermaphroditi. *Calyx* parvus, 5-partitus, lobis imbricatis. *Petala* 5, calyce multo majora, oblonga, patentia, valde imbricata. *Discus* annularis, suberectus, 10-lobus. *Stamina* 5, parva, brevia, basi disci extus inserta, cum staminodiis totidem apice capitellatis v. spathulatis alternantia. *Ovarium* disco insertum, depressum, villosum, 1-loculare, stylo brevi recurvo crasso uno latere e basi ad apicem late stigmatifero, ovulo solitario medio loculi appenso pendulo. *Fructus* ignotus.—Arbor *magna*. Folia *alterna, exstipulata, impari-pinnata, foliolis oppositis, 3–4-jugis, petiolulatis, integerrimis, glaberrimis, oblongis, acuminatis*. Paniculæ *axillares, pedunculatæ, ramosæ, ramulis patentibus, ultimis pedicellisque glaberrimis*. Flores *parvi, albi*.

1. PENTASPADON MOTLEYI, H. f.

Hab. Borneo australi, prov. Banjarmassing, invenit *beat. Motley*.

* *M. Griffithii* (H. f.); foliis petiolatis oblongis v. oblongo-obovatis obtusis 3–4″ longis, $1\frac{1}{2}$–2″ latis, paniculis terminalibus erectis pubescentibus, floribus parvis, petalis brevibus, nervis 2–3 basalibus incrassatis, disco hypogyno inæqualiter lobato, stamine 1 brevi intra marginem disci inserto. *Hab.* Malacca, *Griffith*.

The genus *Pentaspadon* falls naturally into a group of *Anacardieæ*, characterized by a 1-celled, 1-ovuled ovary, and laterally or basally attached ovule, and will rank in it with *Rhus*, *Pistacia*, and *Sorindeia*. It differs from *Mangifera*, *Anacardium*, and *Gluta* in the compound leaves and laterally attached ovule. The small calyx, comparatively large imbricating petals, short stamens with alternate spathulate or capitate staminodia, the staminodia, and depressed ovary with short, very broad, recurved stigma, well characterize the genus.

Tab. XXIV. fig. 1. unexpanded, 2. expanded flower; 3. ovary, disk, and stamina and staminodia; 4. stamen; 5. staminodium; 6. vertical section of ovary: *all magnified.*

Hæmatostaphis, H. f.

Flores dioici; *masc.* parvi, irregulares. *Calyx* trifidus, lobis imbricatis. *Petala* 3, patula, oblonga, concava, obtusa, inæqualia. *Discus* pulviniformis, 3-lobus. *Stamina* 6, infra discum inserta, alterna longiora, filamentis subulatis. *Fl. fœm.* ignoti. *Drupa* oblonga, carne sanguinea, 1-locularis, 1-sperma, putamine crasso osseo, loculo intus uno latere carina elevata apice seminifera percurso. *Semen* immaturum prope apicem loculi pendulum.—Arbor *parva, glaberrima, ramis tortuosis.* Folia *decidua, versus apices ramulorum conferta, alterna, exstipulata, impari-pinnata, petiolo gracili, pinnis multijugis, alternis, petiolulatis, lineari-oblongis, basi inæqualibus, obtusis emarginatisve, integerrimis, subtus glaucis, membranaceis, reticulatim venosis.* Paniculæ *axillares, elongatæ, patentim ramosæ, ramis gracilibus distantibus, ramulis puberulis.* Flores *parvi, albi, pedicellis basi bracteatis.* Fructus *edulis.*

1. Hæmatostaphis Barteri, H. f.

Hab. Ad ripas fluminis Niger prope Nupe, *beat. Barter.* *Nom. vern.* "Dzinjerigya" (*Blood plum*).

This remarkable plant belongs to the tribe *Anacardieæ* of Terebinthaceæ, and to the section with a unilocular ovary and the ovule solitary and suspended. Its immediate allies I consider to be, *Odina*, which has eight stamens and a very different fruit; *Tapiria*, which has ten stamens and a 4-lobed disk; *Solenocarpus*, which has valvate petals and ten stamens; *Smodingium*, in which the stamens are five and the drupe winged; and *Schinus*, which has also ten stamens: all these, however, I believe, form one group with *Hæmatostaphis*, differing from the other unilocular monospermous *Anacardieæ* with ovules suspended from near the apex of the cell, in their compound leaves, and calyx not accrescent or adnate after flowering. It differs from all in the trimerous irregular flowers and in habit.

Mr. Barter describes this plant as a small tree, with deciduous tortuous branches, and deep-crimson fruit like bunches of grapes (whence the generic name). The drupes are eatable, acid but not unpleasant.

Pl. XXV. fig. A. portion of panicle; C. fruiting panicle; B. apex of branch and leaves; 1. ♂ flower; 2. the same, laid open; 3. stamens and disk; 4. transverse, and 5. vertical section of drupe: *all magnified.*

Nov. Gen. Parishia, H. f.

Flores dioici. *Masc.*: *Calyx* 4-lobus, basi cupularis, lobis ovatis valvatis. *Petala* 4, oblonga, apice erosa, imbricata. *Discus* annularis, brevis, 4-lobus. *Stamina* 4, supra basin disci extus inserta. *Ovarium* minimum, columnare. *Fœm.*: *Calyx* 4-lobus, lobis post anthesin accrescentibus foliaceis. *Petala* 4. *Discus*? *Stamina* 4? effœta. *Ovarium* liberum, sessile, ovoideum, abortu 1-loculare, in stylum erectum apice trifidum angustatum, stigmatibus 3 capitatis, ovulo solitario prope apicem loculi pendulo. *Semen* immaturum infra apicem loculi umbilico lato adnatum.—Arbor *pulchra*, coma *patenti floribunda, ramulis apice ferrugineo-tomentosis.* Folia *alterna, exstipulata? impari-pinnata,* foliolis *alternis, multijugis, brevi-petiolulatis, oblongo-ovatis, acuminatis, basi cordatis, integerrimis, coriaceis.* Paniculæ *amplæ, nutantes, ferrugineo-tomentosæ.* Flores *gracili-pedicellati, masc. parvi, pedicellis basi bracteatis, calyce tomentoso.*

1. PARISHIA INSIGNIS, H. f.

Hab. In peninsula Malayana, ad Mergui, *beat. Griffith*; insulis Andaman, *Rev. Dom. Parish* (*Fl. Feby. Mart.*).

A remarkable and beautiful tree, which bears the name of a very intelligent and zealous investigator of the Botany of Moulmayn, the Rev. C. Parish, who procured specimens of this plant from the Andaman Islands, and communicated them to Sir William Hooker. The first aspect of the specimens recalls *Melanorrhœa*—a native of the neighbouring Birmese States, and also an Anacardieous tree, remarkable for the size, abundance, and conspicuous character of its flowers; but whereas it is the petals of *Melanorrhœa* that are foliaceous and accrescent after flowering, it is the sepals of *Parishia* that assume this remarkable character. *Parishia* further differs from *Melanorrhœa* in the quaternary flowers, the small disk, and few stamens; and its lateral ovule places it in another division of the Suborder. Its nearest ally is undoubtedly *Astronium*, a Brazilian genus also with accrescent sepals, and which differs mainly, in habit, in having quinary flowers and longer styles.

TAB. XXVI. A. small portion of male inflorescence; B. of fruiting panicle; C. leaf; fig. 1. male flower; 2. the same, cut vertically; 3. unripe fruit, with remains of petals and stamen; 4. sepal from the same; 5. vertical, and 6. transverse section of unripe fruit: *all magnified.*

Subordo BURSEREÆ.

Nov. Gen. TRIGONOCHLAMYS, H. f.

Flores polygami. *Calyx* magnus, 3-partitus, persistens, lobis triangularibus valvatis. *Petala* 3, parva, oblonga, valvata, tomentosa. *Discus* perigynus tenuis, annularis. *Stamina* 6, margini exteriori disci inserta, filamentis brevissimis. *Ovarium* depresso-globosum, 3-loculare, stylo recto breviusculo, stigmate trilobo, ovulis loculis geminis collateralibus angulo interiori affixis. *Drupa* oblique globosa, lævis, abortu 1-locularis, mesocarpio resinoso, endocarpio crustaceo. *Semen* globosum, umbilico lato angulo interiori loculi affixum, testa membranacea cellulosa, cotyledonibus conduplicatis profunde lobatis, radicula supera.—Arbor *ramulis pubescenti-tomentosis, pustulatis.* Folia *alterna, exstipulata, impari-pinnata,* foliolis 6–10-*jugis petiolulatis oppositis oblongo-lanceolatis integerrimis obtuse acuminatis.* Paniculæ *axillares, robustæ, foliis breviores, ramosæ, rufo-tomentosæ, ramulis pedicellisque basi bracteatis.* Flores *majusculi, sicci rufo-tomentosi.* Fructus *parvus, diametro pisi, nitidus.*

1. TRIGONOCHLAMYS GRIFFITHII, H. f.

Hab. In peninsula Malayana ad Malacca, *beat. Griffith.*

The genus *Trigonochlamys* belongs to the Suborder *Bursereæ* of *Terebinthaceæ*, distinguished by the two collateral ovules, exalbuminous seeds, and plaited or crumpled cotyledons, and to a tribe distinguished by the free ovary (which is 3–4-celled), drupaceous or baccate fruit, and an erect or annular disk not broadly attached to the calyx-tube: to this tribe I refer also *Bursera*, *Balsamodendron*, *Santiria*, and *Canarium*—to which latter *Trigonochlamys* is most nearly allied, differing in its perianth and fruit.

TAB. XXVII. fig. 1. flower unexpanded and laid open; 2 & 3. front and back view of stamens from female (?) flower; 4. pistil; 5. transverse section of ovary; 6. young fruit; 7. vertical, and 8. longitudinal section of the same: *all magnified.*

Nov. Gen. TRIOMMA, H. f.

Flores hermaphroditi? *Calyx* 5-fidus. *Petala* 5, parva, valvata? *Discus* 5-lobus. *Stamina* 10? basi disci extus inserta. *Ovarium* trigonum, triloculare, stylo brevi, ovulis geminis. *Fructus* capsularis, magnus, ovatus v. ovato-cordatus, obtuse cuspidatus, late 3-alatus, trivalvis, 3-pyrenus, valvis coriaceis ab axi late trialato secedentibus, pyrenis parvis faciebus axis late adnatis. *Semina* ?—Arbor *ramulis robustis, pubescenti-tomentosis.* Folia *alterna, sparsa, exstipulata, impari-pinnata, foliolis oppositis 2–3-jugis ovato-lanceolatis obtuse acuminatis integerrimis.* Paniculæ *terminales,* fructiferæ *lignosæ, ramulis tomentellis.* Fructus *2-pollicaris, siccus ater, faciebus* $1\frac{1}{2}''$ *latis planiusculis.*

1. TRIOMMA MALACCENSIS, H. f.

Hab. In peninsula Malayana ad Malacca, *beat. Griffith.*

In the structure of the fruit, *Triomma* resembles *Bursera*, to which it is very closely allied; it differs in the 5-lobed calyx, in the broadly winged fruit, and remarkably in habit.

Nat. Ord. CONNARACEÆ.

Nov. Gen. HEMIANDRINA, H. f.

Flores hermaphroditi. *Calyx* 5-partitus, lobis lineari-oblongis obtusis. *Petala* 5, fere hypogyna, lineari-oblonga, obtusa, patentia, imbricata. *Stamina* 5, subhypogyna, cum petalis alterna, filamentis breviusculis antheris parvis 1-locularibus subulatis. *Ovaria* 3, villosa, in stylos elongatos angustata, 1-locularia, stigmate terminali simpliciusculo, ovulis 2 collateralibus e basi loculi erectis. *Fructus* e carpellis 2–3 globosis hirsutis 1-locularibus. *Semina* ignota.—Frutex v. arbuscula (?) *ramulis teretibus, petiolis pedunculis foliisque subtus siccitate fusco-tomentosis.* Folia *alterna, exstipulata, trifoliolata, foliolis superne glabris subtus reticulatim venosis integerrimis cuspidatis, lateralibus brevipetiolulatis oblique ovatis, terminali longius petiolulato majore oblongo, omnibus basi trinerviis.* Paniculæ *parvæ, ramosæ, solitariæ v. fasciculatæ, petiolis breviores, axillares v. laterales.* Pedunculi *et* pedicelli *graciles, his basi et medio bracteolatis.* Sepala *hirsuta.* Petala $\frac{1}{10}''$ *longa, glaberrima.*

1. HEMIANDRINA BORNENSIS, H. f.

Hab. In sylvis vastis insulæ Labuan, ad oram septentrionalem Borneo, *Thos. Lobb.*

A plant of rather doubtful affinity, but which, from its close resemblance to *Connarus*, I have placed in the same natural family with that genus. It differs from the majority of *Connaraceæ* by the 5 stamens with apparently 1-locular anthers, and 3 ovaries, as also in the almost hypogynous insertion of the petals and stamens.

TAB. XXVIII. fig. 1. portion of peduncle, with pedicel, bracts, and flower; 2. petal; 3. stamen; 4. ovary; 5. young bicarpellary fruit; 6. tricarpellary fruit; 7. vertical section of immature carpel: *all magnified.*

1. ROUREA SORORIA, Planch. in Linn. xxiii. p. 421.

Hab. In ora septentrionali insulæ Borneo, *Low.*

This appears to me scarcely to differ from *R. parallela*, Planch. *l. c.*, ("Penang," Wall. Cat. 8526), and *R. Wallichiana*, Pl. *l. c.*, of Tavoy and Singapore.

2. Rourea concolor, Blume; Planch. *l. c.*

Hab. In ora septentrionali insulæ Borneo, ad Labuan, *Motley*.

1. Connarus odoratus (H. f.); ramulis robustis rufo-tomentosis, foliis pinnatis, foliolis 6–8-jugis glaberrimis lanceolatis longe acuminatis subtus nitidis, panicula decomposita magna calycibusque rufo-tomentosis, petalis linearibus calycem duplo superantibus, ovario 1 hirsuto, folliculis obovoideo-quadratis compressis glaberrimis.

Hab. In ora septentrionali insulæ Borneo, ad Labuan, *Motley*.

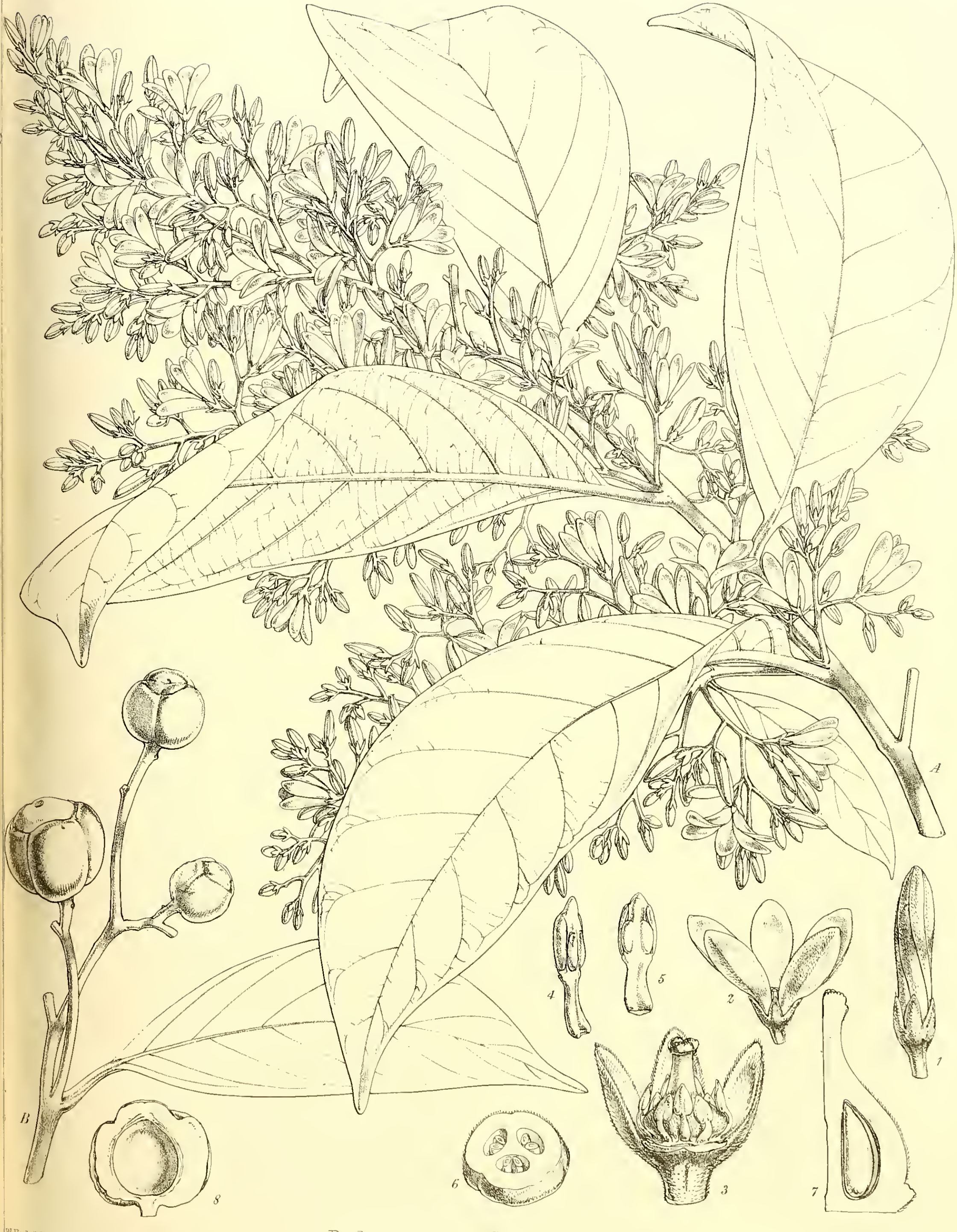
Ramuli lignosi. *Petioli* spithamæi, graciles, stricti, teretes, superne linea tomentosa. *Foliola* brevi-petiolata, 3–5″ longa, longe attenuato-acuminata, subcaudata. *Panicula* erecta, 1–2-pedalis, rachi robusta, ramis erecto-patentibus strictis ramulosis. *Flores* numerosi, violaceo-odorati, brevi-pedicellati, $\frac{1}{4}$″ longi. *Calyx* dense rufo-tomentosus, sepalis lineari-oblongis obtusis, æst. imbricatis. *Petala* linearia. *Stamina* filamentis in cupulam connatis, antheris apiculatis. *Ovarium* stylo elongato. *Folliculus* $1\frac{1}{4}$″ longus, $3\frac{1}{4}$″ latus, venosus, puberulus, demum glaberrimus, coriaceus. *Semen* anguste oblongum, atrum.

W Fitch, del. & lith.

W West, imp

A. Disepalum anomalum, *H. f.*
B. Sphærothalamus insignis, *H. f.*

J^{as} Motley, del. W. Fitch, lith. Barclaya Motleyi, H. f. W. West imp.



W Fitch, del & lith.

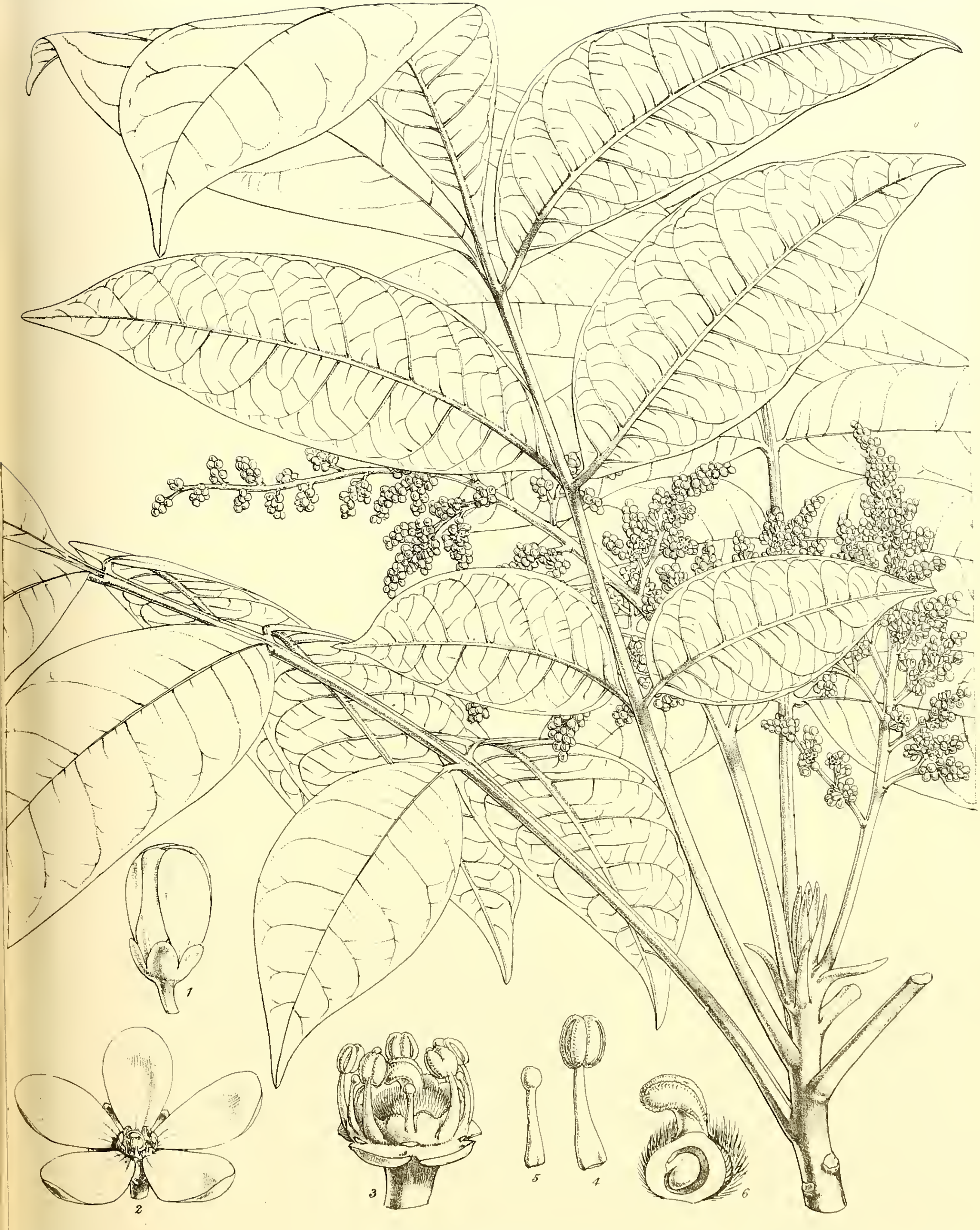
Pachynocarpus umbonatus, n. f.

W. West, imp

W Fitch, del. & lith.

Mangifera Kemanga, *Bl.*

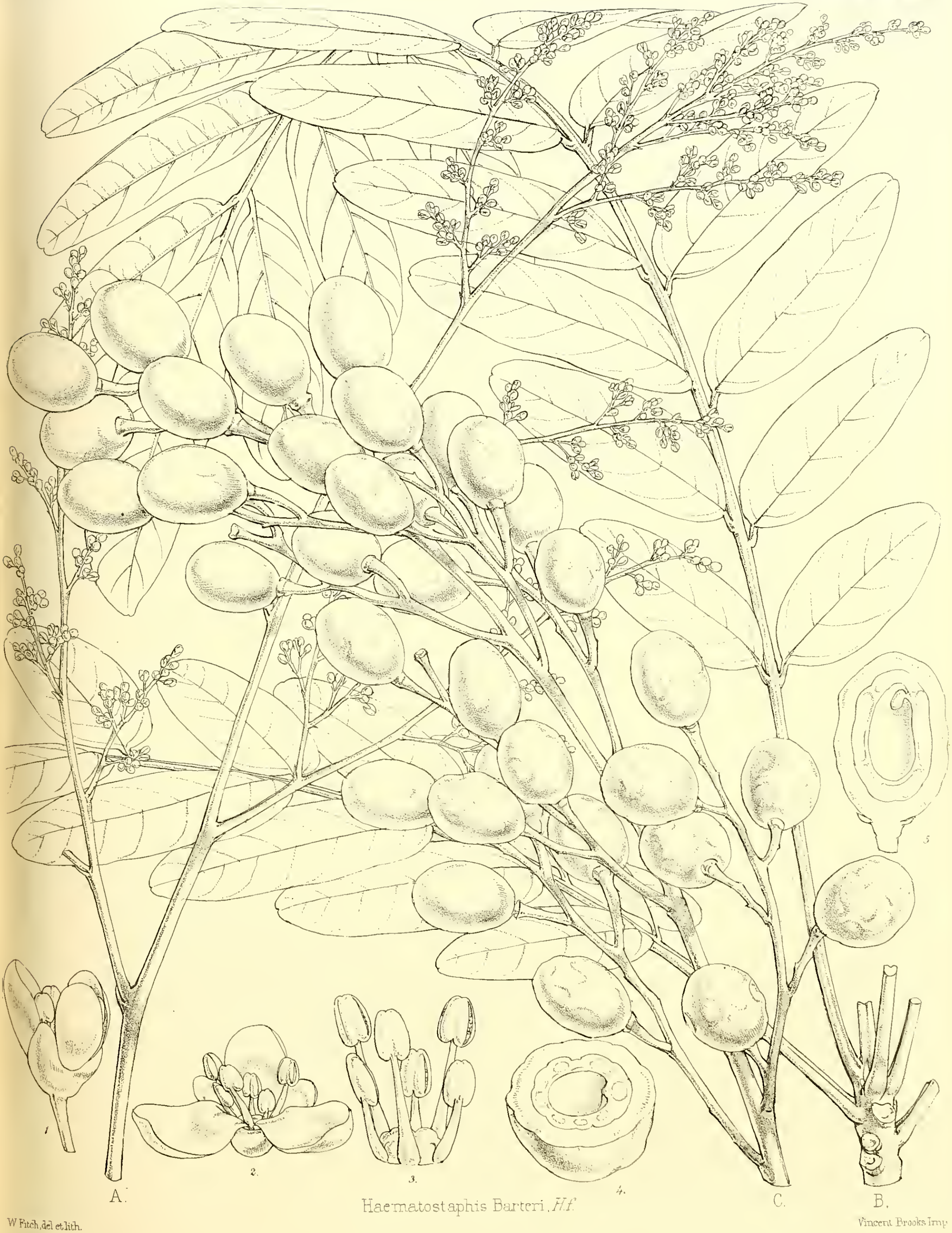
W West, Imp



W Fitch, del. & lith

Pentaspodon Motleyi, *H. f.*

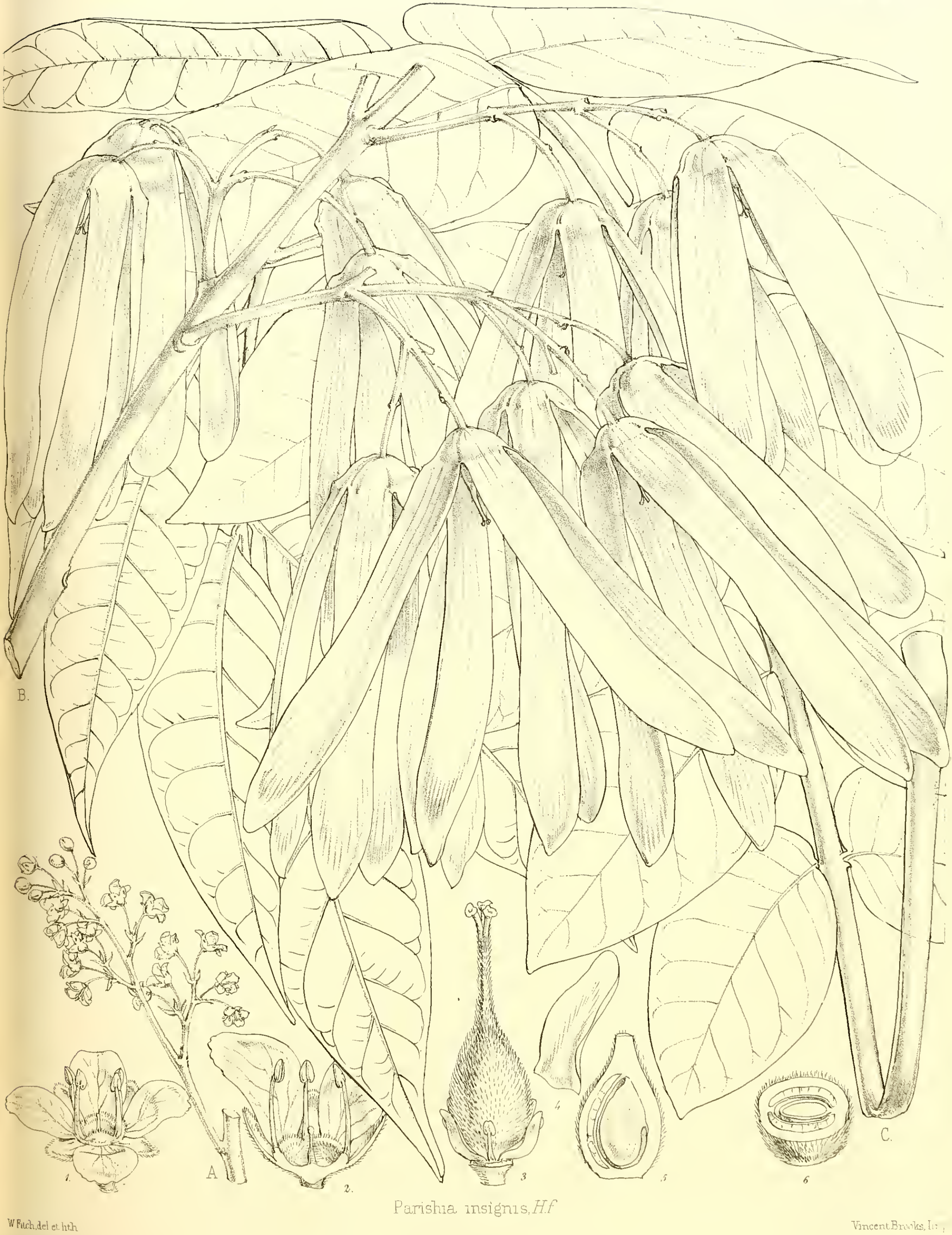
W West, Imp



Haematostaphis Barteri, *H.f.*

W Fitch, del et lith.

Vincent Brooks Imp



Parishia insignis, Hf.

W Fitch, del et lith.

Vincent Brooks, Imp.

W. Fitch, del & lith.

Trigonochlamys Griffithii, Hf.

W Fitch del & lith

Hemiandrina Borneensis, H f.

W West imp

XV. *On some Oceanic* Entomostraca *collected by Captain Toynbee.* *By* John Lubbock, *Esq., F.R.S. & L.S.*

Read June 7th, 1860.

In the present paper is a list containing fifty species of Entomostraca collected by Captain Toynbee in the years 1858 and 1859, and descriptions of fifteen which appear to be new to science, showing how very imperfect is our knowledge of these interesting creatures. Naturalists, however, are not only indebted to Captain Toynbee for having collected these and many other marine animals, but also, and perhaps in a still higher degree, for having carefully recorded the place, date, and circumstances of each capture.

Such collections as these are highly valuable; and as Captain Toynbee fully intends to pursue the same course in his future voyages, he cannot fail to obtain results very interesting in themselves, and very important, perhaps, in their application to practical navigation.

The collections already made contain numerous Mollusca, Annelids, Zoophytes, and *Thalassicollæ*, besides Crustacea, of which, however, I have as yet confined my attention to the Entomostraca.

Our knowledge of the oceanic forms belonging to this group is as yet too imperfect to justify us in attempting to draw any general conclusions. The large genera seem to be ubiquitous,—the *Calani*, however, growing larger in the Northern Seas, while the *Pontellæ* flourish more in warmer latitudes.

Some few species are recorded as occurring both in the Atlantic and Pacific Oceans; but none of the cases are, I think, quite satisfactory, as there has generally been some slight difference between the specimens from the two different oceans.

Other species *appear* to be very local; but until they have been often captured, it would of course be unsafe to come to any conclusion. Many circumstances combine to retard our acquaintance with the geographical distribution of Oceanic species. Certain lines of ocean are repeatedly traversed, while others are almost deserted. The more delicate species can hardly be obtained except when the vessel is going slowly; so that the calm regions near the line have been examined with (comparatively speaking) considerable care, while the more windy seas of the temperate zones are almost virgin water. The introduction of steam also has of course, in this respect, an unfavourable influence on the study of natural history.

It may also happen that a species which has been very abundant for some days may suddenly disappear; and yet the change may be no indication of the geographical limit assigned to the form in question, but be caused entirely by some change in temperature, some threatening of a storm, or some other more obscure cause.

The examination of Captain Toynbee's collection has impressed me still more deeply with the difficulty, or rather the impossibility, of obtaining satisfactory generic characters. I am of course aware that many naturalists are still inclined to consider genera not merely as artificial helps to classification, but as actual groups between which no links are known or will ever be discovered. I have already pointed out certain species which seem to prove the incorrectness of this opinion, and I shall have occasion in the present paper to describe more than one species apparently intermediate between two genera. Indeed, so far from considering such links as rare, it would be more correct to say that every species is a link between other allied forms. The same argument is applicable to species. Of course, as long as any varieties remain undescribed there will be gaps—which, however, exist only in our knowledge, and not necessarily in nature. How many centuries must elapse, even under the most favourable circumstances, before all the existing animals are known to us; and even then how small a proportion will be described of the animals which have peopled the world during the countless ages of past time! How worthless, then, is the argument against the mutability of species which depends on the supposed absence of "links!" When every variety which now exists, and every one which ever has existed, is known, then, and not until then, can this argument be considered conclusive. Moreover, it is admitted by every one that there are certain species which are especially variable, that is to say, which present two or more extreme forms, with all the intermediate gradations. Now we may fairly ask those who assert that no two species are connected by links, how they would separate the instances of variable animals (which they admit to occur) from the case which they say does not exist. If we were to obtain to-morrow all the links between any two species which are now considered distinct, no one can deny that the two would at once be united, and would hereafter appear in our classifications only as one variable species. In fact, therefore, they first unite into one species all those forms, however different, between which a complete series of links is known, and then argue in favour of the permanence of species because no two of them are united by links.

As bearing on this point, I may also mention that there are in the collection about ten or twelve other species, represented each by very few (perhaps only one or two) specimens, which I can neither refer with sufficient confidence to any already known, and which yet differ so little that I cannot venture to describe them as new. I have therefore put them aside for future examination, either when I have more specimens for examination, or when the old species in question are better known. I do not see what else I could have done; but in this way, no doubt, it comes to pass that specimens which can be decidedly determined are named, and the doubtful forms, in which perhaps many interesting series of links lie concealed, are left for re-examination at that more "convenient season" to which naturalists, like other people, are only too apt to defer any inconvenient duty.

A good example of an intermediate form is presented to us by the species which I have named *Calanus latus*. This species possesses some of the characters of *Euchæta*, and others (more numerous) which induced me to place it in *Calanus*. The maxillipeds resemble those of *Euchæta*, and are quite unlike the form which prevails in the immense majority of *Calani*. The long setæ with which the anterior antennæ are provided, and the long seta at the apex, are also similar to those of *Euchæta*; but, on the other hand, the form of the front part of the cephalothorax, and the absence of long caudal setæ, seem to show that it is in reality more nearly allied to the typical *Calani.* Moreover, in certain *Calani* (as, for instance, in *C. elongatus*) the anterior antenna bears here and there long setæ, almost as in *Euchæta. C. latus* seems therefore, to me, to form an interesting link between the two above-named genera. The Calanidæ, many as are the species which yet remain to be discovered, present us with a very perfect gradation of forms; and indeed the whole tribe of Cyclopoidea offers in this respect a marked contrast to the Cyproidea. This latter group is at present poor both in genera and in existing species, and it is in many respects very aberrant. The Cyclopoidea, on the contrary, contain an immense number of species, which, as I have just remarked, form a somewhat complete series, or rather network. In this great family, then, it would seem that most of the types are still existing, that there has as yet been no very great amount of extinction, and that the type is not, geologically speaking, very ancient. The nature of the body is certainly not favourable for preservation, and negative evidence is of very little value in geology; still it is worthy of remark that the group, now so numerous, has not as yet any known extinct representatives, though, from the great differences between some of the existing species, we may safely infer that the group is of considerable antiquity. The Cyproidea, on the contrary, are known to have existed as early as the Silurian period. They are therefore a very ancient type; a great proportion of the known species are fossil; and as the soft parts are never preserved, we cannot expect to recognize among them more than a few of the links which must have connected the different genera with one another, and the whole group with what we now consider the more normal Crustacea.

Diaptomus? abdominalis, again, is obviously a link between *Diaptomus* and the species placed by Dana in his genus *Hemicalanus* and the ordinary *Calani*,—possessing, as it does, the second maxillæ and second antennæ of the latter, with the geniculating anterior antennæ and abnormal posterior legs which are characteristic of the former. Indeed, unless it is admitted to constitute such a link, it must be considered as the type of a new genus. I did not, however, adopt this view in 1856, nor am I disposed to do so now. Such a course, if followed in other similar cases, would lead to an immense and at present unnecessary multiplication of genera. This species, moreover, even "if called by any other name," would be just as much intermediate between the above-named genera as before. In order, however, to retain this species in the genus *Diaptomus*, it will be necessary to modify the generic character given by Dana, in so far as concerns the posterior legs of the females.

The structure of the anterior antennæ, again, is intermediate between that of *Calanus* and that of *Pontella*. The right antenna differs slightly from the left, and may perhaps be rightly described as geniculating; but the prehensile power must be very small.

The second pair of antennæ have the two branches equal. The mandibles and first pair of maxillæ resemble those of *Calanus brevicornis* (Trans. Ent. Soc. n. s. vol. iv. pl. 3. f. 3 & 4). The second pair of maxillæ and maxillipeds are as in *Calanus*; the latter has the terminal segments elongated. Mrs. Toynbee's collection included no mature males. The fifth pair of legs in the females (*l. c.* pl. 10. f. 6.) differ slightly from those originally figured by me. The present specimens, however, were rather smaller, and perhaps, therefore, immature. Some of them had four joints, instead of three, to the abdomen: this is generally characteristic of the male sex; yet these specimens agreed with the others in the form of the abdomen and in other respects, and only differed from the mature females in the form of the fifth pair of legs. We do not, however, yet know whether, as in some other animals, the characteristics of the male sex appear first when the animal is mature, or whether in the young male the abdomen, antennæ, and fifth pair of legs already resemble those of full-grown specimens. I am inclined to doubt whether it be advisable to retain Dana's genus *Hemicalanus*. The characters by which it is separated from *Diaptomus* are not, I think, of great importance, and are both somewhat inconvenient—the difference of size in the fifth pair of legs in the female, from being applicable only to one sex, and the absence of the four small intermediate segments of the second pair of antennæ, because the joints between these segments become fainter and fainter so gradually that in some cases it is difficult to say whether they are present or not.

Mr. Darwin, in his admirable work 'On the Origin of Species' (p. 156), observes that secondary sexual characters are very variable, that "species of the same group differ from each other more widely in their secondary sexual characters than in other parts of their organization;" and again, "that the secondary sexual differences between the two sexes of the same species are generally displayed in the very same parts of the organization in which the different species of the same genus differ from each other." The Entomostraca, and especially the Cyclopoidea, present remarkable examples of this law. In *Pontella*, for instance, the sexual characters are afforded mainly by the anterior antennæ and the fifth pair of legs. The specific differences also are principally given by these organs; and many of the generic characters in the Cyclopoidea are taken from the same source.

The genera *Calanus*, *Pontella*, *Euchæta*, and others are very similar in form, live together in the open sea, and probably upon nearly the same food, and might, at first sight, be supposed to have similar habits. A glance, however, at the great differences in many of their appendages shows that this cannot be the case, and proves to us how little we really understand of their habits and mode of life.

CALANIDÆ.

Calanus.

1. *Setæ antennarum anticarum apicales subapicalibus longiores. Styli caudales vix oblongi.*

Calanus latus, Lbk.

Collected May 3, in S. lat. 0° 40′, W. long. 0° 20′.

2. *Setæ antennarum anticarum apicales subapicalibus breviores.*

A. *Setæ caudales mediocres.*

* *Cephalothorax* 5–6-*articulatus, posticè obtusus aut breviter subacutus.*

Calanus setuligerus, Dana.

My specimens differed from those described by Prof. Dana in having the cephalothorax distinctly six-jointed,—the anterior portion, including the base of the maxillipeds, being separate from the five segments bearing the natatory feet. In some specimens, which in other respects were like the remainder, the antennæ were rather shorter than usual. It would be very desirable to ascertain, by the examination of a number of specimens, how much variation exists in this character. Prof. Dana describes the two posterior subapical setæ of the anterior antennæ as "subequal;" in all my specimens the antepenultimate seta was distinctly the larger of the two.

According to Mr. Toynbee's notes, his specimens had red antennæ and feet; while Prof. Dana's were of a faint purplish-blue colour.

Of two specimens which were captured on the 15th of December 1858, each had two spermatic tubes attached to the posterior part of the cephalothorax. The specimens in question had the segments of the abdomen gradually decreasing in length, the basal being at least half as long again as the second segment.

This species was met with on several occasions.

Collected October 25. S. lat. 13° 43′; W. long. 33° 55′.
„ November 4. S. lat. 33° 27′; W. long. 30° 28′.
„ November 22. S. lat. 40° 53′; E. long. 45° 22′.
„ December 14. S. lat. 5° 49′; E. long. 83° 17′.

** *Cephalothorax supernè visus posticè acutus, angulis posticis non appressis.*

CALANUS BREVICORNIS, Lbk.

This species may at once be distinguished from *Calanus setuligerus*, which it otherwise much resembles, by the shortness of the antennæ, and by the front being produced in front of the stylets and of the base of the antennæ. The cephalothorax was five-jointed in my previous specimens; in the present individuals it had six segments—an important variation, which appears also to occur in *C. setuligerus*.

Collected November 22, 1858. S. lat. 40° 53′; E. long. 45° 22′.
„ „ S. lat. 0° 30′; W. long. 0° 30′.

CALANUS COMMUNIS, Dana.

Collected October 7th. N. lat. 7° 15′; W. long. 27° 2′.
„ June 22nd. S. lat. 0° 40′; W. long. 0° 20′.

CALANUS VULGARIS, n. s. Frons rotundatus. Cephalothorax 5-articulatus, supernè visus angulis posticis acutis, non appressis; latere visus rotundatus, inermis. Antennæ anticæ corpore paulo breviores, setis apicalibus brevibus, anticâ penultimâ elongatâ, posticâ penultimâ antepenultimâque longioribus subæquis. Abdomen 4-articulatum, stylis caudalibus brevibus, setis mediocribus, secundis longioribus.

In general outline, in the proportion of the cephalothoracic and abdominal segments, and in the setæ of the anterior antennæ, this species very closely resembles *C. communis*, from which, however, it differs in the relative shortness of the antennæ, and in having the cephalothorax unarmed behind. It is true that Dana makes no mention of the lateral cephalothoracic hook; but it was present in all the specimens examined by me which possessed the other characters of the species.

Collected May 3. S. lat. 0° 40′; W. long. 0° 20′.
„ October 7. S. lat. 7° 15′; W. long. 27° 52′.
„ November 22. S. lat. 40° 53′; E. long. 45° 22′.
„ November 30. S. lat. 34° 43′; E. long. 77° 0′.

B. *Setæ caudales 2dæ longissimæ. Frons obtusus, rotundatus.*

Calanus Danai, Lbk. Cephalothorax 6-articulatus, posticè obtusus, capite discreto; segmentis tribus penultimis subæquis, postico brevi. Antennæ anticæ corpore paulo longiores, setâ antepenultimâ posticâ longissimâ. Abdomen mediocre, 4-articulatum. Styli caudales breves, setis secundis longissimis.

This species is nearly allied to the three last described by Dana, namely, *C. gracilis, elongatus*, and *attenuatus*. These three, however, all have the anterior antennæ much longer than the body, and the cephalothoracic segments four or five in number, and are altogether longer and slenderer. The second pair of antennæ resemble those of *C. mirabilis* (Trans. Ent. Soc. vol. iv. pl. 5. f. 2), though the arrangement of the hairs is not exactly the same. There are four pairs of natatory feet. Pl. XXIX. fig. 2 represents a leg of the fifth pair, which is somewhat peculiar. The second segment of the abdomen is larger than the other three. The caudal lamellæ are a little longer than the posterior segment.

Collected April 27, 8 A.M. S. lat. 0° 40′; W. long. 0° 20′.
Pl. XXIX. fig. 2. posterior leg, × 30; fig. 3. end of anterior antenna, × 30.

Calanus gracilis, Dana.

The second pair of antennæ in my specimen do not resemble those of *Calanus attenuatus*, nor are they formed upon the type usual in *Calanus*, but resemble those of *Diaptomus*,—the accessory branch having four small intermediate segments, each with a long seta. The abdomen also is quite unlike that of *C. attenuatus* and *elongatus*, next to which this species is placed by Prof. Dana.

Of this species there is one specimen, collected on the 7th July, 0° 40′ S. lat., and 0° 20′ W. long.

Calanus mirabilis, Lbk.

This species was described by me in the 'Transactions of the Entomological Society of London,' vol. iv. pt. 2. p. 10. My specimens wanted the terminal segment of the anterior antenna. This segment bears a short plumose hair in the middle, and four beautiful dark-red setæ, three of which are of considerable size, and two are beautifully plumose. None of them, however, are so large as the two posterior subapical setæ, which are nearly equal in size. In the present specimens the cephalothorax was 6-jointed, the head being separate; the separation of the two last cephalothoracic segments was indistinct, and they were smaller than the two preceding. The caudal lamellæ had four long hairs, but the ends were all broken off. Colour slightly pink.

Collected February 1, 1858. S. lat. 0°; W. long. 0° 30′.

In Pl. XXIX. fig. 1, two of the secondary setæ and a part of one of the large antennary hairs is represented, under a magnifying power of 250.

Euchæta.

Euchæta atlantica, Lbk.

Some of these specimens, and also some collected on the 7th October, had spermatic tubes attached to their abdomen. One of the latter also carried some eggs.

Collected March 25th. S. lat. 0° 30′; W. long. 0° 30′.
„ February 1. S. lat. 0° 30′; W. long. 0° 30′.
„ May 14. S. lat. 0° 40′; W. long. 0° 20′.
„ October 7. N. lat. 7° 15′; W. long. 27° 52′.

Euchæta Sutherlandii, Lbk.

Collected October 7. N. lat. 7° 15′; W. long. 27° 52′.

Undina.

Undina longipes, Lbk.

There was only one specimen of this species. The fifth pair of legs did not exactly agree with my drawing (*l. c.* pl. 6. fig. 5), as the terminal part of the long leg was considerably produced. On referring, however, to the specimen from which my drawing was made, I find that it is perfectly correct; so that probably this organ varies in form.

Collected October 7, 1858, in lat. 7° 15′ N, long. 27° 52′ W.

Undina Darwinii, n. s. Frons rotundatus. Cephalothorax 5-articulatus, supernè visus subacutus, latere visus rotundatus. Antennæ anticæ corporis ferè longitudine, articulo primo elongato, setis brevibus: seta articuli secundi et octavi longiuscula, recta; seta postica apicalis et antica penultima articulo longiores, postica antepenultima tamen brevior. Pes posticus dexter elongatus, sinister brevis. Abdomen 5-articulatum. Styli caudales breves; setæ plumosæ, secundæ vix duplo longiores.

The basal segment of the anterior antennæ is long; probably, however, it consists in reality of three true segments. The second, third, and fourth segments have almost coalesced, or rather, perhaps, have scarcely separated. The second and eighth (apparent) segments bear a rather long straight hair. The posterior penultimate hair is the longest of those near the apex (Pl. XXIX. fig. 5).

The posterior leg of the male is long and rather slender: its form is difficult to describe, but is sufficiently indicated in Pl. XXIX. fig. 4. It consists of five segments, the three middle ones subequal and of moderate length. On the outside of the fourth is a long, slender, twisted and blunt appendage. On the inner side of the second segment is a small appendage, which is probably a rudimentary representative of the inner ramus. The left leg is not half as long as the right; it is small, and of the ordinary type, with short spines. The abdomen is 5-jointed, the segments gradually, though not very regularly, decreasing in size. The caudal lamellæ are short. The abdomen is $\frac{40}{2000}''$ in length, of which the lamellæ measure $\frac{5}{2000}''$; the segments gradually decrease in size. The second caudal seta is $\frac{60}{2000}''$ in length; the others about half as long: but these measures cannot be depended on as exact, as the tips may have been broken off.

Collected January 30, 1858. S. lat. 0° 30′; W. long. 0° 30′.
„ February 10, 1859. N. lat. 8° 0′; E. long. 77° 0′.

Pl. XXIX. fig. 4. fifth pair of legs of male, × 60; 5. end of anterior antenna, × 60.

Diaptomus.

Diaptomus abdominalis, Lbk.

Collected June 7. S. lat. 0° 40′; W. long. 0° 20′.
" October 7. N. lat. 7° 15′; W. long. 27° 52′.

Candace.

Candace ornata, D.

Collected September 15. N. lat. 47° 41′; W. long. 7° 58.

Candace pachydactyla, D.

Collected December 15. S. lat. 0° 40; W. long. 0° 20′.
" September 15. N. lat. 47° 41′; W. long. 7° 58′.
" October 7. N. lat. 7° 15′; W. long. 27° 52′.

Pontella.

Subgenus *Calanopia*.

Calanopia brachiata, D.

Subgenus *Pontellina*.

Pontellina turgida, D.

Collected in S. lat. 0° 40′; W. long. 0° 20′.
" N. lat. 2° 3′; E. long. 86° 14′.

Pontellina perspicax, D.

Pontellina Bairdii, Lbk.

Collected March 25. S. lat. 0° 30′; W. long. 0° 30′.
" April 17. S. lat. 0° 40′; W. long. 0° 6′.

CYCLOPIDÆ.

Clytemnestra.

Clytemnestra tenuis, n. s. Cephalothorax subacutè rostratus, segmento antico lato, posticè utrinque dilatato, tribus segmentis sequentibus subito angustioribus, margine posteriore arcuatis, et lateribus posticè productis et subacutis. Abdomen 6-articulatum, segmentis subæquis, decrescentibus, postico bilabato. Antennæ anticæ 7-articulatæ? segmento apicali longo.

The genus *Clytemnestra* is widely extended, being found in the Pacific and in the Atlantic. At present, however, three species only are known: one was found by Dana in the Pacific Ocean and in the China Sea; and a second collected by Dr. Sutherland in the Atlantic, and described by me in the 'Transactions of the Entomological Society,' n. s. vol. iv. p. 25.

Of the present species, only a single specimen was observed. It was a female, and carried a single mass of eggs. The length was about $\frac{1}{25}$th of an inch. The general outline of the body much resembled that of *C. scutellata*. The anterior antennæ are much longer than in *C. atlantica*, and resemble in their general proportions those of *C. scutellata*. They have also, as in that species, an appendage on the fourth segment counting from the apex; but, whereas in Dana's species the three terminal segments diminish in size towards the apex, in the present species the apical segment is as long as the three preceding put together. Like Dana, I was unable to satisfy myself as to the form of the appendage. The two terminal setæ appear to be shorter than in the species from the Pacific. The basal part of the antenna had moreover only three segments.

There are four pairs of natatory legs. All the branches had three segments, though in the first pair it was doubtful whether there was any real joint. In all the legs the inner branch was the longer of the two, while in the great majority of the Cyclopoidea the reverse is the case.

The second and third segments of the abdomen have almost completely coalesced, their original separation being indicated by a distinct indentation. The last segment is deeply bilobed.

Dana says nothing about the sexual characters in this genus; and I have had no opportunity of examining a specimen which I knew to be a male. It is moreover quite possible that the present specimen may have been immature.

It was very active. According to a sketch made at the time by Mrs. Toynbee, it seems to have been of a lightish lilac colour, with green and yellow tints inside, and the eye red.

Collected April 15, 1858, in lat. 24° 20′ S., long. 62° 53′ E., at 8 P. M.

PL. XXIX. fig. 6; fig. 7. anterior antenna, × 60.

SETELLA.

SETELLA TENUIS, n. s. Corpus 9-articulatum. Antennæ anticæ crassiusculæ, breves, articulis primis duobus subæquis, tertio quintoque longioribus, quarto appendiculato. Maxillipedis digitus ferè dimidii articuli secundi longitudine. Styli caudales elongati; setæ caudales corpore vix longiores.

This species differs from *S. tenuicornis* and *S. longicauda* in the shortness of the anterior antennæ and the length of the caudal lamellæ, from all the species except *S. Aciculus* in having only nine segments to the body, and from all in the shortness of the abdominal setæ, which are but little longer than the body. I was at first inclined to think that this character ought perhaps not to be relied on, and that the setæ might perhaps be imperfect; they taper, however, so gradually, and to so fine a point, that they can have lost very little, if any, of their length.

The deficiency of a segment in this species and in *S. Aciculus* evidently arises from a coalescence of the first two abdominal segments; so that the two pairs of appendages are both attached to one segment. The anterior antennæ have only six distinct segments, though there are indications of others. The fifth is the longest, then comes the third, while the two basal and the fourth are short and subequal.

The appendage which is, as usual, attached to the fourth segment is rather more than half as long as the apical portion of the antenna. The frontal appendage is shaped as in *S. crassicornis*. The caudal lamellæ are elongated.

The separation of the segments is, however, often so indistinct that I am indisposed to attach much weight to the characters thus afforded.

Collected June 26. S. lat. 0° 40′; W. long. 0° 20′.

PL. XXIX. fig. 12, × 30.

CORYCÆIDÆ.

CORYCÆUS.

1. *Antennæ anticæ macrodactylæ, digito non breviore quam carpus.*

A. *Setæ caudales stylis valdè breviores.*

CORYCÆUS GRACILIS, D.
Collected June 21. S. lat. 0° 30′; W. long. 0° 30′.
„ September 29. N. lat. 24° 39′; W. long. 23° 28′.

CORYCÆUS VARIUS, D.
Collected December 30. S. lat. 0° 30′; W. long. 0° 30′.

B. *Setæ caudales stylis non valdè breviores, sæpe longiores. Cephalothorax posticè acutus.*

CORYCÆUS LATICEPS, D.
Collected in S. lat. 0° 30′, W. long. 0° 30′.

CORYCÆUS ANGLICUS, Lubbock.
Collected October 7, 1858. N. lat. 7° 15; W. long. 27° 52′.
„ October 20, 1858. S. lat. 13° 43′; W. long. 33° 55′.
PL. XXIX. figs. 10 & 11.

2. *Antennæ posticæ microdactylæ; digitus articulo secundo brevior.*

A. *Seta articuli antennarum posticarum secundi nuda.*

* *Styli caudales abdomine breviores.*

CORYCÆUS HUXLEYI, n. s. Cephalothoracis segmentum tertium supernè visum breve, angulis posticis productis. Conspicilla parvula, remotiuscula. Antennæ anticæ mediocres, setis longis; antennarum posticarum articulus secundus apice interno bidenticulato, digito ferè longior, setâ longâ, nudâ. Abdomen 2-articulatum, segmento primo paulo latiore et duplo longiore quam secundum. Styli caudales abdomine duplo breviores, setis longioribus.

This species is nearly allied to *Corycæus venustus*, in which species, however, as in many others, Professor Dana has represented the finger as consisting of only two segments; in all the species examined by me, however, the usual three segments were present, though, as is the case in the present species, and probably also in *C. venustus*, the basal is very short.

Length $\frac{17}{1000}$ths of an inch; length of cephalothorax $\frac{12}{1000}''$, of abdomen $\frac{6}{1000}$ths of an inch. The first segment of the abdomen is $\frac{6}{2000}''$, the second $\frac{3}{2000}''$, the lamella $\frac{4}{2000}''$, and the caudal setæ $\frac{8}{2000}''$ in length. The claw forms half the length of the finger.

Collected October 20. S. lat. 13° 43′, W. long. 33° 55′.
„ July 21. S. lat. 0° 30′, W. long. 0° 30′.

Pl. XXIX. fig. 8, × 30; fig. 9. antenna of second pair, × 60?

B. *Seta articuli antennarum posticarum secundi setulosa.*

CORYCÆUS PELLUCIDUS, D.

Collected in S. lat. 0° 30, W. long. 0° 20′.;
S. lat. 13° 43′, W. long. 33° 55′.

CORYCÆUS LONGICAUDIS, D.

Collected in N. lat. 7° 15′, W. long. 27° 52′.

ONCÆA, Philippi.

ONCÆA PYRIFORMIS, n. s. Feminæ cephalothorax 5-articulatus, rotundatus. Maxillipedes mediocres, antennis posticis paululo majores. Abdomen 5-articulatum, stylis mediocribus. Styli caudales abdomine quadruplo, et setæ caudales duplo breviores.

This species is very nearly allied to *A. obtusa*, which it resembles in shape. The stylets, however, are scarcely one-fourth, and the setæ scarcely half as long as the abdomen. I believe, however, that the length of these setæ varies a little. At least, in one specimen, which in other respects resembled this species, the caudal setæ were about a quarter smaller.

The cephalothorax is five-jointed, and tapers a little behind. The anterior antennæ are four-jointed, the apical segment showing traces of articulations. The setæ are of moderate length. The branches of the natatory legs are three-jointed. The claw of the maxillipeds is scarcely shorter than the preceding joint. The abdomen is five-jointed, the three posterior segments being distinct. The two outer spines of the caudal stylets are ciliated only on the posterior margin.

This description applies to several specimens with bags of eggs attached to the upper side of the abdomen, as described by Dana. There were also some similar specimens without eggs, which, however, may also have been females. But in one case I found a couple connected together, which I suppose to have been male and female. The female had two bags of eggs, as usual. The smaller one, which I suppose to have been the male, clasped the anterior narrow part of the abdomen of the female with its anterior legs. These organs were larger than those of the female; and I am inclined, therefore, to think that this may be a sexual character.

In establishing this genus, Professor Philippi makes no mention of the large eyes; and Dana therefore assumed that they were absent, and placed the genus among the Cyclopidæ. Philippi, however, expressly states ('Wiegmann's Arch.' 1843, vi.) that the specimen was lost before the examination was completed; and in all other respects Dana's genus *Antaria* so closely agreees with *Oncœa*, that I cannot but regard them as synonymous, in which case the latter name, by the rule of priority, must be retained.

Neither Philippi nor Dana, who alone has described any species belonging to this genus, mentions the males; but the two sexes are probably alike.

Several of the specimens carried bags of eggs.

Collected May 17, 1858. S. lat. 0° 40′; W. long. 0° 20′.
" " N. lat. 7° 15′; W. long. 27° 52′.
" " S. lat. 40° 53′; E. long. 45° 22′.

Pl. XXIX. fig. 24, × 30; fig. 25. abdomen, seen from above, × 30.

Sapphirina.

A. *Conspicilla contigua.*

Sapphirina cylindrica, n. s. Maris conspicilla contigua, fronti insita. Antennarum posticarum digitus articulo secundo paulo longior. Corpus depressum, elongatum, posticè non attenuatum, 10-articulatum, segmento ultimo parvo, tecto. Lamellæ caudales oblongæ, segmento penultimo non longiores. Setæ lamellæque caudales eâdem ferè longitudine.

The peculiar outline of the body distinguishes at once this species from all those described by Dana, at the same time most nearly resembling his *S. metallina*. He does not figure nor describe the second pair of antennæ in that species; and I am therefore unable to compare them with those of *S. cylindrica*, which, as is shown in Pl. XXIX. fig. 14, are somewhat unlike those of its congeners. The branches of the natatory legs are all three-jointed. The anterior antennæ are short, with only four or perhaps five segments, gradually diminishing in size and length towards the apex. The hairs are rather longer than the organ itself.

Collected April 9, at 6 A.M. S. lat. 0° 40′; W. long. 0° 20′.

Pl. XXIX. fig. 13, × 15; fig. 14. antenna of second pair, × 60; fig. 15. caudal lamella, × 60.

Sapphirina nitens, n. s. Conspicilla ferè contigua. Digitus antennarum posticarum paulo longior quam articulus secundus, articulis duobus digiti inæquis; unguiculo brevi. Lamellæ caudales ovatæ, ad apicem rotundatæ, prope apicem internum dente acuto armatæ, setis quatuor, dimidio lamellæ brevioribus.

This species is very nearly allied to *S. coruscans* of Dana, from which it differs in the length of the two-jointed finger, which (without the claw) is rather longer than the second segment. The *male* has five thoracic segments, which diminish in length (and also slightly in breadth) from the front backwards. The abdominal segments are also five in number, and diminish slightly in size like those of the thorax. They are not so much pointed behind as in Dana's figure of *S. coruscans*. In the *female* the first abdominal segment is short and with the sides truncated; the second is rounded; the third, fourth, and fifth lunate. The caudal stylets are ovate, about twice as long as broad. There are four short setæ, and a little spine on the inner apex. The setæ are not more than one-third as long as the lamella. The lamellæ of the male and female seemed to vary a little in shape and in the position of the two apical hairs.

Collected, 8 A.M., April 27, 1858. S. lat. 0° 40′; W. long. 0° 20′.
Also November 22, 1858. S. lat. 40° 53′; E. long. 45° 22′.

Pl. XXIX. fig. 16; fig. 17. antenna of second pair, × 60.

Sapphirina elegans, n. s. Conspicilla contigua. Antennarum posticarum digitus articulusque secundus ferè æquales, articulis digiti inæquis, unguiculo vix dimidii digiti. Cephalothorax 5-articulatus, segmento postico lunato, latere rotundato. Abdomen 6-articulatum, articulis tertio quarto quintoque lunatis. Lamellæ caudales ovatæ, latitudine plus duplo longiores, apice interno denticulato, setis quatuor parvulis.

This species is nearly allied to *S. inæqualis,* from the Pacific. The forms of the two posterior cephalothoracic segments are different, and the caudal lamellæ are rather longer than twice their breadth.

Length $\frac{1}{10}$th of an inch; length of the finger $\frac{17}{2000}''$, of the 2nd segment $\frac{22}{2000}''$, of the claw $\frac{8}{2000}''$, of the caudal setæ $\frac{6}{2000}''$, of the caudal lamellæ $\frac{27}{2000}''$; breadth of the caudal lamellæ $\frac{12}{2000}''$. The setæ of the appendage to the base of the abdomen were imperfect.

One of the specimens had a number of eggs attached to it.

Collected November 24, 1857. S. lat. 0° 30′; W. long. 0° 30′.

Pl. XXIX. fig. 18, × 15; fig. 19. antenna of second pair, × 30.

Sapphirina parva, n. s. *Feminæ* conspicilla contigua, prominentia. Digitus antennarum posticarum articulo secundo brevior, articulis valdè inæquis, unguiculo dimidii digiti longitudine. Abdomen segmentis primo et secundo angustis truncatis, tertio et quarto latioribus lunatis, postico rotundato. Lamellæ caudales ovatæ, ad apicem rotundatæ, apicę interno denticulato, setis duabus terminalibus, duabus lateralibus, omnibus brevibus (lamellâ ferè quadruplo brevioribus).

This species is nearly allied to *S. detonsa,* a Pacific form. It differs, however, in having longer setæ to the caudal lamellæ; and the general outline is a little different. The length of the second segment of the antennæ is $\frac{15}{2000}''$, that of the finger being $\frac{12}{2000}''$, and of the claw $\frac{6}{2000}''$. The breadth of the caudal lamellæ is $\frac{8}{2000}''$; their length is $\frac{17}{2000}''$, and that of longest seta is $\frac{5}{2000}''$. The total length is about $\frac{1}{15}$th of an inch.

Collected April 9, 1858, in S. lat. 0° 30′, W. long. 0° 30′.

Pl. XXIX. fig. 20, × 30; fig. 21. antenna of second pair, × 60.

Sapphirina, n. s.?

The collection contains also a specimen closely resembling *S. indigotica.* The finger is however as long as the second joint, the claw is not half as long as the finger, and the caudal setæ are barely half as long as the lamellæ. It must therefore, I think, be considered a new species; but having only one specimen, I do not like to describe it.

Collected in S. lat. 0° 40′, W. long. 0° 20′.

Sapphirina orientalis, Dana.

I name this species with some hesitation, as it was originally collected by Dana in the Sooloo Sea, south-west of the Island of Panay. It appears, however, to agree exactly with a specimen collected by Captain Toynbee on the 5th Oct., N. lat. 12°, W. long. 20° 50′.

Sapphirina Danai, Lbk.

Collected in S. lat. 0° 40′, W. long. 0° 20′.

B. *Conspicilla non conjuncta.*

Sapphirina ovatolanceolata, D.

Collected in S. lat. 0′ 30°, W. long. 0° 30′.

Sapphirina Gemma, D.

Collected, June 18, in S. lat. 0° 40′, W. long. 0° 20′.

Sapphirina Thompsoni, n. s. *Maris* conspicilla non conjuncta, fronti insita. Digitus et articulus secundus antennarum anticarum eædem ferè longitudinis, articulis duobus digiti inæquis, unguiculo longiusculo (dimidium digiti longitudine superante). Lamellæ caudales latæ, latitudine tamen longiores, apice interno producto et acuto; setæ caudales quatuor, duæ apicales, aliæ externæ, omnes breves (dimidio lamellæ breviores).

I have named this *Sapphirina* after Mr. Thompson, thinking it but right that one species should be dedicated to the discoverer of the genus. The body consists of ten segments gradually tapering backwards,—the posterior, however, being, as usual, small and almost concealed beneath the penultimate. It is of a somewhat peculiar form; so that I have given a separate figure of it. The first five segments are rounded at the sides, the next four have a minute spine at the posterior corners. The seventh, eighth, and ninth segments have on the under side a small toothed flap. The anterior antennæ have only three apparent segments, the first and third about equal, the middle one shorter. The setæ are short. The total length is $\frac{3}{20}$ths of an inch. The width of each conspicillum is $\frac{13}{2000}''$, and the space between them $\frac{8}{2000}''$. The length of the second segment of the posterior antenna is $\frac{22}{2000}''$, and that of the finger is the same; the claw is $\frac{12}{2000}''$; the length of the caudal lamella is $\frac{20}{2000}''$, and their breadth $\frac{17}{2000}$. The caudal setæ are $\frac{5}{2000}''$ in length.

Collected February 1, 1858, at 3 A.M., in S. lat. 0° 30′, W. long. 0° 30′.

Pl. XXIX. fig. 22, × 15; fig. 23. antenna of second pair, × 60.

Miracia.

Miracia efferata, D.

Collected in S. lat. 0° 40′, W. long. 0° 20′.

POLYPHEMIDÆ.

Evadne.

Evadne Nordmanni, Lovén.

Collected in S. lat. 0° 40′, W. long. 0° 30′.

HALOCYPRIDÆ.

Conchœcia.

Conchœcia agilis, D.

I am not quite sure about this species. The collection contained only two specimens.

Collected in N. lat. 24° 39′, W. long. 23° 28′.
" S. lat. 0° 30′, W. long. 0° 30′.

Pl. XXIX. fig. 29. maxillæ and legs, × 30.

Conchœcia birostrata, n. s. Supernè visa elongatè ovata; latere visa oblonga, subrectangulata, posticè paulo altior, fronte instar rostri producta et angulo superno postico denticulato. Antennæ anticæ setis 5 inæquis, unâ longâ, aliis crassis brevibus. Spiculum antennâ longius, sagitticapitatum. Antennarum posticarum articulus secundus duplo longior quam sequentes simul sumti.

This species is at once distinguishable from all the others at present known, by the posterior angle of the back being toothed. In general outline it resembles the other species of *Conchœcia*, but is deeper behind instead of in front.

The anterior antennæ resemble those of *Halocypris atlantica* in the form and arrangement of the setæ; the spiculum, however, is longer than the antenna by its whole head.

The mandibles and first pair of maxillæ are not unlike those of *Halocypris atlantica* (Trans. Ent. Soc. n. s. vol. iv. pl. 12. f. 5 & 6).

The shell is reticulated but very faintly; and the two valves are similar in outline.

Length $\frac{1}{10}$th of an inch.

Collected April 21 and June 7. S. lat. 0° 40′; W. long. 0° 20′.
N. lat. 7° 15′; W. long. 27° 52′.
S. lat. 13° 43′; W. long. 33° 55′.

Pl. XXIX. fig. 26, × 30; fig. 27. anterior antenna, × 30; fig. 28. posterior antenna, × 30.

Conchœcia intermedia, n. s. Supernè visa ovata, anticè rotundata elliptica, posticè subacuta; latere visa oblonga, subrectangulata, fronte instar rostri producta, dorso ferè recto, angulo postero acutè rectangulato. Spiculum ferè cylindricum, antennâ plus dimidio longius. Antennarum secundarum articulus secundus duplo longior quam ultimi simul sumti. Pes mandibularis articulo secundo elongato, tribus ultimis non inflexis, vix attenuatis.

This species possesses the general outline of *Conchœcia*, with an almost cylindrical spiculum and short setæ to the first pair of legs. Prof. Dana gives the flexure of the three terminal segments of the mandibular palpus as a generic character. Although, however, it is true that they are generally bent down, this is not always the case. Moreover their base is provided with two strong muscles—a flexor and an extensor; so that they must have considerable play; and I have represented a specimen (Pl. XXIX. fig. 15) in which they are as little bent as is the case in *Halocypris*, which also has the two muscles, and must therefore have the power of bending the three terminal segments.

The present species, again, though in general outline it resembles the typical species of *Conchœcia*, differs from it in having the spiculum cylindrical; and the palpus of the mandibles is at any rate not always inflexed.

The anterior antennæ resemble those of *H. atlantica*; but the spiculum is longer than in that species.

The five setæ of the appendage to the second antennæ are all elongated, as usual; but their appearance is peculiar; and I am uncertain whether they are perfect or not, as they scarcely taper at all and yet do not look as if they had been broken off. The same remark applies also to the setæ of the anterior antennæ.

The terminal setæ of the first pair of legs are rather short, as in *Halocypris*. The two valves are similar to one another.

The shell is not latticed.

Length $\frac{1}{20}$th of an inch.

Collected May 3, in S. lat. 0° 40′, W. long. 0° 20′.

Pl. XXIX. fig. 30, × 30.

Conchœcia curta, n. s. Corpus curtum. Latere visa literæ formâ D similis, dorso ferè recto, anticè rostrato, posticè rotundato; supernè visa anticè rotundata, posticè subacuta. Spiculum sagitticapitatum. Antennæ primæ setis 3 longis, subæquis. Antennarum secundarum articulus secundus duplo longior quam ultimi simul sumti. Pes mandibularis articulo secundo vix elongato, articulis sequentibus subæquis, vix attenuatis. Pedes primi setis 3 apicalibus, longis, articulo ultimo perbrevi.

Surely this species must be considered as intermediate between *Conchœcia* and *Halocypris*, since, with the sagittate spiculum, the first pair of maxillæ, and the long hairs at the end of the first pair of legs, which belong to the former, it possesses the general outline of *Halocypris*. Moreover the second segment of the mandibles is not so much elongated as in *Conchœcia*. Upon the whole, however, the characters which point to *Conchœcia* seem more important than those which would unite it to *Halocypris*. The generic description of *Conchœcia* must, however, be altered; but I am unwilling to do so until we are acquainted with a greater number of species, and with the differences which may occur at different ages. The difference in general outline is very marked between the extreme forms; but some of the new species already discovered tend to fill up the gap, and render the rule less easy of application.

The spiculum is $\frac{43}{2000}''$ in length, the anterior antenna being $\frac{30}{2000}''$: they are 3-jointed.

The little appendage of the posterior antennæ has a strong spine on the basal segment, which is opposed to another, longer, curved spine, which springs, as well as the four long setæ, from the small apical segment.

In outline the two valves are nearly, if not quite, similar to one another.

The shell is reticulated, as in *Halocypris rostrata*.

Length $\frac{7}{200}$ths of an inch.

Collected April 19, in S. lat. 0° 40′, W. long. 0° 20′.

Pl. XXIX. fig. 8, ×30; fig. 9. anterior antenna, ×30.

Halocypris, D.

Halocypris atlantica, Lbk.

This species was described by me in the 'Transactions of the Entomological Society,' n. s. vol. iv. part ii. My previous figure, however, gives a somewhat incorrect idea of the organ. The two antennæ were lying one exactly over the other (as I have ascertained by referring to the actual specimen copied); and I have consequently represented too many hairs. In fact there is one long seta, and four rather short thick rod-like hairs which end abruptly and without tapering. In my previous specimen these hairs were imperfect. The spiculum is slightly swollen at the free end.

The second segment of the posterior antennæ is twice as long as the succeeding joints.

Collected in S. lat. 0° 40′, W. long. 0° 20′.

Halocypris brevirostris, D.

This species appears to be very common. The anterior notch is single in one valve, and double in the other. The latter was on the left side in four specimens examined by me.

Collected in S. lat. 0° 40′, W. long. 0° 20′.

HALOCYPRIS ROSTRATA, n. s. Supernè visa elliptica, posticè subacuta; latere visa literæ D formâ similis, dorso ferè recto, anticè rostrato, posticè rotundato. Antennæ anticæ setis inæquis. Spiculum cylindricum, antennâ vix longius. Antennæ posticæ 7-articulatæ, articulo secundo duplo longiore quam ultimi simul sumti.

This species is nearly allied to *H. brevirostris*; and as my specimens were mostly rather smaller and the two were taken together, I was at first somewhat doubtful whether the differences did not depend on age. The second segment of the posterior antennæ is, however, longer in proportion to the terminal portion—a difference which Prof. Dana considers of specific value ('Crustacea,' pp. 1302, 1303). Moreover some of the notched specimens were as large as *H. brevirostris*. The setæ belonging to the longer branch of the posterior antennæ are plumose; those of the two-jointed appendage are naked.

There is an indication of a minute segment at the base of the long branch; and the terminal portion also seemed to consist of six segments rather than five.

The spiculum is scarcely longer than the anterior antenna.

The three terminal segments of the mandibular palpus scarcely diminish at all in breadth. The second segment is short and broad.

The two valves are similar to one another in outline.

The shell is latticed by longitudinal and transverse bars.

Length $\frac{1}{30}$th of an inch.

Collected April 22, in S. lat. 0° 40′, W. long. 0° 20′.

PL. XXIX. fig. 33, × 30; fig. 34. mandible, × 30.

HALOCYPRIS TOYNBEEANA, n. s. Supernè visa, brevissimè ovata; latere visa subrotundata, literæ D formâ similis, dorso ferè recto, angulis rotundatis, fronte obsoletè prominulâ. Antennæ anticæ 3-articulatæ, setis nudis, uno longiore. Antennæ posticæ 9-articulatæ, articulo secundo plus duplo longiore quam sequentes simul sumti.

I have done myself the pleasure of calling this species after Capt. Toynbee, to whose industry and love for science we owe this valuable collection. It differs from *H. inflata* in general outline, and in the posterior antennæ. These latter are unlike those of any other species, in the arrangement and form of the large hairs belonging to the little appendage; these are six in number: four of them are simple and naked; one is longer, and clubbed at the end; and the other is thick, and bent upon itself in the form of a sickle. The larger branch of the antenna is 8-jointed, and the hairs belonging to it are plumose.

The mandibles are like those of *H. inflata* in form, but differ a little in the arrangement of the hairs.

The two pairs of maxillæ and of legs offer no very striking peculiarities.

Length $\frac{1}{15}$th of inch. The animals were very active.

Collected June 25, in S. lat. 0° 40′, W. long. 0° 20′.

A collection made in N. lat. 7° 15′, W. long. 27° 52′, contained some specimens agreeing very closely with this species, except in wanting the recurved spine on the appendage of the second pair of antennæ. This may perhaps be a sexual difference.

PL. XXIX. fig. 35, × 30; fig. 36. anterior antenna, × 30; fig. 37. posterior antenna, × 30; fig. 38. mandible, × 30; fig. 39. carapace, × 30.

PŒCILOPODA.

Baculus, n. g.

Baculus elongatus, n. s. Cephalothorax 4-articulatus, segmento antico maximo, sequentibus brevibus, subæquis. Oculi duo, parvi. Antennæ quatuor, posticis prehensilibus. Truncus buccalis magnus. Maxillipedes fortes. Pedes natatorii octo, biremes. Abdomen 1-articulatum, elongatum.

The interesting specimen above described is quite unlike any other with which we are yet acquainted; but as it bears no eggs, it is impossible to ascertain what is its sex, or whether it is yet mature. If not, it may be a young state of some little-known species; but unless this is the case, it must, I think, be considered as the type not only of a new genus, but also of a new family. In general form it resembles a constable's staff. It is thickest near the front end, and gradually tapers to the other extremity.

The cephalothorax is four-jointed; the first segment occupies more than two-fifths of the whole length. The three following segments are small, and rounded at the sides. The eyes are two in number, small, and seated on a mass of pigment. The anterior antennæ are short, three- or four-jointed, and clothed with rather long hairs on the front end. The posterior antennæ are shorter and stouter. They end in a large claw, which gives them a prehensile character.

Immediately behind the large suctorial mouth is a pair of jaws, the homologies of which I have not been able to determine.

The natatory feet are eight in number. The abdomen appears to consist of only a single segment; it is ringed at the sides, and ends abruptly. At the posterior extremity are two small, slightly projecting disks.

This remarkable species belongs apparently to the Ergasiloidea, and at first sight somewhat resembles *Monstrilla*. From this genus, however, it differs altogether in the form of the abdomen, and in the presence of posterior antennæ—a character which might seem to indicate a greater affinity with *Ergasilus*.

Length $\frac{1}{10}$th of an inch.

Caught April 9, in S. lat. 0° 30′, W. long. 0° 30′.
Pl. XXIX. fig. 40, × 30.

J. Lubbock, del.

G. Jarman sc.

DESCRIPTION OF THE PLATE.

Tab. XXIX.

Fig. 1. *Calanus mirabilis.* End of anterior antenna, × 30.
Fig. 2. *Calanus Danæ.* Posterior leg, × 30.
Fig. 3. *Calanus Danæ.* End of anterior antenna, × 30.
Fig. 4. *Undina Darwinii.* Fifth pair of legs of male, × 60.
Fig. 5. *Undina Darwinii.* End of anterior antenna, × 60.
Fig. 6. *Ctytemnestra tenuis.*
Fig. 7. *Clytemnetra tenuis.* Anterior antenna, × 60?
Fig. 8. *Corycæus Huxleyi,* × 30.
Fig. 9. *Corycæus Huxleyi.* Antenna of second pair, × 60?
Fig. 10. *Corycæus Anglicus.* Antenna of second pair, × 60?
Fig. 11. *Corycæus Anglicus.* Maxilliped, × 60.
Fig. 12. *Setella tenuis,* × 3.
Fig. 13. *Sapphirina cylindrica,* × 15?
Fig. 14. *Sapphirina cylindrica.* Antenna of second pair, × 60.
Fig. 15. *Sapphirina cylindrica.* Caudal lamella, × 60.
Fig. 16. *Sapphirina nitens.*
Fig. 17. *Sapphirina nitens.* Antenna of second pair, × 30.
Fig. 18. *Sapphirina elegans,* × 15.
Fig. 19. *Sapphirina elegans.* Antenna of second pair, × 30.
Fig. 20. *Sapphirina parva,* × 30.
Fig. 21. *Sapphirina parva.* Antenna of second pair, × 60.
Fig. 22. *Sapphirina Thompsoni,* × 15.
Fig. 23. *Sapphirina Thompsoni.* Antenna of second pair, × 60.
Fig. 24. *Oncæa pyriformis,* × 30.
Fig. 25. *Oncæa pyriformis.* Abdomen, seen from above, × 30.
Fig. 26. *Conchœcia birostrata.* Outline, × 30.
Fig. 27. *Conchœcia birostrata.* Anterior antenna, × 30.
Fig. 28. *Conchœcia birostrata.* Posterior antenna, × 30.
Fig. 29. *Conchœcia agilis.* Maxillæ and legs, × 30.
Fig. 30. *Conchœcia intermedia,* × 30.
Fig. 31. *Conchœcia curta,* × 30.
Fig. 32. *Conchœcia curta.* Anterior antenna, × 30.
Fig. 33. *Halocypris rostrata,* × 30.
Fig. 34. *Hatocypris rostrata.* Mandible, × 30.
Fig. 35. *Halocypris Toynbeeana,* × 30.
Fig. 36. *Halocypris Toynbeeana.* Anterior antenna, × 30.
Fig. 37. *Halocypris Toynbeeana.* Posterior antenna, × 30.
Fig. 38. *Halocypris Toynbeeana.* Mandible, × 30.
Fig. 39. *Halocypris Toynbeeana.* Part of carapace, × 30.
Fig. 40. *Baculus elongatus,* × 30.

XVI. *On the Anatomy and Development of* Pyrosoma. *By* Thomas H. Huxley, *Esq., F.R.S., F.L.S., Sec. G.S., Professor of Natural History in the Government School of Mines.*

Read December 1st, 1859.

§ 1. *History of the Genus* Pyrosoma.

The genus *Pyrosoma* was first established in 1804 by Péron, in a memoir* published in the fourth volume of the 'Annales du Muséum,' and accompanied by a plate representing the exterior and a longitudinal section of the animal. Péron thus defines the genus and the species which he observed :—

"Pyrosoma.

"Corpus liberum, subconicum, extremitate ampliore apertum vacuum, aperturæ margine intus tuberculis cincto.

"Pyrosoma atlanticum. Æquatorio-atlanticum, gregarie pelagivagum, viridissime phosphorescens, coloribus eximiis tunc effulgens, in aquis viginti duobus reaumurianis calidioribus occurrens, 10–12, 14–16 centrimetros æquans."

M. Péron's conceptions of the exigencies of a zoological diagnosis were evidently of a singular kind, and his memoir contains not a single observation calculated to throw light upon the true nature of one of the most remarkable animals that has ever been discovered. With respect to the striking property which gave rise to the name conferred on the genus, Péron asserts that the *Pyrosomata* exhibited movements of alternate contraction and dilatation at regular intervals; and that each contraction was accompanied by the development of a luminosity, which, when at its brightest, was red, but, in dying away, passed through shades of orange, green, and blue. The light was developed upon irritation, and entirely ceased with the animal's death. The only indication of locomotive power was the regular contraction just described, whose necessary effect was a slight retrogressive movement, in consequence of the reaction of the water forced out of the open end of the *Pyrosoma*.

In 1815, Lesueur, having previously, as he states, described and figured a new species (*P. elegans*) in the 'Nouveau Bulletin de la Société Philomatique' for 1813, added a number of important details to Péron's account in his "Mémoire sur l'organisation des

* "Mémoire sur le nouveau genre *Pyrosoma*," par M. Péron. Annales du Muséum, tom. iv. p. 437, 1804.

Forskål's Descriptiones Animalium (1775) contains the following passage :—

"29. Medusa Beroë. Tres ejus varietates vidi vel species. * * * * *

"29*c*. rufescens: ovato-oblonga; sæpe 5 poll. longa; intus prorsus vacua. Gallicè, *Concombre de la mer*. In mari Mediterraneo frequens."

Was *Medusa Beröe rufescens* a *Pyrosoma*?

Pyrosomes, et sur la place qu'ils doivent occuper dans une classification naturelle*," and showed that Lamarck was in error in assigning to *Pyrosoma* a place near *Beroë*, the animal being, in reality, a mollusk closely allied to *Salpa* (*l. c.* p. 420).

The species described by Lesueur was named by him *P. giganteum*, and was obtained in the Mediterranean, near Nice.

Pyrosoma giganteum, says Lesueur, has the general form common to the two other species; it is transparent, of a starchy blue colour, soft and gelatinous, though slightly coriaceous; its only aperture, placed at the upper end, is bounded by tubercles and provided with a membranous expansion, which in certain cases serves to close it. The whole body is covered externally with tubercles, but these are not disposed regularly like those of *Pyrosoma elegans*; they vary in their dimensions, some being short and indistinct, while others are greatly developed. The largest are conico-cylindrical, flattened and lanceolate at the extremity (while those of *P. atlanticum* are simply conical), with a small aperture situated upon that side which looks towards the bottom of the sac: this lanceolate extremity is notched on its sharp edges, and presents below, between its pointed extremity and the opening of which we have just spoken, a small but very prominent keel. The inner surface of the *Pyrosoma* is smooth, and provided with a great quantity of little apertures, each of which corresponds with one of the tubercles, and is only the anterior end of a canal, whose posterior aperture is placed at the free extremity of the tubercle,—a fact easily demonstrated by pouring water into the sac-like body of the *Pyrosoma*; for the water passes out immediately, in a multitude of distinct jets, from the extremities of the tubercles.

Lesueur next proceeds to describe the internal structure of the *Pyrosoma*. He mentions the internal and atrial tunics as one internal tunic, and points out their distinctness from the external, except at the aperture and over those rounded lateral bodies, which I have much reason to think are renal organs. The branchial networks are recognized as such; the endostyle is described as "un vaisseau replié sur lui-même;" the testis is noted, but is interpreted as the liver. The stomach is determined as such, while the intestine is regarded as the œsophagus; and the œsophagus is considered to be the pylorus, opening into what Lesueur regards as the intestine—"un canal assez large, glanduleux vers sa base" (p. 417), but which is, in reality, a sinus full of blood-corpuscles.

The peripharyngeal ridge is accurately described as "deux petits filets qui vont en se courbant de chaque côté," &c. (p. 419); and the nature of the nervous ganglion is rightly determined. *Pyrosoma* is classed among the compound organisms, and the fœtuses are carefully though briefly noted. Lesueur confirms Péron's statement concerning the rhythmical contractions exhibited by the whole body in the *Pyrosomata*.

The figures which accompany this memoir are exceedingly good. I judge from them that Lesueur observed the atrial muscles, and that he has mentioned them as the line which separates the first zone of his transverse section (fig. 13 *b*) from the second (p. 415); and again, in the description of the figures 5 & 6, as "les filets qui forment un réseau dont l'usage paraît être de lier les animaux du *Pyrosome* entre eux." In *n*, fig. 5, I imagine

* Read to the Société Philomatique de Paris on the 4th of March, 1815, and published in the 'Journal de Physique' for June of the same year.

I recognize an ovisac. Lesueur describes it as one of the 'œufs' or fœtuses, which are well represented in figs. 8–11.

Contemporaneously with Lesueur *, that great, but unfortunate anatomist, Savigny, directed his attention to the *Pyrosomata*, the peculiarities of whose structure found, at length, an adequate expositor in him; and his account of the anatomy of *Pyrosoma giganteum* is at once so lucid and so concise, that I cannot do better than reproduce it, as an introduction to my own memoir.

The subjects of Savigny's observations were obtained at Nice by Risso, and by him sent to Cuvier.

"This *Pyrosoma* (*P. giganteum*) is a large cylindrical tube, composed of a gelatinous transparent substance, closed and rounded at one end, at the other, truncated and provided with an aperture narrowed by an annular diaphragm, which is not without analogy with the membranous circle of the *Botryllidæ*. The surface of the tube presents conical and smooth eminences of different sizes, some simple and very short, others longer and terminated by a lanceolate piece. Each eminence is pierced at its apex, behind the base of the lanceolate piece, when this exists, by a little circular hole, surrounded by a brown and projecting edge. This aperture, in my opinion, serves to give entrance to the water, and leads into the pharynx.

"The inner wall of the tube presents slight hemispherical enlargements, which correspond with the conical eminences of the external surface, and which are likewise pierced at their apices. The latter apertures, similar to the foregoing both in form and number, are situated opposite the anus, and give exit to the fæces.

"This diametrical opposition of the orifices of its cells is a novel peculiarity of the *Pyrosoma*, and determines the form of the whole body. The functions of each of these orifices seem to me to be sufficiently indicated by their relative position. One is naturally inclined to think that in this genus, as in the foregoing †, it is the most prominent orifice which transmits the food to the pharynx and which admits the water requisite for the branchiæ. Besides this, the water, incessantly renewed at the outer surface of the tube, could not be so rapidly or completely changed in its interior. The arrangement of the viscera in each animal agrees with this first indication.

"To describe the animals of the *Pyrosoma*, we may suppose the cylinder to be placed vertically on its base—I mean, on its rounded and closed end; for the opening of this body is evidently its summit. Each animal then represents an elliptical sac, compressed laterally, whose great axis is horizontal, and consequently perpendicular to that of the cylinder. This sac, formed by a delicate and transparent tunic, is attached to the cell which contains it, only by the circular opposed apertures of its two ends. The extremity which is turned towards the axis of the cylinder is simply rounded: that directed towards the circumference is prolonged into a neck, whose length is proportional to the projection which the cell makes externally, and whose orifice is provided with a festooned

* The second memoir of the second part of the celebrated 'Mémoires sur les Animaux sans Vertèbres,' entitled "Observations sur les Alcyons à deux oscules apparens, sur les Botrylles, et sur les Pyrosomes," bears the inscription, "Lues à la première classe de l'Institut le 1er Mai 1815;" with the note, "Ce mémoire a été présenté le 17 Avril; mais les travaux de la classe en ont fait différer la lecture."

† [viz. *Botryllus.*]

membrane. The lower edge of the sac exhibits the same brown and undulating vessels as the back of the foregoing species, and ought in consequence to be regarded as the corresponding region. The branchial cavity is very large; it occupies those two-thirds of the tunic which lie nearest the circumference of the cylinder: its bottom, which is completely open, communicates freely with the other third, which lodges the viscera of the abdomen. These are small, and situated on the right side. The space which they leave unoccupied is commonly filled by the fœtuses, which successively arrive and are developed there, as we shall see below. The structure of the branchial sac in the *Pyrosomata* may lead one to believe that the water absorbed by the oral, makes its way out by the anal orifice. This would be a feature of resemblance with the *Salpæ*, in which it is indubitable that the water takes this course. However this may be, the network which lines the cavity is otherwise organized: it is loose, and composed of fine, undulating, opake, white vessels, some of which are longitudinal, while others are transverse and cross the former at right angles—a character which is common to all the genera of this family. The network does not occupy the whole cavity, but only its two lateral walls; so that there are obviously, in this genus, two separate and opposite branchiæ, one on the right and the other on the left, and which are much narrowed, and consequently distant, at the top. In the foregoing genera, the two branchiæ, although really distinct, are only separate behind. The pharynx is at the bottom of the branchial cavity, towards its upper angle. The œsophagus is curved sharply to be inserted into a notch of the stomach, which is placed behind the bottom of the branchial cavity. The stomach is fleshy, smooth, compressed, ovoid, or slightly cordiform. The intestine, very delicate at its commencement, suddenly enlarges; a short course brings it to the inferior edge of the tunic, where it receives the insertion* of a large organ analogous to the liver; afterwards it returns to the stomach, behind which it ends in a simple and rounded anus. The fæces are homogeneous, clear, yellow, and divided into little masses, the last of which is often already engaged in the atrial orifice (*oscule anal*), which seems to prove that the rectum has the power of elongating and of adapting itself to this orifice.

"I must remark, that the liver, or the organ which from its position may be regarded as such, is attached to the intestine by a bundle of divergent canals; that it is rounded, commonly opake, rose-coloured, yellow or brown, strangulated above its insertion, and divided into from eight to twelve ribs, by grooves which converge from its base to its apex; it is very soft, and may be broken up into oblong pedunculated vesicles. I may add, as a remarkable fact, that, in many individuals, this organ is colourless, and that it resembles a cellular and transparent globule: it also varies greatly in volume; sometimes, and most frequently, it is of the size of the stomach, sometimes five or six times as large†.

"The nervous system of the *Pyrosomata* does not appear to differ essentially from that of the foregoing animals. There are, in like manner, two tubercles, one on each side of the neck of the branchial sac. The anterior or superior tubercle seems to give off several filaments,

* An error: the organ in question being the testis.

† Savigny has here clearly confounded the testis and the ovisac together under the one name of 'foie.' What he calls the ribbed organ is the testis; the cellular globule is an advanced ovisac.

of which four ascend on this neck, while the others go to the opposite side. The posterior tubercle, which is here inferior, though very apparent in certain individuals, is imperceptible in most. There arise from it four opake yellowish or brown vessels, which traverse the lower side of the tunic; they are evidently the four cords of the dorsal groove of the Ascidians*. Along the upper edge, opposite the four cords of the dorsal groove, are seen two wide, short canals, of a yellow or muddy-brown colour, placed parallel, and so closely united that they might be regarded as a single canal, bent like a siphon, and extending from the middle of the branchiæ to the œsophagus, where its two extremities end. The interior appears to be cellular †.

"This organ, which is sometimes empty and transparent, seems to me to be analogous to that which M. Cuvier regards as the ovary of the *Salpæ*, or at least as their oviduct; perhaps it is, at the same time, oviduct and fecundating organ.

"The ovaries ‡ are orbicular or pyriform, symmetrically opposed to one another, and placed on the sides of the neck of the branchial opening, between the tunic and the branchial network, which they usually overlap. They communicate with two small, sometimes coloured ducts, which embrace the neck and descend as far as the loop formed by the siphon-like canals. These ovaries contain a multitude of rounded, very small, but very distinct ova.

"If I do not deceive myself, the manner in which these germs arrive at maturity is very curious. It would appear that while very small they become detached, one by one, from the ovary, and are successively lodged between the intestine and the bottom of the tunic; there they continue to grow and to be developed, until their final expulsion.

"In fact, we almost always find in this locality an isolated germ, which varies much in size. While small, it is only a perfectly white and transparent globule, in which a round aperture, like a mouth, is discernible; when somewhat larger, this hollow globule already exhibits four little reddish spots; and when larger still, these four spots have become a chain of four small but distinct little fœtuses, which encircle the globule for three-fourths of its circumference. Lastly, when it has acquired its full size, the four fœtuses, provided with all their organs, are united and form a complete ring. In this state it equals a third of the size of the individual which encloses it. It is, as one sees, a new *Pyrosoma* already composed of four animals, and will very soon be independent of the large *Pyrosoma* in which it has originated. How does it escape? I know not. If, as is probable, it makes its exit by the same aperture as the excrements, this opening must be capable of undergoing excessive dilatation.

"These observations, taken in conjunction with those which I have made upon *Botryllus*, demonstrate that the corpuscles contained in the ovaries of these animals are compound germs, not intended for the growth of systems, but for their multiplication. On

* The 'anterior tubercle' is the nervous ganglion; the posterior, merely the anterior end of the endostyle, which is described as the 'cords of the dorsal groove.'

† This 'organ' is the intestine of Lesueur, and, as I have said above, is nothing but a mass of blood-corpuscles accumulated in the hypopharyngeal sinus.

‡ These are not the ovaries, but probably, as I have already said, renal organs. What Savigny calls their ducts seem to be the lower parts of the peripharyngeal ridges.

the other hand, if we open a *Pyrosoma* or *Alcyonium*, we find, among the adult individuals, more or less developed embryos, which can only have proceeded from simple germs whose existence is manifested successively. These last, then, were all contained in the compound and primitive germ."

It is obvious from the last paragraph that Savigny was unaware of the origin of the latter 'embryos' by gemmation. In the 'Système des Ascidies' appended to the 'Mémoires,' Savigny forms the *Pyrosomata* into a family—the *Luciæ*, containing one genus, *Pyrosoma*, divided into two groups of species, *P. verticillatum* and *P. paniculatum*. In the former the animals are verticillate, or disposed in regular rings which project at intervals. It contains the single species *Pyrosoma elegans*, 15 lines long, with seven projecting rings, the first and the last terminal; the tuberosities composing the rings are lanceolate at the ends. There is no annular diaphragm around the wide mouth of the tube. It inhabits the Mediterranean, near Nice. Under the head of this species, Savigny makes the following important remark:—

"M. Lesueur has observed, that the whorl which terminates the tube at its small end is formed by four tubercles, *i. e.* by four animals. He thinks that this disposition is peculiar to the species in question; but, with a little attention, the same arrangement is to be found in the following species, where these four animals seem to be the representatives of the four little fœtuses which are developed in the egg before its extrusion."

The *Pyrosomata paniculata* are species in which the animals are not verticillate, and form very irregular circles, whose apices are everywhere irregularly projecting. This division comprises *P. giganteum* and *P. atlanticum*.

Pyrosoma giganteum has an almost cylindrical body, the external tuberosities being very unequal, hemispherical or conical; the most projecting having their appendage or terminal papilla lanceolate, subcarinate, and finely denticulated. The opening of the tube is commonly narrowed by an annular diaphragm. The total length of the largest tubes is 14 inches; the opening, including the diaphragm, is 2 inches across; the individuals vary in size from 3–5 lines, according as the neck of the thorax is more or less prolonged—a circumstance which is independent of the age of the individual.

The *Pyrosomata* of this species presented several varieties:—

a. Body strongly stained with brown, as well internally as externally, apparently in consequence of a brown substance filling the branchial cavities. Terminal papillæ wide, and for the most part obtuse. Diaphragm very narrow, and leaving a large aperture. Total length 13–14 inches.

b. Body bluish or a little violet, perfectly transparent. Papillæ very narrow. No annular diaphragm at the aperture, which presented only very young individuals. Total length 6 inches.

c. Body bluish, perfectly transparent. Papillæ longer and more pointed than in the preceding varieties. An annular diaphragm, leaving but a very narrow aperture, around which almost all the animals were adult. Total length 5, 6, 7 inches.

This species inhabits the Mediterranean and Atlantic, bordering the French coasts.

In the description of *Pyrosoma giganteum*, Savigny gives some particulars not mentioned in his account quoted above. Thus, he says that the tunic offers but few vessels, "except upon the diaphragm which surrounds the aperture." The tunic is provided "below the abdomen with two transverse muscles, and, besides, is marked by interlacing muscular nervures, which are very fine, and hardly visible with a strong lens...... The festooned membrane at the entrance of the branchial sac would be exactly circular if its posterior and inferior edge were not prolonged into a point.

"Branchiæ wholly separated behind, divided in front as far as their bases, rounded or acuminated at their apices; transverse vessels 18–25, increasing by degrees from the first, reckoning from the top, to the fifth or even the eighth; longitudinal vessels 11–17, the middle one only reaching the first transverse vessel, the following on each side attaining the second, and so on, the most external vessels being the shortest of all."

The other species, or the *Pyrosoma atlanticum*, has a conical body 6 or 7 inches long, with its external protuberances terminating in subulate points, and inhabits the equatorial seas.

Mr. F. D. Bennett exhibited some specimens of *Pyrosoma* at a meeting of the Zoological Society on the 25th of June, 1833, and gave an account of their phosphorescence. A paper by the same author, "On marine *Noctilucæ*," printed in the 'Proceedings' of the Zoological Society for 1837, contains further remarks on the same subject, and the statement that the 'sphincter-like' membrane which surrounds the cloacal aperture is capable of contraction.

In the 'Comptes Rendus' for 1840 (tom. x. p. 285), M. Milne-Edwards published some important observations on the circulation of the *Pyrosomata*, by which he not only demonstrated, for the first time, the existence of a heart, but proved that in these, as in most other Ascidians, this organ is subject to a regular reversal of its peristaltic contractions. The regular movement of the branchial cilia is also noted in this communication. With the exception of this valuable contribution to our knowledge of the genus, I am not aware that, with the exception of M. Vogt's short paper, to be noticed below, any account of observations on *Pyrosoma* has been published since Savigny's time, except my own memoir "On the Anatomy and Physiology of *Salpa* and *Pyrosoma*, together with remarks on *Doliolum* and *Appendicularia*," contained in the 'Philosophical Transactions' for 1851.

In this memoir I have detailed the results of investigations, made under difficult circumstances and with but a few hours at my disposal, upon a single specimen of what I suppose to have been *Pyrosoma atlanticum*.

By the publication of this essay there was added to what had been already made known, an account of the tubules which envelope the intestine, and open into the stomach by a common axis. The lateral circular palettes, called 'ovaria' by Savigny, were shown not to have the function assigned to them. The blood was stated to be contained in one great sinus which extends through the whole of the body; and the reversal of the motion of the heart, observed by Milne-Edwards, was confirmed. The 'four undulating vessels' of Savigny were shown to be the expression of an endostyle, such as exists in other Ascidians. It was further stated that the edges of the vertical branchial bars, only, were ciliated. The ciliated fossa, the peripharyngeal ridges, the languets, and the otoliths were described. The 'liver' of Savigny was shown to be the testis; and the form and mode of development of the spermatozoa were described. The characters of the female organs were determined;

the presence of spermatozoa in the duct of the ovisac was observed; and it was proved that the so-called 'simple embryos' of Savigny are formed by gemmation. None of the compound embryos were observed in this specimen, however; and hence I have always felt a great desire to re-examine *Pyrosoma*, for the purpose of ascertaining the real nature and origin of such singular bodies. From Savigny's habitual accuracy, I had no doubt of their existence and essential correspondence with his account; but it seemed impossible that they should be developed in the way he describes.

In his valuable memoir "Sur les Tuniciers nageants de la mer de Nice*," M. Vogt confirms my account of the structure of *Pyrosoma*, and adds some remarks, which are, unfortunately, very brief, upon the fœtuses discovered by Savigny, and which I failed to find in my specimen. In pl. 10. figs. 9 & 10, some sketches made in 1847, and referred to in a passage of the 'Ocean und Mittelmeer' of the same author, published in 1848, are given. They are thus described at p. 89 of the present essay:—

"In fig. 9 the ovisac is seen below the testicle, immediately in front of the posterior aperture of the body. It has a rounded form, and contains an enormous, yellowish-coloured and almost transparent ovum, below which again are accumulated oviform masses which exhibit a granular vitellus. I could see no further structure in these ova; but, I must confess, I did not carry my investigations very far. In fig. 10 I have given an outline-sketch of the individnal which exhibited five young in its ovisac. The latter has a rounded form, but is much larger than in the foregoing specimen, and having pushed the viscera downwards, it has extended towards the branchial cavity, in which it forms a kind of hernia."

Fig. 9 represents, in fact, an ovisac with a segmented blastoderm, while in fig. 10 the 'five young' are the cyathozooid and the four ascidiozooids of a young fœtus.

I do not understand how the ovisac in M. Vogt's specimen can have occupied the position in which it is figured in fig. 10, the more especially as in fig. 9 it lies in the same place as that in which I have always found it, viz. in the large mid-atrium and altogether behind the intestine. M. Vogt concludes by putting forward the hypothesis that the ova pass down the canal of the ovisac into the neighbourhood of the intestine, where an incubatory cavity, in which their final development takes place, is formed for them in the thickness of the inner tunic.

"This incubation, perhaps, takes place only during certain periods of the year, or of the life of the zooid, whence the incubatory cavity is found only in some individuals and not in all. The formation of ova in the projecting ovary would continue for a certain time. The ova would pass, as they became fecundated, into this incubatory cavity, would develope there, and would ultimately be set free to lead an independent existence. Perhaps, indeed, the incubatory sac may be thrown off bodily, and thus give rise to the base of the new cylinder." (*l. c.* p. 90.)

These observations and suggestions obviously leave much room for further inquiry, and my satisfaction will be easily understood when that opportunity of renewing my investigations which I desired, but little expected, was unexpectedly afforded me. In October of the year 1859, Rear-Admiral FitzRoy, F.R.S., the indefatigable Superin-

* "Recherches sur les Animaux inférieurs de la Méditerranée," Mém. de l'Institut National Génevois, tom. ii., 1854.

tendent of the Marine Department of the Board of Trade, kindly forwarded to me a very beautiful specimen of *Pyrosoma giganteum*, taken by Captain Callow* in the North Atlantic, about 400 miles S. of the Cape De Verd Islands, in the month of August of that year, and admirably preserved by immersion in strong spirits. I was aware, from former experience, that the textures of Ascidians, in general, are admirably conserved in spirit-specimens which are even many years old; and I therefore commenced my inquiries with a sanguine expectation of being able to make out something about the origin of the compound embryos, which a cursory inspection of the specimen proved to exist in abundance. I must confess, however, that I had no anticipation that researches conducted upon a preserved specimen of any animal could be followed out so far as I have been led, step by step, to carry these. And had I not had the opportunity of showing many of my preparations to observers of experience and authority, who can bear witness, at any rate, to the perfect distinctness of the most important of the appearances described, I should hardly have hoped to secure a patient reception for delicate embryological inquiries which profess to have been conducted upon thin sections of a spirit-specimen, rendered clear by glycerine.

I have already published a brief notice of the most important facts which have been developed by my investigations in a paper published in the 'Annals of Natural History' for January 1860, and in a communication to Section D. of the Meeting of the British Association at Oxford in July 1860.

§ 2. *The Anatomy of* PYROSOMA GIGANTEUM.

In the specimen of *Pyrosoma* under description, the ascidiarium† is a firm, hollow, conical body, 4 inches long, and about $\frac{7}{8}$ths of an inch wide at its broad, open end, whilst its rounded apex measures hardly more than half an inch. The translucent, colourless wall of the ascidiarium is on an average about $\frac{3}{16}$ths of an inch thick; but it thins towards the open end, ending in a sharp ledge or rim, which is bent horizontally inwards and ends in a sort of circular valve-like lip, nearly $\frac{1}{5}$th of an inch wide, around the aperture of the central hollow or cloaca.

In relation to the ascidiozooids, the closed, apical, end of the ascidiarium is dorsal or hæmal, inasmuch as the heart is situated on that side of the body of every ascidiozooid which is turned towards the apex. The nervous ganglion, on the other hand, is on the opposite side of the body, so that the open extremity of the ascidiarium is its neural end.

The outer surface of the ascidiarium is rendered uneven by conical eminences, which are scattered over it at irregular intervals, and which are elongated on their neural sides into longer or shorter processes. Among these lie similar eminences without such processes and varying in elevation, until they hardly project at all above the general level of the convex surface of the ascidiarium. Each of these eminences bears a small rounded

* Finding a specimen could be procured in no other way, this gallant and skilful seaman swam for that he obtained. He informs me that it emitted a strong bluish-white light, sufficient to read small print by.

† The entire body of a compound Ascidian may be conveniently termed the *ascidiarium*, while the separate zooids may be called *ascidiozooids*.

aperture, the oral opening of an ascidiozooid; and there are other, similar, apertures dispersed between the eminences. In the specimen under description, the ascidiozooids are almost colourless, or have at most a very pale brownish hue; but how much of this colourlessness may be due to the action of the spirit, I do not know.

Such is the general appearance of the ascidiarium. To examine its internal structure, it is expedient to make sections with a razor in various directions. Although not absolutely necessary, I found it extremely advantageous to treat these sections with glycerine, or with a mixture of gum and glycerine—a process which not only has the advantage of rendering the tissues extremely transparent, but of preserving the preparations for a very long time unchanged*. It might have been reasonably expected that the tissues would undergo serious distortion in such a medium, but this is not the case; on the contrary, the most delicate structures, such, for instance, as the cilia upon the branchial sac, are most exquisitely exhibited in glycerine preparations. As I have said above, I have often had occasion to remark the perfection with which the tissues of the Ascidians generally are preserved by strong spirit, and the subsequent addition of glycerine seems only to increase the transparency of such preserved specimens, without otherwise altering them.

When a segment is cut out of the ascidiarium of *Pyrosoma* and examined from the inner or cloacal side, the surface presented to the eye is seen to be tolerably smooth, or at most minutely mammillated, and to present numerous small apertures, each of which corresponds with, and is opposite to, one of the apertures upon the outer surface: while the latter, in fact, is the oral, the former is the atrial† orifice of one of the ascidiozooids. In a thin vertical and radial section (Pl. XXX. figs. 1 & 4), the orifices are seen to be connected together by a comparatively wide, somewhat oval cavity, composed of the branchial chamber and the atrium of the ascidiozooid, which are separated from one another only by the perforated branchial sac, stretched like a bag-net from one wall of the cavity to the other. It would be a difficult operation to perform, but a fine hair *might* be passed in at the oral and out at the atrial aperture, through one of the meshes of the branchial sac, without injuring any organ.

From what has been said, it follows that each fully-formed ascidiozooid must be equal in length to the thickness of that part of the wall of the ascidiarium in which it occurs;

* Some which have now been more than a year in my possession exhibit no alteration.

† M. Milne-Edwards, in his "Observations sur les Ascidies Composées," 1839, describes the cavity which surrounds the branchial sac, and into which the branchial currents flow, as the 'chambre thoracique;' that part of it which receives the fæces and generative elements he terms the 'cloaca,' while he retains the name of 'anus' for the external aperture of this cloaca. From experience of the inconvenience of this phraseology, I was led some years ago ("Researches into the Structure of the Ascidians," Reports of the British Association, 1852) to propose the term *atrium* to indicate the 'thoracic chamber,' and to reserve the term *cloaca* for the chamber common to several or many ascidiozooids, as in *Botryllus*, &c. The aperture of the atrium may be termed the *atrial aperture*. The membrane which lines it, and which was in part distinguished by Milne-Edwards in the memoir cited, is the *atrial tunic*. The cellulose integument of an Ascidian is for me the *test*. The body-wall which underlies and gives origin to this test, I term the *external tunic*. The proper wall of the alimentary canal (with Milne-Edwards, I regard the branchial sac as a dilated pharynx) is the *internal tunic* of the body. For the meaning of any other terms not explained in the text, I must refer to my "Memoir on *Salpa* and *Pyrosoma*" already cited.

and the whole ascidiarium may be regarded as a succession of tiers of ascidiozooids enveloped in a common test.

The extreme apex of the cone (Pl. XXX. fig. 5) is formed by only four ascidiozooids ranged round a common point. In the next tier there are at least twelve, and the number increases until, in the widest part of the ascidiarium, there are between thirty and forty in a tier. It should be understood, however, that there is nothing very regular in the arrangement of these tiers, and that the zooids in any given tier are of very various sizes and degrees of development.

The Ascidiarium presents for study (1) the ascidiozooids, and (2) the common test which envelopes them *.

The Ascidiozooids.—In investigating the structure of the ascidiozooids, an example from the middle region of the ascidiarium may most conveniently be selected for study. Such an ascidiozooid is represented in longitudinal section in Pl. XXX. fig. 1, in transverse section in fig. 2, and from above and partly in section in fig. 3.

It is somewhat irregularly fusiform, a good deal longer than deep, and deeper than broad. Its outer extremity exhibits the oral aperture, which lies upon the hæmal side of one of the above-mentioned conical protuberances, and is overhung by a tongue-like process of the test—the *labial process*, by whose outgrowth, indeed, its relations and appearance have become so completely altered, that it will be better to become acquainted with the character of the oral aperture in a less modified specimen. On examining one of those oral apertures, in fact, which are hardly, or not at all, raised above the general level of the outer face of the ascidiarium, the plane of the oral aperture is seen to be perpendicular to the axis of the body (taking a line drawn from the oral to the cloacal aperture as that axis). A circular sphincter, composed of a band of unstriped muscular fibres, surrounds the oral entrance, being attached where the lining membrane of the alimentary tract (inner tunic: see note, p. 202) and the integument (outer tunic) pass into one another. The inner diameter of the circular sphincter is $\frac{1}{190}$th of an inch; but the diameter of the oral passage itself is far less, amounting to not more than $\frac{1}{1600}$th of an inch. This results from the circumstance that the test is thickened at the margins of the mouth, so as to diminish its aperture to this extent; and it is at the same time puckered, so that when viewed from without, a number of fine grooves appear to radiate from the lips of the aperture. These must not be confounded with certain fine fibres which radiate from the outer margin of the sphincter into the test, and are perhaps muscular (Pl. XXX. fig. 6).

The test ceases to be traceable upon the walls of the oral cavity a little within the sphincter; and where it ends, the inner tunic is produced inwards into a broad fold with lobed edges, which takes the place of that circlet of tentacles which is found in this position in most other Ascidians. I shall therefore term this the *tentacular fringe*. It is divided altogether into thirteen lobes, of which twelve, though irregular, are tolerably similar and roughly symmetrical, while the thirteenth is situated in the middle of the hæmal half of the circlet, and is very different in form and size from the rest. It is, in

* In the present memoir I propose to confine myself as nearly as may be practicable to anatomical and embryological details, reserving the many interesting histological peculiarities of *Pyrosoma* for a future occasion.

fact, three or four times as long as they are, and is divisible into a broad trilobed base, shaped somewhat like an ace of clubs, and a narrow fringe-like terminal portion. This may be distinguished by the title of the *hæmal tentacle* (Pl. XXX. figs. 6, 6 *a*).

The form, size, and relative position of the oral aperture remain the same in ascidiozooids which have the oral aperture mounted upon a very short cone; but as the cone enlarges, its hæmal grows faster than its neural side, and finally becomes prolonged into the labial process, which bends over at a right angle to the direction of the axis of the zooid*. Concomitantly with, and apparently as a result of, this development of the labial process, the plane of the oral aperture gradually shifts, until, in the first place, it lies parallel with the axis of the zooid, and then continuing to turn, as it were, on its hæmal margin, it eventually takes up a position perpendicular to the axis of the ascidiozooid again, but exactly the reverse of that which it had at first. The labial process so completely overhangs the oral aperture when this stage is attained, that the free access of the water to the interior of the zooid must, one would think, be somewhat impeded.

Two very delicate muscular bands, attached to the inner tunic, succeed one another at short intervals behind the aperture of the mouth, within which the buccal cavity rapidly widens, until it attains its maximum at about the end of the first fourth of the whole length of the zooid. At this point the buccal cavity ends and the pharyngeal or branchial sac commences, the boundary-line between the two being marked by the anterior end of the endostyle and of the epipharyngeal folds, in the middle line of the hæmal side; the peripharyngeal ridge at the sides, and the ciliated sac on the neural side. On each side, opposite the middle of the peripharyngeal ridge, is the circular patch-like yellowish organ regarded as the ovary by Savigny.

The *peripharyngeal ridge* (ciliated band, *mihi*, Mem. on *Salpa*) is a structure which I have found in all the ordinary Ascidians which I have examined. In *Pyrosoma* it is a sort of ridge or inward process of the inner tunic, less than $\frac{1}{900}$th of an inch broad, on which the epithelial lining of the tunic is peculiarly modified, so as to present the appearance of a multitude of transverse rows of elongated corpuscles, each row being set obliquely to the long axis of the band, so as to be inclined from the hæmal side and behind, forwards and to the neural side. These corpuscles are provided with short and delicate cilia. If the peripharyngeal ridge is traced upwards on the inner tunic, it is found to reach the anterior extremity of the cleft-like entrance to the endostyle, and there to pass into a narrow series of similar corpuscles which runs parallel with, and indeed may be said to form the outer part of, the projecting lip or *epipharyngeal fold* ('dorsal folds' of Savigny and others) which bounds the entrance to the endostyle laterally. Arrived at the posterior extremity of the epipharyngeal fold, these prolongations of the peripharyngeal ridge, or, as they may be termed, epipharyngeal ridges, unite with one another and pass down as a single *posterior epipharyngeal ridge* along the middle line of the posterior wall of the pharynx to the œsophageal aperture, before reaching which the single ridge divides, and its branches soon cease to be further distinguishable. On

* In the figures given by Lesueur and by Savigny, the axis of the labial process is parallel with that of the body. In most of the ascidiozooids of my specimen, the end of the process is turned towards the hæmal side, but in some it is bent the other way.

the neural side, the two peripharyngeal ridges pass on to the elevation of the inner tunic in which the ciliated sac opens, and unite upon its posterior half, widening as they do so, whence their junction forms a triangular area with its apex directed backwards.

The very singular structure which I formerly termed the *endostyle*, and which I was at one time inclined to regard as a kind of internal shell, is, in reality, a longitudinal fold or diverticulum of the middle of the hæmal wall of the pharynx, which projects as a vertical ridge into the hæmal sinus, but remains in free communication with the pharynx by a cleft upon its neural side. In consequence of the thickness and opacity of the epithelium which lines the fundus of this fold, it appears (especially in the fresh state) like a strong hollow rod mounted upon a thin ridge-like plate.

Transverse sections, however, demonstrate the true nature of this structure with perfect clearness (Pl. XXX. fig. 8). The bottom of the diverticulum is seen to be occupied by two stout cords, formed of elongated epithelium-cells set perpendicularly to the axis of the cord. These cords are separated from one another by a slight interval. Externally and below they are in contact with two lateral cords of similar cells. Anteriorly the lateral pass into the middle cords, while the latter project beyond the anterior boundary of the groove-like entrance into the cavity of the endostyle (and, consequently, of the anterior ends of the lips or epipharyngeal folds which bound it) and, coated by a process of the inner tunic, constitute the free, rounded, anterior termination of the endostyle.

Posteriorly, the same confluence of the median and lateral cords takes place; but here the endostyle extends much further beyond the limit of the groove and its bounding folds, and constitutes a free, hollow cylindroid or conical process, which, as we shall see, plays a very important part in the process of gemmation, where I shall have occasion to speak of it as the *endostylic cone*.

The *hypopharyngeal band* is not, as in many Ascidians, separated for the greater part of its length from the neural wall of the ascidiozooid. On the contrary, in consequence of the position of the œsophageal aperture close to the neural wall of the branchial cavity, and the non-extension of the atrium forwards in the middle line, the hypopharyngeal band is represented only by the inner tunic of this neural wall, which lies parallel with the outer tunic, and is separated from it only by the neural sinus, which usually contains a great aggregation of blood-corpuscles. These corpuscles are commonly aggregated more densely in the posterior two-thirds of the hypopharyngeal sinus, and not unfrequently are divided, more or less completely, into two lateral portions by a median clear space. When this state of things exists, the hypopharyngeal sinus, under a low power, presents exactly that appearance which is figured by Savigny as a siphon-like tube.

The inner tunic of the hypopharyngeal band is produced in the middle line into eight slender conical processes—the *languets*, which are situated at tolerably equal distances from one another. Thus both the neural and the hæmal walls of the pharynx are separated from the outer tunic in the middle line by nothing but the corresponding sinuses; and the same holds good of the lateral wall in the region of the peripharyngeal ridge. But, at any point behind this, either a vertical and transverse section, or a view from above, shows that the inner tunic (or pharyngeal wall) is separated from the outer tunic by a more or less wide space, enclosed within a membrane which is totally distinct from both the outer and the inner tunics, except at the atrial orifice, where it passes into the former, and at the anus, where it becomes continuous with the latter.

Except for these two breaks, the membrane in question (which is the third tunic of Milne-Edwards, and is what I have elsewhere termed the *atrial tunic*) might be compared to a closed serous sac, reflected over the viscera, on the one hand, and over a part of the external tunic, on the other, but leaving a space between itself and both these parts, which space is filled with blood, and forms a part of the general system of sinuses of the body. A careful examination of the side view (Pl. XXX. fig. 1), the upper view (fig. 3), and the transverse section (fig. 2) will render this statement intelligible.

In the first, the atrial tunic is seen to be reflected over the posterior face of the stomach and first part of the intestine, and then to form the roof and the floor of the cavity, which lies between the intestine and the atrial aperture, and which I shall term the *mid-atrium*. In fig. 3, the atrial tunic is shown to be continued forwards at the sides of the intestinal canal on to the pharynx, united with which, it forms the branchial sac. Arrived close behind the peripharyngeal ridge, it is reflected on to the external tunic, and then passes directly backwards to the atrial aperture. The testis and ovisac, which are seen, in this view, over the alimentary canal, lie altogether above the roof of the mid-atrium (fig. 1), and therefore do not in any way interfere with the free and wide communication of the mid-atrium with the two spaces, or *lateral atria*, which lie between the branchial sac and the body-wall, and are well shown in the transverse and vertical section (fig. 2). Both in this section and in fig. 3, short cords are seen to pass between the parietal and the visceral layers of the lateral atria. They are hollow, and place the parietal sinuses in communication with those of the branchial sac.

It follows from what has been said that the wall of the *branchial sac* of *Pyrosoma* (and, I may add, of all Ascidians with a similar respiratory apparatus) consists, internally, of that portion of the alimentary tract which lies in front of the œsophagus and behind the mouth (or, in other words, of the pharynx), and, externally, of the visceral layer of the atrial tunic. Now, these two membranes do not remain entirely separated by the interposed sinus, but are united at regular intervals, so as to give rise to hollow *vertical bars* separated by equally long vertical clefts—the *branchial stigmata*.

Of these stigmata there are about thirty on each side. The most anterior and the most posterior ones are shorter than the others. Anteriorly, in fact, the first is not more than one-third or one-fourth, or even less, as long as the vertical height of the branchial sac. The stigmata, however, increase in length up to the sixth, and then acquire nearly the height of the sac, so as to leave only a small imperforate space on each side of the languets, on the neural side, and of the endostyle, on the hæmal side. Posteriorly the last four or five also gradually diminish, until the hindmost of all is not larger than the foremost.

The vertical bars bounding the stigmata are fringed by a single series of elongated corpuscles, each of which bears a row of long cilia, and (in the dead state, at any rate) all these cilia project outwards into the lateral atria *.

* In the living condition, as Milne-Edwards has hinted, and as I have shown in my memoir (*l. c.* p. 583), the cilia upon opposite sides of a branchial stigma move in opposite directions.

The branchial stigmata just described are subdivided into quadrate meshes by some fifteen *longitudinal bars* which lie altogether on the inner side of the vertical ones, to which they are attached by their outer edges, projecting like so many narrow shelves into the pharyngeal cavity, and, as I observed in my earlier memoir on this animal*, are devoid of cilia. They terminate abruptly at their anterior and posterior ends, and they do not exhibit the small denticulations along their free edges which I have described in *P. atlanticum.* The water taken in by the oral aperture must pass with perfect ease through these meshes, and then, impelled by the cilia on the vertical branchial bars, make its way through the lateral atria and, on each side of the intestine, to the mid-atrium, whence it finds an exit by the atrial aperture.

As to the proper *digestive canal*, the wide aperture of the œsophagus lies at the posterior, neural, angle of the pharyngo-branchial sac, and has an irregular figure; but whether this irregularity is normal, or arises from the collapse of its walls after death, I cannot say. The œsophagus narrows as it passes back, and then curves sharply round towards the hæmal side, to open, after a very short course, into the large oval stomach, which lies immediately behind the middle of the branchial sac, invested, everywhere but in front, by the atrial tunic, and bathed in the blood which lies between it and that tunic. At its pyloric end it gives rise to the narrow commencement of the intestine, which, after suddenly dilating and turning forwards and to the hæmal side, bends back sharply upon itself, and passing backwards to the neural side and to the right, ends opposite the middle of the stomach in the abruptly truncated anus, which opens into the atrium.

In my memoirs on *Salpa*, *Pyrosoma*, and *Doliolum*, already referred to, I have described, in all these genera, a remarkable system of fine transparent tubes which ramify over the intestine, and eventually open by a single duct into the stomach. I have asked (*l. c.* p. 570), does this *tubular system* represent a hepatic organ? or is it not more probably a sort of rudimentary lacteal system—a means of straining off the nutritive juices from the stomach into the blood by which these tubes are bathed? In *Pyrosoma giganteum* the duct of the system is very obvious, opening into the stomach in front of the origin of the intestine, and somewhat enlarged at its opposite end.

Krohn has described the structure and development of a similar system of tubuli in *Phallusia*†, and I have since ‡ found an organ of the same nature in *Phallusia*, *Cynthia*, *Molgula*, *Perophora*, *Botryllus*, *Botrylloides*, *Clavelina*, *Aplidium*, *Didemnum*, and, indeed, in all genera of Ascidians which have come under my notice, except *Appendicularia*. In some species of *Didemnum*, I have observed that the duct dilates almost at once into a large spheroidal sac. I suspect that Savigny was the original discoverer of this system (see his memoir on *Diazona*, *l. c.* p. 176, and the description of pl. 12). The existence of these tubuli in *Salpa*, *Doliolum*, and *Pyrosoma* has been confirmed by all subsequent observers. M. Vogt, however (*l. c.* p. 31), affirms that the organ consists of solid branches, and that it partakes of the nature of a muscular organ, in neither of which opinions can I possibly concur. I have no doubt whatever that the apparatus is a glandular organ, and that it performs a part, at any rate, of the functions of a liver.

* *Loc. cit.* pl. 17. fig. 3, and p. 583, line 4, where the word 'sinus' should be 'ones.'

† "Ueber die Entwickelung der Ascidien," Müller's Archiv, 1852, p. 331.

‡ See Reports of the British Association, 1852.

The *vascular system* of *Pyrosoma* is exceedingly simple; nor could we anywhere find a more convincing example of the validity (in some cases, at any rate) of Milne-Edwards's views of the circulation in the Mollusca than is offered by this animal. The heart lies close to, and apparently connected with, the right side of the posterior and hæmal wall of the pharynx, between the endostyle and the bend of the intestine; and it appears to have exactly the same structure as in *P. atlanticum*. There are no vessels, the whole interspace between the inner tunic and the outer, or between these and the atrial tunic, being one vast blood-sinus, with which the canals in the branchial bars communicate at each end. I have spoken of the hæmal and of the hypopharyngeal sinuses merely as a matter of convenience; in point of fact, the general blood-cavity is not naturally divided into distinct sinuses*.

The *nervous system* consists, as in *Pyrosoma atlanticum*, of a single ganglion, of an oval shape when viewed sideways, but somewhat heart-shaped when seen from above, its narrower end being turned backwards. It is about $\frac{1}{126}$th of an inch long, and is composed of a dark granular mass invested by a delicate structureless membrane. It lies between the inner and outer tunics, the former being raised, so as to form a slight protuberance over it. On the posterior half of this protuberance lies the broad lower median portion of the peripharyngeal ridge. In its anterior half, the opening of the ciliated sac appears. The principal nerves given off from the ganglion are the following. Two, a smaller internal and a larger external, pass from the antero-lateral parts of the ganglion, forwards towards the oral aperture, branching as they go. I suspect that a nerve runs up on each side, beneath the peripharyngeal ridge; but I cannot make sure of the fact. A considerable nervous trunk is given off to the postero-lateral walls of the body; and, finally, two delicate trunks arise posteriorly, one on each side of the middle line, which run back, so as to have the languets between them, and passing up at the sides of the œsophageal aperture, are lost under the divisions of the posterior epipharyngeal ridge.

In *Pyrosoma atlanticum* I observed a mass of deep-red otoliths in contact with the posterior end of the ganglion (*l. c.* p. 583), but no such structures are discernible in the present species. The *ciliated sac* ('tubercule antérieur' of Savigny)—an organ of universal occurrence among Ascidians—is in *Pyrosoma giganteum* an elongated, laterally compressed,

* I have described the circulatory system of *Salpa* in similar terms to these, in my memoir on *Salpa* and *Pyrosoma*, and notwithstanding the criticism my statements have received both from M. Vogt and Prof. Leuckart, I must maintain their correctness. M. Vogt affirms that I have committed 'a grave error' in declaring the blood-canals of *Salpa* to be lacunæ between the two layers of the mantle,—apparently supposing that I mean thereby the test and the external tunic, and forgetting my careful discrimination of test, outer tunic and inner tunic, at p. 585 of the memoir cited. In fact, nothing can be easier than to observe the entire distinctness of the inner and outer tunics in a bud or embryo of *Salpa* or *Pyrosoma*—to see that the viscera and blood-canals do really lie between these tunics, and that they are by no means, as M. Vogt states, lodged in cavities excavated in the 'inner mantle.' Prof. Leuckart has equally mistaken my meaning when (*l. c.* p. 14) he ascribes to me a participation in Eschricht's opinion as to the existence of a serous sac surrounding the body of *Salpa*. My words in the passage cited by Prof. Leuckart are, "In very young *Salpæ*, this space [the interval between the inner and outer tunics] is like the cavity of a serous sac." Still less can I find in my memoir any such opinions as those ascribed to me in the note to p. 43 of Prof. Leuckart's valuable memoir. While on the subject of errors, however, I am glad to take the opportunity of pointing out that several statements made at second-hand in my memoir, regarding Ascidians other than those specially described, are incorrect. The diagram of *Pelonaia* (pl. 19), again, is altogether erroneous—this Ascidian differing, as I have since found, in no essential respect from *Cynthia*.

funnel-shaped bag, about $\frac{1}{100}$th of an inch long, which lies in the sinus, and, passing obliquely forwards and towards the hæmal side, opens as above described. Its aperture has somewhat prominent lips, and is rather narrower than its upper portion. The posterior end of the sac appears to terminate cæcally, and is applied against the posterior surface of the ganglion. The middle of the hæmal side of the sac sometimes appears to be connected with a spheroidal tubercle, whose axis forms nearly a right angle with that of the sac.

The muscular system is exceedingly simple in this species of *Pyrosoma*, consisting, besides the oral sphincter and buccal muscles already mentioned, of only an atrial sphincter and the 'mid-atrial' muscles.

The atrial aperture (fig. 7) is even smaller than the oral, not measuring more than from $\frac{1}{800}$th to $\frac{1}{500}$th of an inch in diameter. Radiating striæ diverge from its margin on the surface of the test, which, as at the oral aperture, forms a thick lip, and is continued for some little distance inwards upon the wall of the mid-atrium. A sphincter formed of pale smooth fibres, and constituting a circular band $\frac{1}{168}$th of an inch in diameter, is developed at the junction of the external and atrial tunics. There is a similar but less distinct appearance of radiating fibres to that exhibited at the oral sphincter.

The mid-atrial muscles ($\mathring{g}$ 2) are broad flat bands of smooth muscular fibres, which lie in close contact with, and apparently attached to, the atrial tunic. One of these bands occupies about the middle two-fourths of the height of each lateral wall of the mid-atrium, and has a direction perpendicular to the axis of the ascidiozooid. The bundle of fibres spreads out a little at each end, and then seems to be inserted by a sort of tendon into the outer tunic. Close to this tendinous insertion, at either end, a bundle of fibres (whether merely fibrous or muscular I cannot say) arises, and passes, partly to the nearest similar insertion of one of the mid-atrial muscles of the ascidiozooid above or below, partly to the same point of the mid-atrial muscle of some other ascidiozooid. Hence, when the wall of the ascidiarium is viewed from within, it presents such an interlacement of fibres as that exhibited in fig. 9.

These muscles, in contracting, must tend to diminish the capacity of the atrium of the ascidiozooid to which they belong, and, if they all act together, to shorten and narrow the ascidiarium. I do not suppose that their effect in the latter direction can be very great; but it might well be sufficient to account for the slight contraction of the whole ascidiarium, and consequent retrogressive motion, observed by Péron and others.

In my previous memoir, I have pointed out that the round, granular, yellowish patches on each side of the entrance of the branchial sac, and opposite the middle of the peripharyngeal ridge, are not, as Savigny imagined, the ovaries. I am greatly inclined to regard them as renal organs, but for the present defer the discussion of their structure and functions.

The reproductive organs of each ascidiozooid of *Pyrosoma* may be divided into actual and potential—the *genitalia* of the ascidiozooid itself, and the blastema whence the genitalia of its buds will take their origin. I shall call this last the generative blastema; while the genitalia proper are divisible, as I have already pointed out, into a single ovisac and a single testis. Both ovisac and testis are situated in the left five-sixths of the roof of the mid-atrium; but the testis is to the right, the ovisac to the left. The size of both these organs has a definite relation to the age and advancement in development of the ascidiozooid in which they occur, being larger and more advanced as it is older and nearer perfection. Hence the early stages of both ovisac and testis can only be observed in buds and young ascidiozooids. The generative blastema will be most conveniently considered in connexion with the process of gemmation and in describing the most advanced condition of the fœtus. The description of the ovisac will form the most fitting commencement of the history of sexual propagation in *Pyrosoma* (§ 3); all that remains, therefore, is to give in this place some account of the structure of the testis and of the character of its products.

The testis lies in the hæmal sinus above the mid-atrium, and on the right side of the ovisac. It consists of about a dozen cylindroidal cæca, free at their neural ends, but connected at their hæmal extremity with the dilated upper end of a vas deferens, which passes directly to the neural side and somewhat backwards, to open by a slightly raised papilla on the roof of the mid-atrium. The cæca are $\frac{1}{50}$th of an inch long, or thereabouts. Each consists of a delicate structureless membrana propria investing an aggregation of spheroidal corpuscles about $\frac{1}{4000}$th of an inch in diameter. Near the attached end of each cæcum the rod-like heads of the spermatozoa become visible, and gradually take the place of the spheroidal cells. The duct has the same structure as the cæca. It presents an upper and a middle dilatation, but is not more than $\frac{1}{760}$th of an inch wide at its termination. The middle dilatation is usually full of closely packed spermatozoa.

The structure which has been described is characteristic of any of the fully-formed ascidiozooids in the middle of the ascidiarium, or towards its apical end, in which regions the number of such ascidiozooids bears a large ratio to the total.

But towards the open end of the ascidiarium fully-formed ascidiozooids become scarcer and scarcer, until, close to the inflected cloacal lip, none are discernible. On the other hand, all those ascidiozooids which are to be found in this region possess an appendage which is not to be discovered in the others, in the shape of a long tubular diverticulum of the external tunic, or stolon, which extends from the neural side of the body, behind the œsophageal aperture, into the lip of the cloaca, at whose free edge it ends in a cæcum. The walls of these diverticula, composed of the external tunic only, exhibit strongly marked parallel longitudinal striæ, as if they were composed of muscular fibrillæ*.

The test.—The common integument, or test, in which all the ascidiozooids are enclosed, appears to the naked eye to be quite glassy and homogeneous; but when thin sections taken in various directions are submitted to the microscope, it is found to possess marked structural peculiarities. Dispersed through its general substance are numerous cells with radiating processes, like connective-tissue corpuscles, and containing a central endo-

* Savigny has figured these stolon-like diverticula in his pl. 22. fig. 1, 1, and he speaks of them in the "Système des Ascidies," p. 208, where, in characterizing the test of *Pyrosoma giganteum*, he says that it generally presents few vessels, "except in the diaphragm of the opening." He appears not to have been acquainted with the origin of these "vessels." In describing his variety *c* of this species, he states (*suprà*) that the opening was surrounded by animals which were almost all adult.

plast or nucleus. The cells measure on an average $\frac{1}{4000}$th of an inch in diameter; and their processes become very fine before they are lost in the surrounding nearly homogeneous matrix. In two regions this general structure is departed from. At the cloacal wall of the test, there lies immediately beneath the surface a thin film of reticulated tissue, consisting of cells similar in their essential structure to those just described, but set more closely, more granular, elongated, and united together by the coalescence of their processes. Again, in a plane which would correspond with the peripharyngeal ridges of the ascidiozooids, and therefore near the outer surface, the test exhibits a very faint longitudinal striation, as if it were fibrillated.

There is no distinct epidermic layer on either face of the test. The corpuscles are, as usual, stained dark yellowish brown by iodine; while the matrix yields, though weakly, the characteristic reaction of cellulose.

§ 3. *The Agamogenesis by Gemmation of* PYROSOMA GIGANTEUM.

Throughout the whole extent of the ascidiarium, the number of ascidiozooids appears to be undergoing a constant increase, by the development of buds from those which already exist; at least, I have not yet met with any adult ascidiozooids devoid of a more or less advanced appendage of this kind. Gemmation always takes place from that part of the middle of the hæmal side of the body of the ascidiozooid, which lies opposite the bend of the intestine and between the posterior extremity of the endostyle and the reproductive organs. At first, therefore, the bud is situated near the posterior or cloacal end of the body, and on the same side as the closed apex of the ascidiarium.

Gemmation does not take place in *Pyrosoma*, as in so many of the lower animals (*e. g.* the *Hydrozoa* and *Polyzoa*, or *Salpa* and *Clavelina* among the Ascidians), by the outgrowth of a process of the body-wall whose primarily wholly indifferent parietes become differentiated into the organs of the bud, but, from the first, several components, derived from as many distinct parts of the parental organism, are distinguishable in it, and each component is the source of certain parts of the new being, and of these only. Thus the body-wall or external tunic of the parent gives rise to the external tunic of the bud; while a process of the endostylic cone of the parent is evolved into the alimentary tract of the bud, and the reproductive organs of the latter are furnished by a part of that tissue whence the reproductive organs of the parent took their origin.

Pl. XXX. fig. 14 represents the condition of what I may term the gemmiparous region of the body in a young ascidiozooid, in which no distinct trace of a bud is discernible externally. The outer tunic, it will be observed, passes evenly backwards, and has the same structure in the situation of the future bud as elsewhere. The endostyle is continued upwards and backwards as a cellular cord, which contains a cavity continuous with the groove of the endostyle, is about $\frac{1}{1200}$th of an inch thick, and is rounded-off at its extremity. From this a thin sheet of indifferent tissue is continued downwards and backwards, so that its plane forms nearly a right angle with the direction of the end of the endostyle, and suddenly thickens to $\frac{1}{740}$th of an inch. After this it tapers off gradually to its extremity, which lies free in the cavity of the blood-sinus, at a distance of $\frac{1}{130}$th of an inch from the ovisac of the ascidiozooid, which is $\frac{1}{210}$th of an inch in diameter, and so far advanced that there can be no question as to its real nature. The total length of this mass (which, for reasons which will shortly appear more fully, I have termed the *generative blastema*) is $\frac{1}{152}$nd of an inch; and for the greater part of its extent it has the character of indifferent tissue. But the sudden enlargement to which I have referred is occupied by a body which has all the characters of an ovum, consisting of a structureless yelk $\frac{1}{640}$th of an inch in diameter, and of a clear germinal vesicle ($\frac{1}{1200}$th), enclosed in which is a germinal spot ($\frac{1}{4800}$th). It will appear by-and-by that this is, in fact, the solitary ovum (surrounded by its rudimentary ovisac) which will come to maturity in the bud to be formed at this spot; and it is not a little remarkable that the first recognizable part of the new organism should be the foundation of that structure which will eventually develope into a creature distinct from it.

In fig. 15 a more advanced condition of a bud is depicted: the backward continuation of the endostylic cone is broader, more distinctly hollow, and is so bent up as to form a more acute angle, both with the line of direction of the endostyle and with the plane of the generative blastema. In consequence of this change, and of the general enlargement of the parts, they can no longer be contained within the blood-sinus, whose outer wall is now elevated into a conical cap which fits over the conjoined ends of the process of the endostyle and the generative blastema. That part of the external tunic which constitutes this cap is thickened, and exhibits the texture of indifferent tissue. The ovum in the generative blastema is now very distinct, and the tissue around it is so disposed as to mark out the walls of an ovisac which measures $\frac{1}{480}$th of an inch in diameter. The clear germinal vesicle measures $\frac{1}{800}$th of an inch; and its spot has the same diameter as before. Behind the ovisac, which occupies the greater part of the cavity of the diverticulum constituting the bud, a distinct constriction marks off the rest of the generative blastema, which lies closely connected with the external tunic of the parent, and altogether excluded from the cavity of the "cap" of the nascent bud. It is now no longer taper, but cylindrical and rounded at the end; and near its anterior extremity a new germinal spot, surrounded by a small clear vesicle, is visible.

Fig. 16 represents a bud $\frac{1}{320}$th of an inch broad by $\frac{1}{480}$th of an inch high. The process of the endostylic cone is very distinctly hollow and somewhat thin-walled, while its axis is nearly parallel with that of the bud. In fig. 17, the bud, now subcylindrical, has increased in length to $\frac{1}{192}$nd of an inch; and the front view of a similar bud, given in fig. 18, shows that the hollow process of the endostylic cone is slightly constricted in the middle, and that the interval between its walls and the external tunic is occupied by a granular mass.

In fig. 19, a marked advance is discernible. The bud is distinguishable into a body or rudimentary ascidiozooid $\frac{1}{112}$th of an inch long, and a much shorter stalk or peduncle. The ascidiozooid is broad at its attached end, more or less tapering at its opposite extremity. Its external tunic is distinct, but proportionably thinner than before, and is continued into the outer wall of the peduncle and thence into the external tunic of the parent. The hollow process of the endostylic cone is about as broad as before, in the peduncle; but after traversing this, nearer its anterior than its posterior side, it suddenly dilates into a pyriform sac, somewhat similar in contour to the rudimentary ascidiozooid itself. The upper taper end of this sac seems to be attached to the inner surface of the apex of the outer tunic of the ascidiozooid. Anteriorly and posteriorly, its walls appear thick, the enlargement being much more marked posteriorly. The side of the sac turned towards the eye, between these thickenings, exhibits five faint rings, with comparatively clear centres. In order to avoid circumlocution, I may so far anticipate the results yielded by the investigation of later stages of the buds, as to state the nature of the parts which have now been described. The rings are the indications of the commencement of as many branchial stigmata; the anterior apparent thickening is the result of the formation of the rudiment of the endostyle; the posterior apparent thickening is produced by the rudiment of all that part of the alimentary tract which lies behind the branchial sac, into which almost the whole of the dilated end of the prolongation of the endostylic cone is converted. A comparatively clear space surrounds the apex of the branchial sac, below which the inner surface of the external tunic presents a band-like aggregation of indifferent tissue, the rudiment of a body which corresponds with what Krohn has called the elæoblast in the *Salpæ*; and finally, projecting from the posterior wall of the external tunic, and apparently connected with the elæoblast, is an elongated mass, the anterior portion of the generative blastema, which has now become completely separated from the posterior part. The anterior end of the latter, in fact, extends only into the peduncle, while its posterior moiety lies, attached to the outer tunic of the parent, in the great hæmal blood-sinus. The generative blastema may therefore be now distinguished into three parts—parental, peduncular, and gemmular,—of which the two former remain connected, until a new bud is developed in the distal end of the peduncle, while the latter, now contained wholly within the bud, and separated from the others by a considerable interval, is itself divisible into three portions. The first of these is the ovum, or rather ovisac, larger and more distinct than in the last-mentioned stage; the second is that part of the blastema near this, which will become the testis, but which, at present, has no definite form; and the third is represented by a slender band of indifferent tissue continued up to the apex of the branchial sac (the future extremity of the endostylic cone) which is the generative blastema of the nascent ascidiozooid and will supply reproductive organs to its buds. The interspace between the branchial sac and the outer tunic of the bud is in free communication with the blood-sinus of the parent, by means of the interval between the endostylic cone and the wall of the peduncle; and, in fact, this interspace is itself the foundation of all the blood-sinuses of the bud.

This is as much as can be clearly made out from the inspection of side views of buds in this and earlier stages; but much additional information is to be gained from other views of similar buds. Fig. 26 exemplifies the appearances yielded by a bud about $\frac{1}{192}$nd of an inch in diameter, when seen from above.

The transverse section of the wide sac-like prolongation of the endostyle thus presented to the eye is four-sided; the lateral and posterior walls are concave, while the middle of the anterior wall is produced into a sort of fold; so that the contour of the sac may be compared to that of a crown. Masses of indifferent tissue fill the interspace between the concavity of the lateral wall of the sac and the sides of the external tunic, while the interval between the posterior wall and the hinder part of the external tunic is nearly filled up by the young ovisac. Fig. 27 represents an advance upon this condition,—the two principal changes to be noted being, first, the conversion of the lateral masses of indifferent tissue into hollow oval bodies containing a very small cavity, and, secondly, the prolongation of the posterior cornua of the alimentary sac.

It is obvious that if either of these buds were viewed sideways, the middle fold of the anterior face of the sac would appear like an anterior thickening, while the posterior prolonged cornua would simulate a posterior enlargement, and the whole would closely resemble fig. 19; and it now becomes important to prove, by the study of more advanced stages, the nature of the sac, of its anterior median fold, of its posterior cornua, and afterwards of the lateral sacs. Fig. 28 represents a larger bud, which presents more of its anterior, than of its upper, aspect to the eye. The anterior fold, consequently, is represented by only two dark streaks with a clear interval. The posterior cornua are more elongated than before. There is a rounded opake spot at the anterior end of the bud. In fig. 29, the dark streaks have become the middle bands of the endostyle; the anterior spot is obviously the nascent oral aperture; while the posterior cornua have become separated from the rest of the cavity of the sac, communicating with it by only a small aperture. The cornua are, at present, of equal size; but in fig. 30 the left cornu exhibits a trihedral dilatation, which is obviously the commencement of the stomach, while the right cornu and the part which joins it with the left have become, the latter the foundation of the arch of the intestine, and the former of the rectum. There can be no doubt, therefore, that the greater part of the sac into which the prolongation of the endostyle is developed becomes what would in other animals be called the pharynx, namely, that portion of the alimentary canal which lies between the œsophagus and the mouth*.

Side views, such as those given in figs. 20 & 21, of buds, in similar stages of development, are equally instructive. The attached apex of the sac is seen to become the posterior end, or cone, of the endostyle. The small size of the gastro-intestinal, in proportion to the pharyngeal portion of the alimentary tract, and the free communication of the latter with the prolongation of the endostylic cone of the parent, which traverses the peduncle, are clearly seen; and I entertain no doubt that, by means of the last-mentioned communication, the cavity of the pharynx (or, as we shall see it becomes, that of the branchial sac of the bud) is placed in communication with that of the parent. In favourable lateral views of buds in this stage, it is easily made out that the wall of the pharynx unites with the external tunic at its anterior end, and here gives rise to the oral aperture, whose tentacular fringe is only subsequently developed.

Having traced the fate of the sac-like dilatation of the prolonged portion of the endostyle thus far, I will now direct the attention of the reader to the coincident progress of the lateral sacs, or oval hollow bodies, as I previously termed them. In fig. 27 they are very small and thick-walled; in fig. 28 their cavity is larger, their walls are proportionally thinner,

* The development of the Ascidian pharynx, as traced out by Krohn in *Phallusia*, and by myself in the present memoir, appears to me to afford ample demonstration of the justice of Milne-Edwards's view, that the branchial sac of the Ascidian is the homologue of the pharynx of the Polyzoon. It is due to my friend Prof. Allman, however, to refer to what he has said in support of another theory, in his able essay "On the Homology of the Organs of the *Tunicata* and the *Polyzoa*," Transactions of the Royal Irish Academy, vol. xxii.

and the sacs themselves are both absolutely and relatively larger. In fig. 29 they are very much larger and thinner, and their relations to other organs are especially worthy of attention. The outer layer of each is applied to the outer tunic of its side, leaving a small interspace, which communicates freely with the great posterior sinus, in which the intestine and genitalia are disposed, and with the anterior sinuses which lie between the pharyngeal wall and the external tunic. This interspace is, in fact, the parietal sinus. The internal layer, continuous with the outer anteriorly and posteriorly, but separated from it by a wide chamber for the rest of its length, is applied against the wall of the pharynx for four-fifths of the extent of the latter, and then coats the lateral portions of the gastro-intestinal tract, forming the antero-lateral boundary of the great posterior sinus. The space between the wall of the pharynx and the inner layer of the sac communicates anteriorly with the anterior sinuses, posteriorly with the posterior sinuses, and it is interrupted at several points by the union of the pharynx and inner layer with one another. It represents the system of branchial sinuses.

In side views it is not easy to make out the boundaries of the lateral sacs; but it is most important to observe that, as has been already mentioned, in the middle of the lateral face of the pharynx, and, therefore, also in the middle of the lateral face of the inner wall of the sac, a series of opake rings with clearer centres, the rudiments of the branchial stigmata, make their appearance (figs. 19 and 20). These correspond with the points of union of the pharynx and the inner wall of the sac. They are, at first, small, round, and very indistinct, but, by degrees, they elongate in a direction perpendicular to the long axis of the pharynx, and their real nature becomes apparent. Hence it is clear that these stigmata must eventually open into the lateral sacs, as indeed they may be seen to do in such buds as that represented in fig. 30; and hence also it follows, that the lateral sacs are the rudiments of the lateral atria.

At first the lateral atria appear to be perfectly distinct from one another, and no atrial aperture is discernible. In buds such as that represented in fig. 29, again, they do not extend, posteriorly, further than the sides of the alimentary canal; but in more advanced buds (fig. 30) they are produced backwards on each side until they pass beyond the level of the posterior margin of the stomach, so that they now constitute the entire lateral boundaries of the great posterior sinus. The longitudinal section (fig. 21) of a somewhat smaller bud than that represented in fig. 30 shows, however, that, in this condition, the atria are no longer distinct, but are united together below the stomach by a comparatively narrow and short canal (p), which is the mid-atrium.

I have not traced out all the details of the process of coalescence of the lateral atria; but I suppose that each branchio-parietal portion of the atrium, at first a distinct sac, is prolonged downwards and inwards, under the stomach, and that the opposed walls of the prolongation become applied to one another, coalesce, and then become perforated. At any rate, the mid-atrium is now surrounded by a membranous wall, continuous on all sides with the lining of the lateral atria, and applied superiorly and anteriorly against the stomach and œsophagus, posteriorly and inferiorly against the external tunic, but not touching either of these parts, except for a small space on the floor of its chamber, where it becomes united with the external tunic to allow of the formation of the atrial aperture.

In the present bud (fig. 21) this aperture is situated on the neural side of the body, in front of the posterior end, which is chiefly occupied by the genitalia; but as development goes on, the mid-atrium increases disproportionately, and encroaches upon the other organs, upwards and forwards, in such a manner that its anterior wall invests the whole posterior and lateral faces of the gastro-intestinal division of the alimentary canal; while its roof (to speak metaphorically) thrusts the genitalia altogether into the hæmal region of the body, and its posterior and inferior walls, extending backwards, carry the external tunic with them, and eventually cause the atrial aperture to take its place at that extremity of the body which is directly opposed to the mouth, and far behind the genitalia (see figs. 22–25).

The communicating apertures between the mid-atrium and the lateral atria increase in size *pari passu* with the growth of the parts; and hence, in the fully formed ascidiozooid, the gastro-intestinal division of the alimentary canal is enclosed in a sort of vertical mesentery (formed by the anterior wall of the mid-atrium in the middle line, and the internal wall of the lateral atria at the sides), whose layers are continued, on either hand, into the outer wall of the branchial sac. At the anterior boundary of the branchial sac they are reflected into the outer or parietal layer of the lateral atrium.

The facts which I have detailed * are exceedingly important for the comprehension of Ascidian structure in general. From its mode of development, it is perfectly obvious that the inner wall of the branchial sac of *Pyrosoma* is not composed of tentacles which have coalesced, but that it is, originally, a simple imperforate dilatation of the pharyngeal portion of the alimentary canal. The development of the atrium adds a second or outer wall to this dilatation; and when, by the formation of this double wall, the branchial sac is constituted, the stigmata make their appearance in its parietes—the atrial and the pharyngeal walls becoming united around the margins of each stigma.

When a bud has attained a length of between $\frac{1}{17}$th and $\frac{1}{38}$th of an inch, the narrow neck connecting it with the peduncle is obliterated, and it lies free in the general test of the parent ascidiarium. It next elongates until its oral and atrial apertures are placed in connexion with the exterior and the cloaca respectively (the latter connexion appearing to be effected first), and then it increases in depth until it acquires the appearance of the adult. Before it is detached, however, the portion of the peduncle nearest it enlarges and assumes the shape of a new bud; so that the proximal end of the peduncle now passes into a small bud with whose apex a larger one is connected (fig. 22). And I suspect that this process is repeated as long as there is any reserve of generative blastema in the parental organism. I have, however, never actually seen more than two buds thus connected together. As the buds are all developed from the hæmal region of the pre-existing ascidiozooids, it follows that the new ascidiozooids formed by gemmation must at first be thrust among the old ones, towards the apical end of the ascidiarium.

So much in elucidation of the mode in which the buds attain the form and general arrangement of organs characteristic of the adult. I now proceed to speak of such among the minor changes which these organs undergo as call for particular remark.

* The accurate Krohn, in his account of the development of *Phallusia* (Müller's "Archiv," 1852), was the first to note the separate origin and subsequent confluence of the lateral atria. In this genus, however, each lateral atrium has, at first, a distinct external aperture.

Of the outer tunic all that requires to be said is, that it becomes relatively thinner as development goes on. In buds which are situated within a certain distance of the open end of the ascidiarium, and which have attained a length of $\frac{1}{17}$th of an inch (fig. 24), the outer tunic of the neural wall of the atrium is raised into a slight rounded projection (r^2), and in older buds (fig. 25) this gradually elongates, and extending towards the open end of the ascidiarium, and finally into the lip of the cloacal aperture, becomes converted into one of the stolons of the test.

The atrial muscular bands are visible in buds not more than $\frac{1}{30}$th of an inch in length (fig. 23); the pharyngeal muscular bands, only in more advanced zooids.

The tentacular fringe appears first as an inward thickening of the parietes of the mouth. The hæmal tentacle is markedly the longer, even in such buds as that represented in fig. 24. The ganglion is discernible in buds $\frac{1}{70}$th of an inch long (fig. 20) as an opake oval mass situated between the peduncle and the oral end of the bud, and very much larger in proportion to the rest of the organism than afterwards. The ciliated sac appears as a short cæcal diverticulum of the pharyngeal cavity, connected with the anterior and hæmal side of the ganglion.

A most curious structure is visible in buds $\frac{1}{70}$th of an inch long, and remains obvious until they have attained a length of $\frac{1}{20}$th of an inch or thereabouts. For want of a better name, I will term this the 'diapharyngeal band.' In the section, fig. 21, its upper part is visible, passing obliquely downwards and backwards from between the two middle bands of the endostyle; while, in figs. 22 & 23, its lower extremity is seen to end in the pharynx, immediately over the posterior moiety of the ganglion. The diapharyngeal band is hollow, and effects a communication between the hæmal and neural sinuses; and if, as is possible, the heart of the bud has at this period but little functional activity, the existence of this direct channel may facilitate the circulation of the blood. However this may be, this structure becomes longer and thinner as the development of the bud advances; and all that remains of it, in buds $\frac{1}{17}$th of an inch long (fig. 24), is a small tubercle which lies over the posterior part of the ganglion. Eventually even this disappears.

I have already spoken of the origin of the branchial stigmata. Fig. 21 represents an accidental, but very fortunate, longitudinal section of a bud $\frac{1}{70}$th of an inch long; the razor having passed rather to the right of the middle line above, rather to the left below. As it is seen from the right side, the inner surface of the left wall of the branchial sac is exposed to view. Of the eleven stigmata, those in the middle are the longest and most oval, those at the two ends of the series shortest and most rounded. They look clear in the centre, but on careful examination they are seen to be closed, the sheet of indifferent tissue which forms the innermost wall of the pharynx being continued over them. I am strongly inclined to think that it is this sheet of indifferent tissue which gives rise to the longitudinal branchial bars, for in more advanced buds (fig. 22), in which the median stigmata have undergone much elongation, the same layer is continued over their hæmal and neural ends, while it has disappeared in the interval, except along three longitudinal lines, where it evidently forms the foundatiom of as many longitudinal branchial bars. In the more advanced stages, new stigmata are added to the anterior and posterior ends of the series. Those already formed elongate, and new longitudinal bars are added, until the walls of the branchial sac assume their perfect form*.

As I have explained, the sac-like alimentary tract originally ends in a conical point at that extremity which is opposite its oral end; and this cone is connected with the external tunic. In subsequent stages the cone remains distinct, being directed at an obtuse angle to the rest of the hæmal wall of the pharynx, while the cellular bands which eventually render the endostyle so conspicuous, cease at its base. It, at first, communicates by its widely open base with the pharyngeal or branchial cavity; but as development proceeds, it becomes narrower, in proportion to the endostyle, and at length is represented by that slender backward prolongation of the endostyle or 'endostylic cone' described at the commencement of this memoir and represented in fig. 14.

The languets do not appear till development has advanced a long way; in fact, in the very young buds there is no room for them, as almost all the space between the place of the commencement of the œsophagus and the place of the ganglion, is occupied by the aperture of communication between the prolongation of the endostylic cone and the pharynx. As growth proceeds, the distance between the ganglion and the œsophageal aperture gradually increases, both absolutely and relatively, and in buds $\frac{1}{30}$th of an inch long, one or two small tubercles are visible, projecting from the hypopharyngeal band, between the œsophageal aperture and that of the canal which traverses the prolongation of the endostylic cone. These gradually increase in number, elongate, and assume their adult shape and size (figs. 24, 25).

The figures will sufficiently explain the further changes of form undergone by the gastro-intestinal portion of the alimentary canal.

The hepatic tubular system makes its appearance in such buds as that represented in fig. 22, as a minute diverticulum of the stomach, which elongates, applies itself to the intestine and ramifies over it. Krohn (*l. c.* p. 331) saw it originate in a similar manner in *Phallusia*.

The heart, similar to that of the adult in form and texture, is distinctly discernible in buds not more than $\frac{1}{30}$th of an inch long, attached, in its ordinary position, to the wall of the pharynx, just in front of the bend of the intestine, between it and the endostylic cone. I have not been able to trace out the first condition of this organ and the changes which it undergoes in acquiring the state now described.

The renal organs are plainly visible in buds not more than $\frac{1}{50}$th of an inch long as aggregations of clear, round, almost colourless corpuscles, between the atrial and the outer tunic.

In describing the first stage of the bud (fig. 14), I have spoken of a thin layer of indifferent tissue which passed from the end of the endostylic cone, or prolongation, into the generative blastema. In more advanced stages, this tissue forms a sort of hood over the

* Krohn (*l. c.* pp. 324 and 327) states that the stigmata of the embryo *Phallusia* make their appearance as round apertures; but he affirms that new ones are added, not only in front and behind, but in the neural and hæmal sides of the first formed series.

end of the saccular rudiment of the alimentary tract (figs. 15 and 16), and seems to be the means of connecting the end of that sac with the external tunic.

After a time, however, a clear space appears around the apex of the sac, and separates this connecting mass from the rest, which now, consequently, appears as a broad zone (*æ*) surrounding the sac below its apex, but above the uppermost of the branchial stigmata (fig. 19). This zone remains as a broad, thickish girdle of indifferent tissue, closely connected with the outer tunic externally and in front, and with the generative blastema behind, in buds of $\frac{1}{70}$th—$\frac{1}{50}$th of an inch long (figs. 21 and 22); but in larger zooids its tissue has undergone a great change, and it has become a transparent mass, through which ramified corpuscles, like connective-tissue corpuscles, appear scattered (fig. 23). In this condition it is exactly analogous to the structure termed elæoblast in the *Salpæ* by Krohn. Its bulk is now equal to a fifth or a sixth of that of the entire bud, but in subsequent stages (figs. 24, 25) it diminishes both absolutely and relatively in size and eventually it disappears.

In buds $\frac{1}{50}$th of an inch in diameter, the generative blastema remains in its primitive condition, except that it and the ovisac it contains, have increased in size. Its anterior pointed end is closely juxtaposed to the endostylic cone. In the zooid represented in fig. 23, which measured $\frac{1}{30}$th of an inch in length, the generative blastema has become divided into two parts, the smaller of which remains in close apposition to the endostylic cone, while the larger, retaining its connexion with the posterior and upper wall of the mid-atrium, becomes widely separated from the other. The interval between the two is occupied by the elæoblast. Even before the separation has taken place, the larger portion has become distinctly differentiated into two parts, the ovisac, on the left, separating itself from a rounded mass of indifferent tissue, on the right. This last is the rudiment of the testis. From rounded, it becomes pyriform, the narrowed neck of the pear remaining in connexion with the atrial wall, and eventually becoming metamorphosed into the vas deferens, while the broad end increases in size, and is directed more forwards as well as upwards.

In a bud $\frac{1}{17}$th of an inch long (fig. 24) the testis measures $\frac{1}{380}$th of an inch in length, while its broad end is above $\frac{1}{500}$th of an inch thick. The apex of the vas deferens already pushes a little eminence of the atrial tunic before it.

In a young ascidiozooid, somewhat more advanced than that represented in fig. 25, the vas deferens is $\frac{1}{380}$th of an inch in length, and is of nearly even diameter throughout, except at its upper end, where it is slightly dilated and plainly hollow. It is connected with the posterior part of the terminal enlargement, which is nearly $\frac{1}{200}$th of an inch thick, and is divided into three short lobes, each about $\frac{1}{500}$th of an inch thick. Like the previously existing pyriform enlargement, these rudimentary cæca are solid masses of indifferent tissue. Traces of a distinct membrana propria are discernible around each cæcum. In still larger ascidiozooids the number of cæca increases, and the whole organ becomes larger, until it assumes its adult form; and it is only when nearly in this condition, that spermatozoa are visible in the vas deferens and the adjacent parts of the cæca.

The development of the ovisac will be described below. At first both the testis and the ovisac have ample room within the sinus of the zooid in which they are lodged; but as they increase in size, the duct of the ovisac extending towards the neural side and forwards, and the duct of the testis extending towards the neural side and backwards, push the atrial tunic before them, so that their openings are eventually situated on slight papillary elevations. The principal portions of the two organs, on the other hand, consisting of the sac of the ovisac and the cæca of the testis, as they enlarge, pass into chambers in the test, which are formed for them by the recession of the outer tunic, and whose cavities, consequently, communicate freely with the hæmal blood-sinuses.

With respect to that part of the generative blastema which remains in connexion with the endostylic cone, one of its endoplasts or nuclei soon acquires a larger size, and becomes surrounded by a clear space, thus giving rise to a new germinal vesicle and spot, round which will eventually be formed the solitary ovum and ovisac of a new bud, developed from the zooid, whose origin has just been traced, in exactly the same way as itself has arisen.

Thus, if we start with a single ascidiozooid, it may give rise, to all appearance, to an indefinite succession of buds, by successive enlargements and detachments of the end of the peduncle of the first; and each bud thus developed carries within itself, in its generative blastema and endostylic cone, provision for an indefinite succession of other buds. It must be recollected, however, that while the tissue of the rudiments of the alimentary and reproductive systems of each bud is directly descended, with comparatively little alteration, from the blastoderm of the embryo *Pyrosoma*, yet this tissue cannot be said to be embryonic; the tissue of the endostylic cone being considerably differentiated, while the outer tunic of each bud is derived from the still more modified outer tunic of the parent ascidiozooid. These facts, therefore, lend no countenance to the doctrine, whose fallacy I have demonstrated in a previous memoir, that budding depends on a retention of the primitive tissue of the germ in any part.

§ 4. *The Gamogenesis, or Sexual Development, of* PYROSOMA GIGANTEUM (Plate XXXI.).

It will conduce to intelligibility, if the somewhat complex history of this process is divided into stages, characterized partly by the size of the ovisac, partly by its structural characters. I shall describe, under each stage, a specimen or specimens, illustrating the peculiar features of that stage, but it will be understood that insensible gradations are observable between the different stages; and, in order that the whole process of development may be viewed continuously, it will be advisable to consider, as the first stage, that condition of the ovisac in which it is first recognizable as a completely distinct organ, a condition which it attains, as I have already stated, in buds such as that figured in Pl. XXX. fig. 23.

First Stage. *Ovisacs less than $\frac{1}{350}$th of an inch in diameter and without ducts.*

Fig. 1, Pl. XXXI., represents an ovisac measuring $\frac{1}{420}$th of an inch in diameter. It is ellipsoidal in form, and nowhere presents any prolongation which can be regarded as even the rudiment of a duct. The wall of the ovisac is comparatively thick, and obscurely cellular in structure, but it is devoid of any structureless investment or membrana propria. The contained ovum consists of a solid-looking, well-defined germinal spot $\frac{1}{2700}$th of an inch in diameter, occupying the centre of a germinal vesicle $\frac{1}{800}$th of an inch in diameter, with a thin but well-defined wall, and perfectly clear contents. The yelk is represented by a small zone of structureless, yellowish substance, which invests the germinal vesicle, and, on the one hand, passes into the wall of the ovisac, while, on the other, it is separated from that wall by a narrow clear space.

Second Stage. *Ovisacs less than $\frac{1}{200}$th of an inch in diameter and unimpregnated.*

The ovisac represented in fig. 2. exemplifies this condition very well. It has a diameter of $\frac{1}{300}$th of an inch. Its form is spheroidal, and it is produced on the side towards the atrial wall of the blood sinus in which it lies, into a short subcylindrical diverticulum, which is directed forwards, and slightly towards the neural side of the ascidiozooid in which it lies. This diverticulum, or rudimentary duct, is $\frac{1}{436}$th of an inch in length, and its slightly narrowed anterior extremity passes into the atrial tunic. At its opposite end, where it becomes continuous with the ovisac, it measures $\frac{1}{970}$th of an inch in diameter. At this extremity, the cavity of the duct is in free communication with that of the ovisac, but at a little more than half way towards the opposite end, or in other words towards the atrium, the cavity ceases, the termination of the duct appearing to be a solid cellular mass. In this condition, therefore, there would appear to be no communication between the interior of the ovisac and the atrial cavity.

The wall of the ovisac exhibits no distinct membrana propria, but is composed of a single layer of flattened corpuscles, about $\frac{1}{5000}$th of an inch in diameter, imbedded in, and connected together by, a structureless substance. The wall of the duct is similarly composed, but its hæmal is much thicker than its neural wall. In the cavity of the duct nothing save a clear fluid is discernible, and the same fluid seems to fill the interval observable on one side, between the wall of the ovisac and the ovum.

The latter consists of a very finely granular, spheroidal vitelline mass $\frac{1}{438}$th of an inch in diameter, within which lies a germinal vesicle ($\frac{1}{640}$th) with perfectly clear contents, inclosing an opake, spheroidal, germinal spot ($\frac{1}{1920}$th). The yelk is in close contact with the inner side of the anterior wall of the ovisac—the germinal vesicle is close to its surface at the same point, and the germinal spot is applied to the inner surface of the anterior wall of the vesicle, so that it is as near as possible to the wall of the ovisac.

I have not been able to discover a trace of a vitelline membrane in ova in this stage. It may be doubtful whether the space between the wall of the ovisac and the ovum is a natural or an artificial product. My observations upon the ovisacs of a fresh *Pyrosoma* (Phil. Trans. 1851) lead me to adopt the latter hypothesis.

Third Stage. *Ovisacs under* $\frac{1}{100}$th *of an inch in diameter and in process of impregnation.* (Pl. XXX. figs. 3, 4, and 8*.)

Of the two specimens in this stage which I have figured, the larger (fig. 3) is rather the less advanced. Its duct is longer than the diameter of the ovisac, and is not only hollow throughout its whole length, but, at its anterior end, opens into the atrium, with which, therefore, its cavity is in free communication. Whether a similar connexion obtains between the cavity of the ovisac and that of the duct, or not, I cannot certainly say. A marked constriction is generally observable at the point of junction between the duct and the ovisac, corresponding to an inwardly projecting lip, which greatly narrows the apparent aperture of communication (fig. 4); and in some cases, the cellular wall of the lip appeared to have grown out, in such a manner as still further to diminish that aperture; but I have been unable, in any one instance, fully to assure myself of the closure of the passage. If, however, as I have reason to believe, the vitellus, in the fresh state, completely fills the ovisac, the aperture will be effectually closed by its means.

The ovum in the ovisac represented in fig. 3, measures $\frac{1}{192}$nd of an inch in diameter, that in fig. 4, $\frac{1}{210}$th. In each case the vitellus is somewhat more opake than in the previous stages; but, as before, I have been unable to find any vitelline membrane, even when, as in fig. 8*, the ovum has been turned out of the ovisac. But I have constantly observed that while the greater part of the circumference of the yelk exhibits a well-defined dark contour, that portion which is away from the side on which the germinal vesicle lies, has a faint, hazy outline, as if it were undergoing solution. This appearance is well shown in figs. 4 and 8*, and it is worth recollecting in connexion with the subsequent fate of the yelk.

In both the ova represented in figs. 3 and 4, the germinal vesicle measures $\frac{1}{480}$th of an inch in diameter, and its contents are, as before, perfectly clear. A change of figure has accompanied its increase in size, for it is now oval, its long diameter being more or less perpendicular to the direction of the duct. Furthermore, it is situated at the surface of the ovum, at a point close to, but on one side of, the aperture of the duct; and that face which is nearest the surface of the vitellus is not unfrequently flattened.

The germinal spot retains its previous size ($\frac{1}{1920}''$) and appearance. One or two minute clear spaces are to be seen in it, occasionally, in this and in other stages, but I suspect they are accidental.

In the specimen represented in fig. 3, the duct appears to contain only a clear fluid, as before, except that a few indistinct striæ are visible towards its upper end. One would hardly know what to make of them, if it were not for the circumstance, that a bundle of minute filaments, a few of which would readily give rise to the striation in question, hangs from the mouth of the duct. The filaments are sticking in its atrial aperture by one end, while the remainder of their length protrudes.

The filaments are exceedingly delicate, and so entangled that their individual dimensions cannot be estimated. The whole bundle, however, measures about $\frac{1}{430}$th of an inch in length. The ends of the filaments inserted into the aperture are thickened, and more or less rod-like. In a slightly larger ovisac (fig. 4) no such filaments are visible about the mouth of the duct, but its upper dilated end contains a conical plug, composed of precisely similar bodies, and a similar plug occupied a corresponding position in every other ovisac, in this stage, which I have examined. If the ovisac is not disposed in such a manner, that the plane of the constricted junction between the duct and the ovisac is perpendicular to the stage of the microscope, so as to afford a true profile view, the broad end of the plug will appear to be in direct contact with the vitellus, close to the germinal vesicle. But I have never met with any such absolute contact in a true profile view. On the contrary, in such a view, the end of the plug appears to be jammed in the upper aperture of the duct, and there is a small interval between it and the surface of the vitellus.

But it must be remembered that (as I have already pointed out) in the fresh state, the vitellus, in all probability, occupies the whole cavity of the ovisac, and itself stops the upper aperture of the duct; and, if this be the case, it is exceedingly likely that the slight separation between the yelk and the plug of filaments is a post-mortem change. At any rate no filaments are ever discoverable in the cavity of the ovisac, and as I have been able to find no complete diaphragm across the upper aperture of the duct, there seems to be no reason for their absence, unless we suppose that the vitellus itself bars their entrance. But in this case the plug and the vitellus must come into direct contact.

This point is of great importance, because there can be no doubt that the filaments in question are spermatozoa. The 'plug,' and the contents of the vas deferens of the testis are precisely similar in appearance. The plug is not visible before the atrial end of the duct is open, thus providing free access for spermatozoa floating in the atrium. As there are no cilia on the inner surface of the duct, it seems impossible to account for the presence of the dense mass of filaments within it, except on the supposition that they have an inherent propulsive power; and the only free, filamentous bodies possessed of such a power we know of, in the animal economy, are spermatozoa.

Furthermore, in my former memoir on *Pyrosoma* (*l. c.* p. 584), I have recorded the following observation:—

"In young specimens, when the ovum is small and the yelk pale, this gubernaculum [the duct] frequently appears to be solid; but in fully grown specimens, when the ovum [ovisac] has its full size, and the yelk is dark and granulous, it presents the appearance of a wide tube, especially at its upper part. And here, there was frequently an appearance of dark striæ and moving granules, prompting the belief that spermatozoa had travelled thus far. In one instance the sac of the ovum was empty, and the gubernaculum or duct widely distended; the appearance of spermatozoa in the duct was here very strong. (Fig. 5.)"

I entertain no doubt, then, that the specimens described exhibit the process of impregnation in *Pyrosoma*; that the spermatozoa make their way up the duct and come into contact with the surface of the yelk. Whether that reciprocal action of the spermatozoon and the ovum, which constitutes the essence of fecundation, takes place immediately on the occurrence of this contact, I cannot pretend to say with certainty, but I doubt it; for, as will be seen, though very remarkable changes take place shortly after impregnation, they are not those which in other animals follow upon fecundation.

It is not a little singular that, in consequence of the immature condition of the testis of zooids whose ovisacs are in the stage under consideration (*Pyrosoma* resembling *Salpa* in the much more rapid advance towards maturity of the female, than of the male, organ, in each zooid), the spermatozoa which effect impregnation must be derived from another zooid if not from another ascidiarium. The latter alternative is not so improbable as it looks at first sight, if we consider that a current constantly sets through the body of each zooid from the oral to the atrial aperture, and so out at the cloaca. Hence, the spermatozoa which are poured by the vas deferens of any given zooid, in which the testis has attained its full development, into its atrium, must be almost immediately carried into the cloaca; and as a powerful current is setting into the cloaca from every other zooid, it does not seem possible that the spermatozoa should make their way into any one of these zooids against it. But on the other hand, as the *Pyrosomata* live in great troops, the spermatozoa cast out of the cloaca of any one *Pyrosoma* may very readily be taken in by the oral aperture of another, and passing with the current through the branchial stigmata into the atrium, may easily reach the aperture of the oviduct.

If this reasoning is valid, *Pyrosoma* affords a curious illustration of Mr. Darwin's docrine of the rarity of self-fertilization even among hermaphrodite animals.

Fourth Stage. *Ovisacs from* $\frac{1}{100}$th *to* $\frac{1}{40}$th *of an inch in diameter, in which the yelk disappears and the germinal vesicle becomes fixed to the wall of the ovisac.* Figs. 5—8*a*.

Figure 5 represents an ovisac $\frac{1}{90}$th of an inch in diameter, and fig. 6 another of $\frac{1}{70}$th of an inch. The first thing to be observed about these ovisacs is, that they have increased in dimensions disproportionately to their ducts; for while, in the preceding stage, the duct is longer than the transverse diameter of the ovisac, in the present stage, it, at first, hardly equals, and subsequently remains much shorter than, that diameter. The duct, in fact, does not attain a greater length than $\frac{1}{150}$th of an inch, and in the larger examples of this stage it appears shrunken and withered. The spermatozoa, however, are always visible in its upper dilated end (fig. 6 *b*), but sometimes they no longer form a distinct bundle, but appear scattered, and then their rod-like heads are very distinct.

In the wall of the ovisac and of the duct, a differentiation has taken place into an outer structureless membrana propria, and an inner epithelial layer. The latter is pale, the corpuscles, which lie in the wall of the ovisac in this as in earlier stages, appearing to be thinner and separated by wider clear interspaces. That change which arrests the attention of the observer most forcibly, however, is the entire absence in the present, as in all subsequent stages, of that vitelline mass which is so conspicuous in less advanced ovisacs. As a consequence of this disappearance of the yelk, the germinal vesicle lies apparently free and bare, in contact with one wall of the ovisac. There is not the slightest difficulty in observing these facts, nor the least ambiguity about the microscopical appearances; but the circumstances appeared so unprecedented, that, when I first became acquainted with them, I mistrusted the obvious interpretation of those appearances. However, I found, not only that the contour of the yelk contained in the smaller ovisacs was perfectly well defined, but that, by careful manipulation with needles, under the simple microscope, I could turn out the ovum entire, the vitellus being so firm and consistent as to retain its form (fig. 8*);

and yet I could neither observe the smallest trace of the yelk in entire ovisacs in this stage, nor, however carefully I opened them, discover any trace of yelk within them. I found, furthermore, not only that, by a little pains, I could open the ovisac so as to view the germinal vesicle from within (figs. 6 and 7), but that I could evert it, turn it in all directions, and even detach it entirely: and when I discovered, by these means, not merely that no vitellus surrounds the germinal vesicle in this stage, but that it is enclosed and held in place by something which is assuredly not vitellus, I was forced back into my original conclusion, that in this stage the vitellus, as such, has disappeared.

There is, however, one suggestion which deserves careful consideration. It may be said, that what I have termed the germinal vesicle (represented separately in figs. 6 *a* & 8) is in fact the ovum. To meet this objection, I would beg the reader to compare figs. 8 and 8*; the former of which represents the body whose nature is in dispute, and the latter an ovum which has not reached its full size, the two figures preserving the true relative proportions of the originals. It is at once obvious that the circular solid-looking corpuscle, situated towards the upper end of fig. 8, is identical in all essential respects with the germinal spot of fig. 8*, the only difference being that it is slightly larger, measuring $\frac{1}{1600}$th of an inch, while the germinal spot of the entire ovum is about $\frac{1}{1900}$. But if this corpuscle represent the germinal spot, then the only structure which corresponds with the wall of the germinal vesicle in fig. 8* is the structureless, oval, membranous sac, wrinkled on one side, which encloses the germinal spot in fig. 8. This sac, it must be admitted, differs a good deal from the germinal vesicle of fig. 8*, not only in size, but in form and in contents. In the first place, it is much larger, measuring $\frac{1}{380}$th of an inch in length, while the germinal vesicle of fig. 8* is only $\frac{1}{560}$; next, it is oval and irregular on one side; and thirdly (and this is the most important difference), it contains a homogeneous yellowish deposit, which is especially accumulated around the germinal spot, but is absent under the wrinkled moiety of the vesicle.

All doubts as to the identification of the body (fig. 8) with the germinal vesicle and spot of fig. 8*, however, vanish when a series of ovisacs, intermediate in size between that which yielded the ovum, fig. 8*, and that represented in fig. 6, are studied. Thus in fig. 4, the unquestionable germinal vesicle is oval, and its long diameter amounts to $\frac{1}{500}$th of an inch; while in the ovisac represented in fig. 5, in which the yelk has disappeared, the body in dispute is precisely similar to the germinal vesicle of fig. 4, except that it is a little more flattened and a little longer ($\frac{1}{460}$th). Its contents are quite clear, and its wall is but very slightly corrugated. But no one can question the identity of this body with that represented in place in fig. 6, and separately magnified in fig. 6*a*, which has a long diameter of $\frac{1}{417}$th of an inch, whose walls are much wrinkled, and which contains a dense yellow deposit.

I have no hesitation then in regarding the body, fig. 8, which agrees in all essential respects with that represented in fig. 6*a*, as the germinal vesicle of the primitive ovum, stripped of its vitellus.

Though devoid of any vitelline investment, however, the germinal vesicle has been neither free nor bare, in any ovisac which I have examined. It is always seen to occupy one spot of the inner face of the ovisac, a little behind and to the right of the upper aperture of the duct; and when the ovisac is opened, the germinal vesicle is found to adhere to this point with considerable tenacity. It is, in fact, held in place by a continuation of the epithelial lining, which lies between it and the cavity of the ovisac—the germinal vesicle being now situated between the epithelium and the membrana propria, so that while its outer face is covered by the latter its inner face is invested by the former. All this will be rendered easily intelligible by examining the profile views (fig. 6 and 6*a*), and the view from within (fig. 7), of the germinal vesicle *in situ*.

But it has been seen that the ovum, containing the germinal vesicle, originally lay inside the wall of the ovisac, which has become metamorphosed into the epithelium, and hence it follows that the germinal vesicle, after losing its yelk, must pass through the epithelium of the ovisac. It will be recollected that the mammalian ovum becomes similarly related to the epithelium of the Graafian follicle, and that the germinal vesicle of the bird's egg in like manner passes into and through the peripheral layer of its yelk.

Throughout the present stage there is not the least difficulty in observing the germinal vesicle and its spot in the uninjured ovisac. The spot, in fact, is particularly well-defined, and immediately strikes the eye when even a low magnifying power is used. But, with such a power (say 200 diameters), it is easy to fall into error as to the shape of the germinal vesicle. It constantly appears to be hemispherical, the truncated side being that which is turned away from the upper aperture of the duct. This appearance arises from the fact that, with such a power, one sees the contents and not the wall of the germinal vesicle, and as the yellow deposit fills only that moiety which lies nearer the upper aperture of the duct, it appears like a semicircular cake. Under a higher power (500 diameters) the wrinkled* membrane of the other moiety of the vesicle is always readily discernible.

Fifth Stage. *Ovisacs between $\frac{1}{40}$th and $\frac{1}{30}$th of an inch in diameter, in which the germinal spot disappears, and a number of minute granules take its place.*

The germinal vesicle, held in place on the neural wall of the ovisac, immediately behind and rather to the right of the upper aperture of the duct, in the manner which has just been described, next undergoes changes of very great interest and importance. I have devoted a very great deal of time and patience to the analysis of these changes, but it is only recently that I have felt satisfied with the results of my investigations; and I must warn any one who is disposed to repeat these observations, that while everything which I have described up to the present moment may be demonstrated with the utmost readiness in almost any thin vertical section of the ascidiarium, the conditions of the germinal vesicle which I am about to describe occur but very rarely, and require the aid of high powers of a thoroughly good microscope for their complete elucidation. Out of a vast number of preparations which I have made, at intervals, during the last twelve months, not more than eight or nine have exhibited the exact features of which I am about to give an account.

The germinal vesicle represented in fig. 8*a*, belongs, strictly speaking, to the preceding

* The fact that the *Pyrosoma* observed by me had been preserved in spirit should always be recollected. It is highly possible that the wrinklings are artificial.

stage. But it differs from the characteristic germinal vesicles of that stage, in that its spot has lost its solid, opake aspect and has apparently become a vesicle with a thin, sharply-defined wall, but so pale that under a low power it would readily escape notice. Its diameter is $\frac{1}{1920}$th of an inch. The vesicle itself measures $\frac{1}{570}$th, it is much flattened, and its contents are somewhat paler than before. I have described this germinal vesicle here, because I believe that it is in that condition which constitutes the transition from the typical form of the last to the typical form of the present stage. As this last is of very great importance, I will note down the appearances presented to me by several germinal vesicles which exhibit it.

If I examine a slide, at present under my microscope, I observe, under a low power, in one place, an ovisac belonging to the fourth stage. The germinal vesicle, with its yellow contents, is very obvious, and the round, sharply-defined germinal spot strikes the eye at once. If I now move the slide a little way, I bring into view a large ovisac about $\frac{1}{42}$nd of an inch in diameter. In this, it is only with difficulty that I can trace the outline of the germinal vesicle, and nothing is to be seen of the germinal spot. This indistinctness of the germinal vesicle does not arise from want of size or clear definition; for, if I put on a high power, I find it to have a diameter of $\frac{1}{290}$th of an inch, and its contour is perfectly well marked. The yellow deposit occupies about half its cavity as before, but it is paler; and partly on this account, and partly by reason of a further change in the structure of the epithelium of the ovisac, the vesicle is less obvious than previously. Of the germinal spot not a trace is to be seen anywhere, although the vesicle and its contents are quite transparent. Whether the contents exhibit any new structure or not cannot certainly be made out, on account of the interference of the wall of the ovisac, through which the germinal vesicle is seen. In another ovisac in this stage, also about $\frac{1}{42}$nd of an inch in diameter, the germinal vesicle, very similar to that first described, measures $\frac{1}{320}$th of an inch in length, and is half filled with the yellow deposit. No vestige of the germinal spot is to be seen, but, on that side of the contents which in earlier stages is occupied by the germinal spot, there are a number of minute, spheroidal clear granules, none exceeding $\frac{1}{10000}$th of an inch in diameter and arranged so as to form an elongated patch on the surface of the contents, the rest of which is quite free from such bodies. In another ovisac of about the same size the germinal vesicle is $\frac{1}{240}$th of an inch in diameter with pretty nearly half that thickness, and similar granules are observable upon the face of its contents, while there is nothing to be seen of a germinal spot.

But the best example of this stage is that afforded by yet another ovisac $\frac{1}{35}$th of an inch in diameter, whose germinal vesicle, $\frac{1}{350}$th of an inch in diameter, is represented in fig. 8*b*. Here the contents can be searched through and through with the greatest ease; but not the least trace of a germinal spot is discoverable, while the minute clear corpuscles $\frac{1}{10000}$th to $\frac{1}{9000}$th of an inch in diameter, scattered over the face of the contents, are exceedingly distinct. Whether they are free, or whether they are imbedded in any clear substance, I cannot say certainly, but I suspect the latter to be the case.

Putting the facts observed in this stage together, we find, that in ovisacs between $\frac{1}{40}$th and $\frac{1}{30}$th of an inch in diameter, the germinal vesicle increases in size until it attains as much as $\frac{1}{240}$th of an inch in long diameter; and that the germinal spot, as such, entirely disappears. On the other hand, on that side of the contents towards the wrinkled part of the membrane of the germinal vesicle, a number of minute, pale, spheroidal corpuscles make their appearance and spread over the face of the contents. Considering that, as we have seen, the germinal spot becomes pale before it ceases to be visible, and bearing in mind that the power of subdivision is one of the most characteristic properties of the class of bodies to which the germinal spot belongs, I do not think it very hazardous to assume that the corpuscles in question result from the division of the germinal spot.

In all the ovisacs of this size the epithelium has undergone a very remarkable change. Instead of the thin cellular lamella which has previously lined the interior of the ovisac, a transparent substance excavated by many large spheroidal cavities of various sizes (which when the ovisac is viewed by a low power give it the appearance of being filled with numerous clear vesicles) occupies its cavity.

Sixth Stage. *Ovisacs about $\frac{1}{30}$th of an inch in diameter, in which the germinal vesicle has disappeared but a blastodermic membrane occupies its place.*

Figure 9 represents an ovisac of $\frac{1}{31}$st of an inch in diameter *in situ*. It will be observed that the duct is now very small in relation to the sac, and that the modified epithelium of the latter manifests the vesicular appearance characteristic of the later stages. The germinal vesicle is no longer to be seen, but, exactly in the position it ought to occupy, there is a patch of substance which, in profile (fig. 9), is obvious as a thick, darkish yellow line, but viewed from within or from without (fig. 9 *a*) is only visible under a high power, in consequence of the excessive paleness and delicacy of its components. It is, in fact, a very thin membrane $\frac{1}{160}$th of an inch long and about half as wide, composed of a single layer of spheroidal, or more or less polygonal, corpuscles, each of which has an average diameter of $\frac{1}{1900}$th of an inch, though some are smaller and some are larger. Every one of these contains in or near its centre a small, apparently vesicular, more strongly refracting and hence more conspicuous body, usually not more than $\frac{1}{9600}$th of an inch in diameter, but sometimes attaining to fully twice this diameter. That margin of this membrane which is turned towards the upper aperture of the duct (fig. 9 *a*) is tolerably sharply defined, and has an evenly curved contour, so that this extremity of the patch has almost a semicircular outline. The rest of the membrane, on the other hand, has an elongated, irregular form, and less distinctly defined edges.

In another ovisac $\frac{1}{37}$th of an inch in diameter, there is the same entire absence of the germinal vesicle and the same presence of a delicate membrane of precisely the same characters, but not more than $\frac{1}{192}$nd of an inch in long diameter and $\frac{1}{240}$th of an inch wide. In this specimen the edge of the membrane which is turned towards the duct is still more distinctly semicircular, and it is almost as well-defined as the edge of the germinal vesicle in its latest condition, though no distinct membrane is discernible. The irregular part of the membranous disk bears a smaller proportion to the semicircular part, than in the preceding case.

In each instance the membranous disk, which has been described, lies between the modified epithelium and the membrana propria. In position, therefore, it exactly corresponds with the germinal vesicle; its colour, when the light passes through a thickness of it sufficient to give colour, is exactly that of the contents of the germinal vesicle; the diameter of the semicircular portion is but very slightly greater than that of the germinal vesicle in its later stages; and finally, the minute bodies which occupy the centre of each component corpuscle of the membrane are not a little similar in character to the small spheroidal particles which appear upon the contents of the germinal vesicle during the latest stages of its existence.

Putting all these circumstances together, I venture to express the belief that this membrane, which the further progress of development proves to be the blastoderm out of which all the parts of this embryo take their rise, results from the metamorphosis of the contents of the germinal vesicle; and that the curved contour which lies towards the upper end of the duct is, in fact, the contour of that side of the germinal vesicle which first becomes filled with the yellow deposit.

Thus far, I feel little difficulty in interpreting the appearances presented; but if the surface and the immediate edges of the blastoderm are examined with great care, minute rod-like bodies will be seen scattered about, so similar in form and size to the heads of the spermatozoa, that I have been frequently tempted to regard them as such, and the more so, as in this stage the duct looks shrunken and shrivelled, and contains but very few, if any, remains of the plug of spermatozoa so conspicuous previously.

In this stage, each of the blastoderms which I have examined has presented these appearances; but as, in spite of long search, the total number which I have found in this state does not exceed four, I do not feel myself in a condition to pronounce positively upon the nature of the bodies in question.

Seventh Stage. *Ovisacs from $\frac{1}{36}$th to $\frac{1}{25}$th of an inch in diameter, in which the blastoderm rapidly increases, and becomes segmented into the rudiments of five zooids.*

Up to this stage the ovisac lies within the sinus system of the parent, which, as I have already pointed out, becomes accommodated to its increased dimensions, partly by the thrusting of the atrial tunic into the cavity of the atrium, but, to a much greater extent, by the formation of a chamber in the test, in consequence of the extension outwards of a diverticulum of the outer tunic. In the recent condition, the blood of the parent must circulate in the narrow space left between the walls of the ovisac and those of its containing chamber; and it seems reasonable to suppose that the former imbibes into its interior a supply of nutritive material, which will contribute towards the subsequent development of the embryo.

But during and after this stage, the ovisac bearing the embryo is to be found loose in the mid-atrium, which, in its later stages, it fills. To arrive at this position it must necessarily break through the wall of the atrium or atrial tunic, and through the duct which still connects it with that tunic. The latter process is easily intelligible, considering the very small relative size and delicacy of the duct; but I confess I do not understand how the rupture of the atrial tunic can be effected without serious hæmorrhage. However, the zooids in which the detached ovisacs have attained a large size appear to be in as good condition as any of the rest.

Henceforward I shall speak of this complex body, composed of the ovisac and the embryo proper, as the *fœtus*, reserving the term *embryo* for the blastoderm and the results of its modification. In such a fœtus as that represented in fig. 10, the blastoderm is a broad, elongated, membranous patch $\frac{1}{63}$rd of an inch long by $\frac{1}{108}$th of an inch wide, and so opake as at once to strike the eye when the fœtus is viewed with even a very low power. It is composed of somewhat coarse, granular-looking corpuscles, and lies between the membrana propria and the modified epithelium; but the former is separated from it by a very thin layer of structureless substance which extends for some little distance beyond the limits of the blastoderm on each side. The further course of development shows that this layer is the rudiment of the test of the future ascidiarium.

Fœtuses of very slightly increased or even of less size exhibit a marked change in the embryo, which has elongated sufficiently to extend over half the circumference of the ovisac and has, at the same time, become indented at opposite points of its margins, so as to be marked out into five short segments. One of the two terminal segments becomes much enlarged, spreading over and investing one pole of the ovisac like a cup; while the other four remain far smaller, and, the indentations between them deepening, they are eventually connected only by narrow isthmuses of blastoderm. These segments are the rudiments of as many zooids; but the large cup-like one has a totally different fate from the rest, and for distinction's sake I shall term it the *cyathozooid*, while the others are, in their order of nearness to it, the 1st, 2nd, 3rd, and 4th ascidiozooids* respectively. The zooids are not merely connected with one another by the isthmuses of blastoderm above-mentioned, but the structureless test has greatly increased in thickness, and now invests them all, like a thick layer of transparent varnish. The membrana propria of the ovisac is no longer distinguishable outside this rudimentary test.

The remains of the duct are often still traceable, towards the conclusion of this stage, at one end of an equatorial diameter of the fœtus (supposing the cyathozooid to be situated at one of its poles); but later, it is no longer to be discovered.

Eighth Stage. *Fœtuses from $\frac{1}{25}$th of an inch up to the largest which have been met with.*

In describing this final stage of development, it will be convenient to consider, first, the changes in general arrangement, size and form, of the different parts of the fœtus; and secondly, the special modifications which each of these parts undergoes.

The cyathozooid, at first, occupies but a comparatively small segment of the surface of the spheroidal fœtus, and the slightly curved series of ascidiozooids stretches out from it, over about half the circumference of the uncovered portion of the ovisac (Pl. XXXI. fig. 11). But, by degrees, the cyathozooid extends so far as to invest nearly half the surface of the ovisac, and, at the same time, the chain of ascidiozooids (considered as a whole) gradually assumes a new direction, and applies itself closely to the face of the cyathozooid, whose circumference it half encircles (fig. 13). The blastoderm of the ascidiozooids, however, remains perfectly distinct from that of the cyathozooid, the two being united only by the layer of test, which, in the earlier stages, invested both, and whose contiguous edges now seem to run into one another.

* I have, throughout the present memoir, used the term 'ascidiozooid,' as more euphonious than 'ascidiite,' employed in my notice in the 'Annals of Natural History' for 1860.

If a line traversing the centre of the cyathozooid and the centre of the ovisac be regarded as the axis of the whole fœtus, then, in the present condition, the longest diameters of the first and of the last ascidiozooids are parallel with that axis, and that extremity of each, at which the elæoblast is situated, is directed away from the cyathozooid. The long diameters of the intermediate ascidiozooids, on the other hand, cut the axis of the fœtus at a high angle, their elæoblastic ends being those which are nearer the cyathozooid (fig. 13).

As development advances, the first and the fourth ascidiozooids retain their parallelism to the axis of the fœtus, while the whole series elongates, so that the fourth comes to be situated close to the first (Plate XXXI. fig. 14), the four encircling the base of the cyathozooid completely. This elongation of the whole series is effected, mainly, at the expense of the isthmuses, which elongate so much as to be converted into slender cords, of which the first connects the cyathozooid with the neural face of the first acidiozooid; the second connects the hæmal region of the first ascidiozooid, at a point just opposite the endostylic cone, with the neural face of the second ascidiozooid; the third similarly unites the second and the third; and the fourth, the third and fourth.

But the elongation of the isthmuses is not merely sufficient to allow the fourth ascidiozooid to come close to the third; it is also enough to permit of a movement of rotation on the part of the second and third ascidiozooids. The first and fourth, as has been seen, early take up such a position that their long axes are parallel with the axis of the fœtus; and, by degrees, the second and third revolve, their adjacent ends being allowed to separate by the elongation of their connecting isthmuses, until their long diameters, from being very obliquely inclined to that axis, also become parallel with it, and with the long diameter of the first and fourth. Thus, at last, the long diameters of all four ascidiozooids are parallel with one another and with the axis of the fœtus, their similar ends being turned the same way (fig. 14), while the isthmuses slope obliquely from the neural region of one to the hæmal region of the next. The long diameter of each ascidiozooid is at right angles with its proper axis (which would be a line drawn from the oral to the cloacal aperture), and, hence, the neural and hæmal sides of the body are at opposite ends of its long diameter. The neural side is that, which is turned in the same direction as the aperture of the cyathozooid, while the hæmal side is the opposite. The mouth is at that end of the true axis or short diameter of the body which is turned outwards; while the atrial aperture eventually makes its appearance at the other end of this diameter and, consequently, on that face of the ascidiozooid which is adjacent to the ovisac and cyathozooid.

At the commencement of the series of changes here indicated the ascidiozooids are, individually, much smaller than the combined cyathozooid and ovisac; but as development advances, the latter diminish while the former increase; and as, by the increase of size of the ascidiozooids, the interval between them becomes both relatively and absolutely less, they, at last, completely hide the combined cyathozooid and ovisac from view, so that it is not always an easy matter to find the latter (Plate XXXI. fig. 15). The test increases, concomitantly with the ascidiozooids, enveloping them and filling up their intervals so as, finally, to form a spheroidal investment for the entire tetrazooidal fœtus (figs. 14 & 15).

During the whole of these changes and until the fœtus attains a diameter of $\frac{1}{14}$th of an inch, it remains within the mid-atrium of the parent, which, at last, it completely fills. With Savigny, I am unable to understand how it escapes, unless indeed it becomes freed by the destruction of its parent. For it seems quite impossible that the fœtus should find a way open to it by any conceivable amount of dilatation of the atrial aperture. Nor does one ever find a fully formed ascidiozooid without a fœtus in its mid-atrium. And if, at the same time, it is recollected that only one ovum ever comes to maturity in an ascidiozooid, so that when the fœtus has arrived at its full development the parent's "occupation is gone," it seems less improbable that the destruction of the latter should be involved in the maturity of its offspring.

Such is a general description of the changes in the size, form, and position of the chief constituents of the fœtus, in virtue of which it assumes its final characters. It now becomes necessary to trace the internal modifications which each of these constituents undergoes.

1. *The Cyathozooid.*—In my brief preliminary sketch of the development of *Pyrosoma* ('Annals of Natural History' for January, 1860), I have termed this part the "rudimentary cloaca;" but it would have been a more accurate account of the matter, if I had called it the 'mould' or 'forerunner' of the cloaca. Rudiment of the cloaca, in the strict sense of the words, it is not; for, as we shall see, the atrial apertures of the ascidiozooids never really open into it.

When the cyathozooid is first distinguishable as a separate segment and traces of structure are discernible in it (Plate XXXI. fig. 11), it presents, when viewed from above, near that edge which is most distant from the first isthmus, a rounded depression. Viewed sideways, the blastoderm appears to be divided into two lamellæ, the separation between which is most marked immediately under the depression. In a line between the depression and the first isthmus a clear streak is visible, the first rudiment of what I shall term the *appendix of the cyathozooid.* As the development of the fœtus progresses, the interspace between the two layers of the blastoderm enlarges and the depression becomes an opening, into which, however, the thick test is continued, projecting like a conical tongue into the interspace or cavity just mentioned, in such a manner as to leave but a narrow median passage, by which I conceive that a free communication between the cavity of the cyathozooid and the exterior must be effected (figs. 17 & 18). At the same time, the aperture is gradually shifted from the margin to the centre of the cyathozooid, so that, eventually, its middle corresponds to one pole of the fœtus (fig. 14), and gives the latter the appearance of a cup, or of an egg with its top cut off. Contemporaneously with these changes that streak which I have mentioned takes shape as a singular appendage situated between the two layers into which the outer wall of the cyathozooid is differentiated, and a communication, which, I believe, existed from the first between the cyathozooid and the first ascidiozooid by means of the first isthmus, becomes patent and obvious. But a description of the structure of a more advanced cyathozooid will best render these changes intelligible.

Fig. 14 represents a fœtus $\frac{1}{18}$th of an inch in diameter. The cyathozooid and ovisac, taken together, have the form of an ellipsoid, truncated at that end which presents the aperture of the cyathozooid, and rounded at the other. The circular aperture of the cyathozooid (β) is $\frac{1}{105}$th of an inch across, and is bounded by a constricted perpendicular lip $\frac{1}{400}$th of an inch deep. The aperture leads into a wide cavity about as deep as the lip (γ), into which the prolonged tongue of the test projects. The canal which traverses the centre of this tongue, and which consequently must place the cavity of the cyathozooid in communication with the exterior, appears very distinct. The appendix (δ) has the form of a curved tube, with its concavity turned towards the cavity of the cyathozooid. Its anterior end is slightly enlarged, while its posterior end, also a little dilated, is seated upon a slight prominence: both ends seem to be open.

On one side of this appendix, a canal (θ), $\frac{1}{150}$th of an inch long by $\frac{1}{950}$th wide, passes obliquely towards the cavity of the cyathozooid and apparently opens into it. Posteriorly it is continued, at an obtuse angle, into a similar tube having about the same length, and eventually passing into the first isthmus, now $\frac{1}{126}$th of an inch long. It will be observed that, notwithstanding the advanced condition of the ascidiozooids in this fœtus, their upper extremities do not rise so high as the level of the middle of the ellipsoid formed by the cyathozooid and ovisac. The point at which their atrial apertures will eventually be formed, consequently, can hardly be so high as the lower end of that ellipsoid.

As has been already hinted, with the advance of the fœtuses in size all their relations become changed. The ascidiozooids, instead of presenting a fraction of the length of the combined ellipsoidal cyathozooid and ovisac, and occupying only a small portion of the mass of the fœtal spheroid, gradually become fully thrice as high as the ellipsoid in question, and form by far the greater proportion of the mass of the spheroid (fig. 15). The ovisac and cyathozooid, again, diminish, not only relatively but absolutely (fig. 16), inasmuch as their largest diameter does not eventually amount to more than $\frac{1}{70}$th or $\frac{1}{80}$th of an inch, while the lip and the internal cavity of the cyathozooid become less distinct structures than before.

But the most curious change is that which has taken place in the test in the vicinity of the cyathozooid. It has, as it were, separated itself from the latter, following the ascidiozooids as their vertical diameter increases, whereby the central tongue of the test is pulled completely out of the mouth of the cyathozooid, as one might pull a finger out of a glove (compare figs. 18 and 19, Plate XXXI.). As a consequence of this operation a cavity, which gradually increases in dimensions, is developed between the outer surface of the cyathozooid and the inner wall of the test; and as the atrial ends of the ascidiozooids ascend in consequence of the growth of the latter, they open into this cavity, which thus manifests itself as the cloaca (fig. 19). The tongue-like prolongation of the test becoming pulled out and flattened as the cloaca widens, ultimately ceases to project into the cavity of the latter, and becomes converted into the lip of its aperture. In fig. 19 it still protrudes for some distance into the cloacal cavity.

2. *The Ascidiozooids.*—From their small size, flattened form and general opacity, it is by no means so easy to trace satisfactorily the successive changes by which the other segments of the blastoderm are converted into perfect ascidiozooids, as it is to follow out the development of the buds. Nevertheless, knowing the latter process, it is not difficult to interpret the appearances presented by the segments of the blastoderm, in the course of their development.

When the blastoderm first becomes marked out into those segments which eventually constitute the ascidiozoöids (Plate XXXI. figs. 11 and 12), each segment is about $\frac{1}{126}$th of an inch long by as much broad, and has a thickness of less than $\frac{1}{500}$th of an inch. Like the blastoderm whence it proceeded, the segment appears to consist of nothing but a dense, opake mass of indifferent tissue.

In a somewhat more advanced condition, the first signs of organization appear in the form of a clear median longitudinal streak visible in each segment when it is viewed from above. The streak is bounded by two more-opake lines, and on each side of the whole is a more opake mass. If the fœtus be turned, so as to display a transverse section of one of the segments, the clear streak is seen to correspond with a central cavity answering to the alimentary tract of a bud, while the more opake lateral masses are plainly small sacs —the lateral atria. The isthmus between any one segment and the next is clear in the middle, and has every appearance of a tube connecting the alimentary tracts of the two segments; but if, as I have already said, the first isthmus enables the alimentary tract of the first ascidiozooid to communicate with the cavity of the cyathozooid, then the cavities of all the alimentary tracts of the ascidiozooids must be, indirectly, in communication with this cavity and, through it, with the exterior. In point of fact, I believe that the four primary ascidiozooids stand in the same relation to the cyathozooid, as four buds formed from the ascidiozooids in the way described above would do, if, in the process of gemmation as many remained connected together and with the parent; for, as we have seen, all the branchial sacs of the buds communicate with that of the parent and, by the latter, with the exterior. And the mode of connexion of the different ascidiozooids is exactly the same in the two cases; for, in somewhat more advanced fœtuses (in which the ascidiozooids are about $\frac{1}{100}$th of an inch long and broad), it is obvious that the clear streak above mentioned corresponds with the interval between the bands of the endostyle, and that the end of the alimentary tract of any one embryonic ascidiozooid which is continued into the isthmus corresponds with the endostylic cone of ordinary buds; while that part of any embryonic ascidiozooid which receives an isthmus is the interval between the œsophageal aperture and the ganglion, just as this is the place into which the peduncle of a bud opens.

In ascidiozooids of this size, the nature of what I have termed the lateral atria is demonstrated by the appearance of four or five stigmata in their inner wall, just as in buds at a corresponding stage. At the same time, that part of the indifferent tissue of the embryo which lies in the immediate vicinity of the pointed end of the alimentary tract (the future endostylic cone) becomes converted into a mass of clear reticulated tissue, the elæoblast (*æ*). This body is developed more largely laterally than in the middle line, so that it appears, at first, as if it were composed of two distinct portions; but its two moieties are really continuous with one another on the hæmal side of the alimentary tract. The position of the future oral aperture is just indicated in the middle of the exposed surface of the ascidiozooids in this stage; but I could not ascertain anything definite as to the condition of the intestine. Indeed, from the flattened form of the embryonic ascidiozooids and their close apposition to the ovisac, it is exceedingly difficult to decipher all the details of their internal structure.

Ascidiozooids of $\frac{1}{70}$th of an inch in length exhibit a well-defined, though not open oral aperture, $\frac{1}{380}$th of an inch in diameter. The branchial stigmata have increased in number to nine or ten on each side and the middle ones occupy the whole depth of the branchial sac; but there are, as yet, no longitudinal branchial bars. The mode of origin of the stigmata appears to be just the same as in the buds.

The nervous ganglion makes its appearance as a thick mass of indifferent tissue between the isthmus and the oral aperture; and the contour of the gastro-intestinal part of the alimentary canal is discernible on that face of the embryo which is nearest the ovisac. The isthmuses have lengthened to $\frac{1}{380}$th of an inch.

A fœtus $\frac{1}{24}$th of an inch long, whose ascidiozooids had a length of $\frac{1}{63}$rd of an inch, presented the clear profile view of one of the latter, which is represented in Pl. XXXI. fig. 13*a*. The central tube or canal of the first isthmus is obvious, and it opens freely into the branchial sac of the ascidiozooid between the ganglion and the oral aperture. The central canal in question is bounded by the inner tunic of the ascidiozooid, between which and the outer tunic is an interval which is connected, on the one hand, with the sinuses of the ascidiozooid, and on the other, with the space between the two walls of the cyathozooid. The ganglion is very distinct and occupies nearly the whole interval between the oral aperture and the isthmus.

The diapharyngeal band, already visible in earlier stages, is continued from above the posterior half of the ganglion to the roof of the branchial cavity; but its proportions are more slender, as it measures $\frac{1}{240}$th of an inch long, by $\frac{1}{1920}$th of an inch thick. The oral aperture is not open, but its lobed tentacular fringe may be observed, the hæmal tentacle being even now distinguished from the rest of the fringe by its length and form.

Nine or ten branchial stigmata are discernible; but there are, as yet, no longitudinal branchial bars. The intestine is completely fashioned; and the elæoblast is large, conspicuous, and composed of a reticulated tissue.

In a fœtus $\frac{1}{21}$st of an inch long, with ascidiozooids $\frac{1}{56}$th of an inch long by $\frac{1}{64}$th of an inch from their oral to their cloacal extremities and nearly hemispherical in form (the flat side of the hemisphere being applied to the combined ovisac and cyathozooid), the isthmuses measure $\frac{1}{250}$th of an inch in length; and it is obvious that, while their central canals connect together the branchial sacs, the interspaces between their double walls place the sinuses of the ascidiozooids in communication. There are ten branchial stigmata, of which the first and last are very small; and six or seven longitudinal branchial bars have made their appearance. The mid-atrium is distinctly developed below and behind the gastro-œsophageal part of the alimentary canal. The place of the atrial aperture is indicated by the union of the atrial and outer tunics, in a round spot at the posterior part of the mid-atrium. In fact, the whole zooid is nearly in the same condition as the bud represented in Pl. XXX. fig. 22. The renal (?) organ has made its appearance as a patch of opake yellowish cells.

Ascidiozooids $\frac{1}{42}$nd of an inch long, by $\frac{1}{56}$th from their oral to their cloacal apertures, which form part of a fœtus $\frac{1}{18}$th of an inch long, and surround the lower half of the combined cyathozooid and ovisac, have ten or eleven stigmata and seven longitudinal branchial bars. The hæmal tentacle is well developed, the rudiment of the ciliated sac is discernible, and between the aperture of the central canal of the isthmus and the œsophagus are two rudimentary languets. The diapharyngeal band is very slender. The elæoblast has a length of about $\frac{1}{90}$th of an inch. The rudiment of the atrial aperture (round, and about $\frac{1}{330}$th of an inch in diameter) lies altogether below the level of the equator of the combined cyathozooid and ovisac. There is an indistinct appearance as of a small cavity between it and the latter organs. The posterior end of the endostyle appears quite distinctly to be continued back into the central canal of the isthmus. The rudiment of the heart is obvious, in close connexion with, and apparently developed from the wall of the branchial sac; and there are two slight papillary elevations in the place whence the stolons will be given off.

In a fœtus of about the same diameter as the preceding but whose ascidiozooids have a vertical diameter of $\frac{1}{33}$rd of an inch, while the combined cyathozooid and ovisac are $\frac{1}{50}$th of an inch long, the neural boundaries of the ascidiozooids project a little way beyond the open end of the cyathozooid. The upper edges of their atrial apertures, now $\frac{1}{180}$th of an inch in diameter, are still fully $\frac{1}{210}$th of an inch below the margin of the cyathozooid; and although the formation of the true cloacal chamber has commenced by the separation of the test from its cyathozooidal mould, yet its depth is so slight (not more than $\frac{1}{330}$th of an inch) that the end of the tongue-like inward prolongation of the test still lies between the lips of the mouth of the cyathozooid.

A fœtus of $\frac{1}{16}$th of an inch in diameter has the combined cyathozooid and ovisac not more than $\frac{1}{56}$th of an inch long, and cup-shaped—its upper, open end being as broad as its middle. The atrial apertures of the ascidiozooids (which measure $\frac{1}{30}$th of an inch in long diameter) are vertically oval, $\frac{1}{80}$th of an inch long, and lie almost wholly above the level of the upper edge of the cyathozooid. They open at once into the cloacal cavity, which, as measured from its roof, formed by the now hardly-projecting tongue-shaped process, to the upper edge of the cyathozooid, is $\frac{1}{84}$th of an inch deep.

The stolons of this fœtus are $\frac{1}{336}$th of an inch long, and are directed towards the aperture of the cloaca.

In one of the most advanced fœtuses I have met with (Pl. XXXI. fig. 15), about $\frac{1}{15}$th of an inch in diameter, the greatest length of the ascidiozooids (or the diameter parallel to the fœtal axis) was $\frac{1}{22}$nd of an inch, while their antero-posterior diameter was $\frac{1}{42}$nd of an inch. The long diameter of the combined ovisac and cyathozooid (the latter being now completely hidden between the hæmal moieties of the ascidiozooids) was only $\frac{1}{76}$th of an inch; or, in other words, they had not a third of their former dimensions. Each ascidiozooid of this fœtus has a roughly semicircular profile, the straight side being turned towards the axis of the fœtus. The curved contour is more convex on the hæmal, more flattened upon the neural face. From side to side each ascidiozooid is much compressed, so as not to measure more than $\frac{1}{56}$th of an inch in this direction.

The oral aperture is not yet pervious; but a circular groove of the outer surface of the test, $\frac{1}{95}$th of an inch in diameter, indicates the area in whose centre it will appear, around which centre lie the oral sphincter and the tentacular fringe. The latter, at present, not only projects into the buccal cavity but is divided into its processes; and the hæmal tentacle, $\frac{1}{310}$th of an inch long, exhibits its characteristic enlarged base and finger-like process. The peripharyngeal ridge exhibits its distinctive structure. Rather in front of its upper loop, a small process (the upper end of the diapharyngeal band) projects from the roof of the pharyngeal sac; and a corresponding remnant of the lower end of the same band is seen, as a small projection of the neural wall of the cavity, just above the tubercle of the ganglion.

The urinary (?) organ is very distinct as a mass of pale, spheroidal, granular bodies, and occupies its normal place.

The ganglion, and so much as could be made out of the ciliated sac are similar to the same structures in adults; but the ganglion has a length of only $\frac{1}{240}$th of an inch.

In one of the ascidiozooids of this specimen the isthmus can be well studied as it passes off from the neural side immediately behind the ganglion. Where it joins the ascidiozooid it is $\frac{1}{275}$th of an inch wide, but, in the middle of its length, it has a diameter of not more than $\frac{1}{870}$th of an inch. In consequence of its passing obliquely from the neural face of one ascidiozooid to the hæmal face of the next, it is, of course, rather longer than the largest diameter of the ascidiozooid (or more than $\frac{1}{22}$nd of an inch long). Viewed from the side, it looks like a clear, transparent tube, divided by a partition into two channels; but where it bends round, and so exhibits a transverse section, this partition is itself clearly seen not to be a simple septum, but to be formed by two membranous lamellæ, which stretch from wall to wall of the isthmus, and are themselves separated by an interval of $\frac{1}{4800}$th of an inch. In fact, the central canal has now assumed this partition-like character. If traced up to the neural wall of the one ascidiozooid with which it is connected, the outer membrane of the isthmus obviously passes into the outer tunic of the ascidiozooid, while the walls of its contained, inner canal are continuous with the inner tunic, or pharyngeal mucous membrane, of the same part. On the other hand, if it be followed to the hæmal wall of the other ascidiozooid, the outer membrane of the isthmus passes into the outer tunic of that region, while the wall of the inner tube is continuous with the endostylic cone. It is obvious, therefore, that the composition of the isthmus is, in reality, the same as in earlier stages and that, while its central canal connects the pharyngeal cavities of the two ascidiozooids, the interspace between this canal and the outer walls of the isthmus connects their sinuses.

Between the attachment of the isthmus and the œsophageal aperture only two languets are developed from the hypopharyngeal region. The great sinus beneath them is full of agglomerated blood-corpuscles.

The endostyle is still broad proportionally ($\frac{1}{150}$th of an inch), but all its parts are well developed. It ends posteriorly in a short process or endostylic cone, $\frac{1}{380}$th of an inch long, which, as I have said above, passes into the central tube of the isthmus.

A cellular mass, $\frac{1}{540}$th of an inch long, is attached to the external tunic, close to the end of the endostylic cone, if not directly connected with it; and this, I am inclined to think, is the rudiment of the generative blastema. I have not been able to detect any distinct structure (as of an ovisac or testis) in it, which is remarkable when one considers the early appearance of the ovisac in the buds.

The branchial stigmata are altogether twelve in number. The anterior and posterior are rudimentary while most of the others extend across almost the whole depth of the branchial sac. The cilia are perfectly distinct upon their edges. The longitudinal branchial bars are nine in number. The intestine has nearly the same form as in the adult, and the tubular, hepatic system is well formed. The heart is visible in its place. The elæoblast is a mass of clear reticulated tissue, causing the hæmal wall to bulge a little on each side of the middle line, and occupying the interval between the endostyle and generative blastema, on the one hand, and the heart and intestine on the other.

The atrial aperture is enormous in proportion, occupying the greater part of the inner face of the ascidiozooid above the level of the cyathozooid and attaining a length of fully $\frac{1}{42}$nd of an inch and a breadth of $\frac{1}{112}$th of an inch. In other words, the atrial aperture is six times as large as it is in the adult ascidiozooid, though the latter is at least eight or ten times as large as one of the zooids of the fœtus under description. In consequence of the great proportional size of these oval apertures, whose long diameters are parallel with the axes of the fœtus, the intervening wall of the cloaca is very narrow.

The cyathozooid and ovisac are $\frac{1}{50}$th of an inch long by $\frac{1}{70}$th wide and more cylindrical than cup-shaped. The aperture, still distinctly visible, has a diameter of $\frac{1}{500}$th of an inch; and as the cloacal chamber is now $\frac{1}{54}$th of an inch deep, the margin of the aperture is but just on a level with the convex, neural margin of the œsophagus of any of the ascidiozooids. Where the former tongue-like process existed, the roof of the cloaca now hardly projects inwards at all.

The atrial muscles are visible as very delicate, straight bands, $\frac{1}{47}$th of an inch long by $\frac{1}{3800}$th wide, which take an oblique course on each side, from a point a little below the end of the endostyle, neurad and a little forwards, to a point opposite the commencement of the œsophagus. In the middle of their course these bands lie very near the lips of the atrial aperture.

The stolons are $\frac{1}{230}$th of an inch long; they pass almost horizontally inwards, towards the rudimentary lip of the cloaca, and are curved towards its cavity, at their blind extremities. The corpuscles of which their walls are composed are more elongated than before and, sending processes into the adjacent substance of the test, cause the cæcal ends of the stolons to have a very peculiar, brushlike appearance.

3. *The Test.*—As I propose to reserve the description of the histological changes undergone by the embryo of *Pyrosoma* for another occasion, I will merely state, in this place, that the test appears, at first, to be a structureless excretion. Subsequently, cellular bodies, like connective-tissue corpuscles, are discernible in its most superficial layer, and are disposed in such a manner as to form a very regular, hexagonal network, with large meshes. The most advanced fœtus has presented neither of the fibrous layers visible in the adult test.

Ninth Stage. *The conversion of the tetrazooidal fœtus into the adult ascidiarium.*

The most advanced fœtus which has been described differs from the adult ascidiarium not merely in size, in the paucity of its ascidiozooids, in the form and proportions of the latter, in the absence of buds, or ever so slightly differentiated reproductive organs, in them, and in their large atrial apertures (all of which are peculiarities which we may easily conceive to be altered by age and growth), but in still more important characters, seeing that in the adult ascidiarium I have met with no trace of the cyathozooid or the isthmuses, nor have I been able to discover any ascidiozooid with two stolons.

The first theory of the mode of formation of the adult ascidiarium which suggests itself is obviously that which supposes that the four ascidiozooids of the fœtus give rise, by budding, to all those of the adult *Pyrosoma*, at the same time losing the two stolons, and acquiring reproductive organs, so as to be undistinguishable from their agamogenetic progeny.

But difficulties arise when we compare this theoretical conception with the structural characters, and the ascertained laws of gemmation of *Pyrosoma*.

In every ascidiozooid of the adult ascidiarium (and there is no reason to suppose that those of the tetrazooidal fœtus constitute exceptions to the rule) budding takes place, as we have seen, from a single definite region of the body, situated in the posterior moiety of the hæmal surface; and the buds remain, in nearly the same plane as that in which they were given off, until they have attained some distance from the parent. It has been seen, in fact, that three buds, given off successively from one ascidiozooid, may be visible, one below the other, in the same, not very thick, longitudinal section. But in the tetrazooid, as in the adult, the hæmal side is that turned away from the aperture of the ascidiarium. If, then, the buds thrown off from the ascidiozooids of the fœtus all remain on the hæmal, or apical, side of their parents, we ought, on examining the adult organism, to find the four primitive ascidiozooids close to the margin, with a series of two or three buds, in various stages of development, attached to each.

As a matter of fact, however, no section taken near the margin of the aperture has ever presented an appearance essentially different from that represented in Pl. XXX. fig. 4. The ascidiozooids have always been young, and, on the average, younger, the nearer they were to the margin. But they have never been younger than such a bud as is represented in fig. 24, Pl. XXX.; and those of the first three or four tiers have always possessed imperfectly developed sexual organs, and buds not more advanced than those represented in figs. 19 and 20.

That the ascidiozooids which lie nearest the aperture are the result of the budding of other ascidiozooids is beyond all doubt. As I have traced the development of the stolon from such a modified bud, it is clear that the bud is not developed, as I had once imagined, from the stolon of another ascidiozooid,—these stolons being invariably traceable, without a break, into the lip of the cloaca, where they end cæcally. There appears to me, then, to be no other course open but to suppose that these young ascidiozooids which lie nearest the aperture, are buds which were originally developed from the hæmal region of ascidiozooids which lie nearer the apex, and that they have consequently passed round and to the neural side of their parents. If this migration of the buds really occurs, it will follow, as Savigny supposed, that the four apical ascidiozooids of the adult are the modified zooids of the fœtus,—the buds developed from their hæmal walls not remaining upon their apical side, but passing up between them on to their neural sides, and there becoming themselves new centres, whence fresh buds are thrown off, which gradually take their places in a still higher tier.

I can conceive of no other mode in which the structure of the fœtus, the structure of the adult and the law of budding can be reconciled; and yet I am reluctant to admit so seemingly artificial a process on anything short of direct evidence. Such evidence, however, is only to be obtained by the examination of young *Pyrosomata* but little larger than fœtuses, none of which have come into my possession.

§ 5. *Summary and discussion of the results of the observations on the gamogenetic development of* Pyrosoma giganteum.

If the observations detailed in the preceding pages be correct, and no flaw be found in that interpretation of them which has been offered, it follows that—

1. The ovisac of *Pyrosoma* at first contains an ovum, altogether similar to that of other animals, and in particular resembling that of many *Cœlenterata*, *Molluscoida*, and *Mollusca*, in the absence of a vitelline membrane.

2. Impregnation is effected by the passage of the spermatozoa up the duct of the ovisac, and it would seem that these spermatozoa must immediately come into contact with the yelk; but when, and how, the essential act of fecundation (consisting in the action of the spermatozoa upon the germ) takes place, does not appear.

3. There is neither complete nor partial, yelk-division; but the vitellus disappears, as such, apparently becoming diffused through the contents of the ovisac, which rapidly increases in size. By this deliquescence of the yelk the germinal vesicle is laid bare.

4. The germinal vesicle adheres to a particular spot of the epithelial lining of the ovisac, close to the opening of its duct and, eventually traversing that epithelial lining, takes up a position between it and the *membrana propria* of the ovisac.

5. In the meanwhile, a turbid deposit takes place in that moiety of the germinal vesicle which lies nearest the aperture of the duct; and the germinal spot, a remarkably obvious structure in this and preceding stages, is partially imbedded in this deposit.

6. The germinal vesicle grows and becomes more flattened; but soon, although it is quite translucent, the germinal spot can no longer be found in it. In the place of that structure and resulting, as I suppose, from its division, a number of small, clear, spheroidal corpuscles are visible upon the face of the deposit in the germinal vesicle.

7. Next, the germinal vesicle, as such, is no longer visible; but, occupying the same place, preserving the same colour, having very nearly the same size and, on the side turned towards the duct, the same curved contour, there is a flat patch, consisting of a single layer of excessively delicate corpuscles, each with its clear space and central particle—constituting the commencement of the blastoderm.

8. The blastoderm enlarges, assumes a band-like form, and becomes divided by constrictions into five segments: of these, one becomes the cyathozooid—a temporary structure, which is especially attached to one pole of the ovisac, and, among other purposes, serves as a sort of precursor, or mould, of the cloaca; the other four are converted into ascidiozooids.

9. The ascidiozooids enlarge and eventually give rise to the tetrazooidal fœtus described by Savigny. The cyathozooid and the ovisac which it surmounts diminish in size and, probably, eventually disappear. The lining epithelium of the ovisac early acquires a peculiar vesicular structure.

10. All these changes, subsequent to the formation of the blastoderm, take place in the

mid-atrium of the parent, which the fœtus, at length, completely fills. There appears to be no placental connexion between the fœtus and the parent; but the nutritive matter contained in the large ovisac may well be supposed to pass into the sinuses of the cyathozooid and thence into those of the ascidiozooid, and thus to subserve the nutrition of the whole fœtus.

In successively commenting upon the preceding paragraphs, I shall consider how far the embryogeny of *Pyrosoma* can be parallelled by that of other animals, and how far it offers exceptional peculiarities.

1. I do not think that any one, acquainted with the structure of the ovarian ova of other Ascidians and of the *Mollusca* generally, will entertain the slightest doubt that the parts called germinal spot, germinal vesicle and vitellus, respectively, in the preceding pages, really have the nature I have assigned to them. The ovisac corresponds with a single acinus of the ovary of other *Mollusca* and *Molluscoida*, and is altogether similar to the solitary ovisac of *Salpa*.

2. The process of impregnation presents nothing anomalous; but, as regards the act of fecundation, it is remarkable that the spermatozoa should so long remain aggregated in a mass in the upper end of the duct, without, to all appearance, penetrating into the cavity of the ovisac or into the substance of the yelk. Still more singular is that appearance of scattered, rod-like bodies, not unlike the heads of spermatozoa, upon and about the very young blastoderm. If I could feel thoroughly assured that these bodies are really the spermatozoa, I should be inclined to follow out to some length a series of considerations suggested by the fact, as to the essential nature and place of occurrence of impregnation. For the present, however, I will merely remind the reader that the so-called 'disappearance of the germinal vesicle,' and even a certain progress in yelk-division, may take place without impregnation*; whence it may seem less strange than it appears at first sight, to suppose that the influence of the spermatozoa may be exerted, in some cases, not upon the yelk, nor upon the germinal vesicle as such, but upon the nascent blastoderm.

3. The only animals which, so far as I know, present a condition of the yelk at all comparable to its liquefied and pellucid state in *Pyrosoma*, are *Ascaris dentata*, *Cucullanus elegans*, and *Oxyuris ambigua*. In these nematoid worms, the vitellus, according to Kölliker †, is represented only by a clear, transparent fluid containing a very few granules, and it takes no direct share whatever in the formation of the embryo. The vitellus seems to play an equally subordinate part in the great majority of the *Articulata*, but in these animals it is commonly opake and granular.

4. If the ovisac of *Pyrosoma* be compared with the Graafian follicle of a mammal, the resemblance (notwithstanding their obvious differences) of the two structures is marked; and the manner in which the germinal vesicle traverses the epithelium of the ovisac of *Pyrosoma* is singularly like the manner in which the mammalian ovum imbeds itself

* See Leuckart, art. "Zeugung," Wagner's Handwörterbuch, iv. p. 958. What Leuckart says here about the Frog is not in accordance with the results of the careful experiments of Newport (Phil. Trans. 1851, p. 190), who arrives at the conclusion that segmentation certainly does not take place in the unimpregnated ovum. Vogt's case is not satisfactory, as there is no counter evidence to show that impregnated ova would have developed under the circumstances. Bischoff's observations on the Sow (Ann. des Sci. Nat. 1844), however, appear to be unexceptionable evidence.

† Beiträge zur Entwickelungs-geschichte wirbelloser Thiere. Müller's Archiv, 1843.

among the cells of the proligerous disk. A still closer parallel, perhaps, is presented by the bird's egg, if we consider the mode in which its germinal vesicle (which at first occupies the centre of the future egg, and is contained in a primitive ovum surrounded by, at any rate, a rudimentary vitelline membrane) passes to the surface, and eventually lies immediately beneath the membrane which encloses the food-yelk *.

5, 6, 7. The consideration of the phenomena enumerated under these heads opens up the whole vexed question of the fate of the germinal vesicle.

Since the imaginations of Dr. Martin Barry have fallen into just discredit, most physiologists have more or less distinctly adopted the doctrine that the germinal vesicle and its contents lose their identity and disappear; and that the embryo-cells, whence the blastoderm arises, are new structures not directly derived from them.

The evidence by which this conclusion is supported, however, will be found, if closely sifted, to be, for the most part, not only negative, as by the nature of the case it must be, but weakly negative. That is to say, not only is the conclusion based upon the circumstance that, at a given period, the observer was unable to find the germinal vesicle or to identify its contents,—but, in most cases, the circumstances are such that he might very well have missed them had they existed. Even in *Pyrosoma* it is no easy matter, until one has had some practice, to find the germinal vesicle when it is passing into the blastoderm, although, in all the earlier stages, nothing can be more obvious; and had the ovisac of *Pyrosoma* been filled with even a very slightly granular yelk, I believe the discovery of the germinal vesicle, at this period, would be almost impracticable. What wonder, then, that it should be impossible to identify the germinal vesicle or its contents in the midst of the more or less opake and coarsely granular substance of which the yelk of ninety-nine ova out of a hundred is composed? The only case to which this reasoning does not apply is that described by Kölliker in the paper already referred to (*l. c.* p. 76):—

"As regards the internal changes undergone by the eggs [of *Ascaris dentata*], the most striking fact is that, immediately after fecundation, the germinal spot and the germinal vesicle have disappeared and the clear and transparent yelk contains nothing but scanty elementary granules. This is a point of great importance; and to show that there is no possibility of being deceived about it, I add, that the ovum of *Ascaris dentata*, including its chorion and vitelline membrane, is so transparent that all the outlines of a body which may happen to lie beneath it are quite sharply and distinctly recognizable, and its contents are so clear and patent that hardly the smallest elementary granule of the yelk can remain hidden. Which of the two parts first disappears, the germinal spot or the germinal vesicle, I cannot as yet say with certainty; but, in one individual, I saw two ova which had hardly traversed the seminal cells in the fundus uteri, and though they still exhibited a germinal vesicle, had no germinal spot. In another individual, I observed the same thing in an ovum imbedded in the midst of the seminal cells; so that I have some ground for the opinion that it is the germinal spot which disappears first. Further and repeated observations must decide whether this is the rule or whether, in other cases, it is not the germinal vesicle which disappears first. But I must observe, that this first stage of the development of the ova appears to be of very short duration;

* See Dr. A. Thomson's admirable article "Ovum" in Todd's Cyclopædia.

for, while no fecundated female *Ascaris* which I examined would have failed to supply me with a complete series of all the other stages of development, it was but thus rarely that these first processes presented themselves.

"As the ovum, now deprived of its germinal vesicle and spot, is propelled downwards by the peristaltic contractions of the uterus, the first embryo-cell is formed in the middle of its clear yelk. I have never been able to detect the mode of its origin. . . . . By endogenous development, the embryo-cells give rise to other cells, which become the blastodermic mass whence the embryo is formed. The yelk, as such, disappears."

I am prepared to admit the full force of this carefully observed example of the disappearance of the germinal vesicle and the merging of its contents in the yelk, but it is the only case, within my knowledge, to which great weight can be attached; while, on the other hand, independent observers have (of late years) recorded equally definite and positive observations that in some groups of animals, at any rate, the germinal vesicle does not disappear, but that it gives rise by division to the primary cells of the embryo.

Thus, Dr. Nelson, in his memoir "On the Reproduction of *Ascaris mystax*" (Phil. Trans. 1852, pp. 580, 581), affirms that the germinal vesicle of the impregnated egg of this worm bursts, and sets free the germinal spot, which is directly transformed into the first embryo-cell.

The deservedly great authority of the late Johannes Müller may be cited on the same side—so far, at least, as that singular mollusk, *Entoconcha mirabilis*, is concerned.

Dr. Gegenbaur affirms the occurrence of a similar process to be the rule among the *Calycophoridæ*, *Physophoridæ*, and certain other *Hydrozoa*, and in that singular annulose animal, *Sagitta*. Thus, in describing the development of *Oceania armata* (Zur Lehre vom Generationswechsel, 1854, p. 28), Gegenbaur says (the italics are his own) :—

"Every act of division is preceded by a division of the nucleus, and consequently the first act by the *division of the germinal vesicle*: the transparency of the yelk allows of the most precise observation of all these phenomena, and the following of *the development of the nuclei of the later embryo-cells out of the original germinal vesicle* (the nucleus of the primitive ovi-cell)."

Again, at p. 50 of his "Beiträge zur näheren Kenntniss der Schwimmpolypen" (1854), the same author remarks, in giving an account of the development of these *Calycophoridæ* and *Physophoridæ* :—

"A process which may be here traced with particular clearness is the constant *division of the germinal vesicle, which precedes the division of the yelk*; and the products of the division of the germinal vesicle behave similarly, in relation to the subdivision of the yelk-masses. I observed this process of yelk-division in *Agalmopsis*, *Physophora*, *Forskalia*, *Hippopodius*, and *Diphyes*, without noticing any important differences among them."

Leydig expresses the same conclusion, though more guardedly, in his account of the development of the ova of *Notommata Sieboldii** :—

"The nuclei of the division-masses are very clear; and it appeared to me *as if the homogeneous, clear nucleus of the ripe ovum* (*the germinal vesicle*) *stood in a genetic rela-*

* "Ueber den Bau und die systematische Stellung der Räderthiere." Siebold und Kölliker's Zeitschrift, 1855.

tion to the nuclei of the division-masses—i. e., gave rise to them by immediate division. The ovum is, in fact, more transparent than in other *Rotifera;* and I have observed the absence of the germinal vesicle."

In a subsequent passage Dr. Leydig adverts to these observations as having inclined him to alter his previously entertained opinions respecting the fate of the germinal vesicle.

So far as the *Vertebrata* are concerned, such evidence as we possess as to the independent origin of the embryo-cells appears to be altogether of the weakly negative sort. I do not think it can be said that there is adequate foundation for the general assumption that the contents of the germinal vesicle take no direct share in their production; on the contrary, as respects the Frog, I find definite evidence tending to a contrary conclusion. Prevost and Dumas, and Von Bär, as is well known, proved the existence of a canal leading from the centre of the dark part of the Frog's egg to a cavity which Von Bär considered to be the seat of the germinal vesicle. Newport (Phil. Trans. 1851) described and figured this canal and cavity, and showed that the germinal vesicle is, in the ovarian ovum, lodged in the cavity. The vesicle is said to be dense, white, and opake, and its interior to be full of secondary cells*. Newport affirms that no trace of the vesicle is to be found in ova that have left the ovary, but that an accumulation of white nucleated cells sometimes occupies its place, in ova which are in the act of leaving the ovary.

Remak (Entwickelung der Wirbelthiere, 1855), apparently unacquainted with Newport's observations, doubts whether the cavity down to which the canal leads, and which he terms Von Bär's 'Kernhöhle,' contains the germinal vesicle, though he inclines to the opinion that it does. But it is a most important circumstance that he proves (*l. c.* p. 137) that the division of this cavity accompanies each division of the yelk-mass, and that, eventually, these cavities become what he terms the nuclei provided with nucleoli, which occupy the centres of the division-masses of the yelk, and are the homologues of the embryo-cells of *Ascaris*. If both Newport's and Remak's observations are correct, it would seem impossible to deny that the embryo-cells of the Frog proceed from the contents of the germinal vesicle.

I think, then, that considering the only case in which the contents of the germinal vesicle are not traceable, under circumstances in which it might be reasonably expected that, if they really exist, they should be visible, is that observed by Kölliker; while, on the other hand, the equally definite observations of Nelson, Müller, Gegenbaur, and myself (and the less distinct evidence of Newport, Remak, and of Leydig) testify to the origin of the blastoderm in one way or the other from the contents of the germinal vesicle, in various members of no less than four† out of the five primary divisions of the animal kingdom; the balance of the evidence is in favour of the conclusion that the embryo-cells are the progeny of another cell, and that here, as elsewhere, extracellular cell-development is a phenomenon of rare, if not of altogether questionable, occurrence.

* Newport, it should be observed, used the term 'cell' not very critically. But, ten years ago, cell-worship had attained its culminating point.

† *Cœlenterata, Mollusca, Annulosa, Vertebrata.* I may add, that the first appearance of the blastoderm on the surface of the ovisac of *Pyrosoma* is so like that of the blastoderm in the ovum of any of the higher *Articulata*, as strongly to suggest a similarity of origin.

8, 9, 10. Thus far the problem has been to find a parallel for those early embryogenetic processes which are ordinarily common to large assemblages of living beings. Analogies for the more special modifications which the blastoderm undergoes may be sought for in the group of which the genus *Pyrosoma* forms a part. In the first place, it may be asked, are there, in this group, any examples of the division of the blastoderm into segments, one of which is to serve a temporary purpose, while the others become ascidiozooids?

Leaving the development of the caudal appendage of ordinary Ascidians out of consideration, as hardly a case in point, it yet appears that even in these Ascidians, the body of the embryo is, during its locomotive stage, divided into two segments, the anterior of which gives rise to the so-called suckers (which are diverticula of its wall with involuted ends), while the posterior is the rudiment of the body.

Löwig and Kölliker, in their description of the compound larva of *Botryllus* (originally discovered and described by Sars), consider the three processes which are given off from the "large round 'mamelon' provided with an orifice" as the homologues of the three processes given off from the anterior division of the larval body in the simple Ascidians. In this case this 'mamelon,' which they consider to be the rudiment of the cloaca, must correspond with that anterior division. But the examination of their figures and descriptions renders it hardly doubtful to my mind that the 'mamelon' is a structure homologous with the cyathozooid of the fœtal *Pyrosoma*, the eight rudimentary ascidiozooids of the *Botryllus* being arranged around its base, just as the four are disposed in the fœtal *Pyrosoma*. If this reasoning be correct, it follows that the cyathozooid of *Pyrosoma* corresponds with the anterior division of the body in the ordinary Ascidian larva, *e. g.* of *Clavelina*.

The peculiar connexion of the embryo *Pyrosoma* with its ovisac, and the extrusion of the latter combined with the embryo, as a single fœtus, into the mid-atrium of the parent, are, however, peculiarities for which we should in vain seek a parallel among ordinary Ascidians. But there is one family of this class, the *Salpæ*, which resemble *Pyrosoma* in having an elæoblast, and in possessing no caudal appendage in the larval state (differing in the same respects from all other Ascidians), in which the search for analogies is more hopeful.

Most *Salpæ*, like *Pyrosoma*, possess, as Krohn was the first to point out, but a single ovisac, connected by a peduncle-like duct with the wall of the mid-atrium. Prof. Leuckart, who, with a knowledge of all that had been written upon the question, subjected the reproductive processes of the *Salpæ* to a renewed and very careful scrutiny, some years ago* stated (*l. c.* p. 47) that the ovum of *Salpa mucronata* consists of a granular, tolerably viscid yelk, enclosing a large, vesicular germinal vesicle, with a simple germinal spot. No vitelline membrane was to be detected,—the only covering of the ovum being the ovisac, which is closely applied to the surface of the vitellus, and is lined internally with a layer of small nucleated cells. The peduncle of the ovisac is a short, narrow duct, which only becomes a little thicker at its anterior end and, like the ovisac, is lined by an epithelium. Its anterior end opens into the atrium; and in the vicinity of the aperture

* Zoologische Untersuchungen, Zweites Heft, Salpen u. Verwandte. Giessen, 1854.

the inner tunic exhibits an elongated, discoid thickening, in which numerous small nucleated cells, like those in the ovisac and its duct, are to be detected. This description, it is obvious, would apply equally well to the young ovisac of *Pyrosoma*.

It does not appear that the entrance of the spermatozoa into the duct of the ovisac has been observed in the *Salpæ*.

I have stated in my Memoir already cited (Phil. Trans. 1851, p. 577), that in a more advanced stage, probably after fecundation, the ovisac (which I called ovum) appears like a cellular mass. H. Müller (Siebold and Kölliker's Zeitschrift, iv. p. 331) speaks of the occurrence of yelk-division at this stage, without, however, describing that process more particularly. Vogt did not observe it, nor does Leuckart add much to our information on this head:—

"I can say little more about it [yelk-division] than that it begins during the change of place of the ovum (as H. Müller has also observed), and, as in the allied Ascidians, is a total yelk-division. When it has arrived in the fœtal chamber (Brutsack), the yelk exhibits the well-known mulberry appearance" (*l. c.* p. 52).

It is unfortunate that these observations are not so precise and detailed as they might have been; for the question at once suggests itself, is this appearance presented by the ovisac really due to yelk-division? What has become of the epithelium of the ovisac? Might not the change in the appearance of the latter be due to an alteration in the character of the epithelium, similar to that which obtains in *Pyrosoma*?

The next steps in the development of *Salpa* are, as I pointed out in 1851 (*l. c.* pp. 575–577), the enlargement of the ovisac, the shortening of its duct, and the consequent approximation of the ovisac to the atrial wall, and, finally, the protrusion of this part of the atrial wall into the atrium, so as to form a chamber containing the ovisac. This the German observers term the "Brut-sack," which may be rendered "fœtal chamber."

Arrived in the fœtal chamber, I have said (*l. c.* p. 575) that the fœtus "becomes divided into two portions,—a larger turned towards the respiratory cavity, and which projects more and more into it, and a smaller, subspherical, turned towards and lying in the cavity of the sinus, and bathed by the parental blood." The former becomes the embryo, the latter the placenta.

Leuckart's description comes to the same result, but is much fuller in details (pp. 52, 53):—

"When the vitelline mass has increased to about double its primitive diameter, and has become changed by continual division into numerous small division-masses about $\frac{1}{100}'''$ in diameter, it loses its spherical form. A circular constriction appears in it, by which its anterior end is marked off as a hump-like process. This constriction indicates the boundary between the fœtus and the placenta. The placenta is, at first, the more considerable of these two parts. It is, one may say, the remains of the vitelline mass (yelk-sac) which is left after the formation of the rudiment of the embryo, and now, instead of being directly applied to developmental purposes, is metamorphosed into an accessory fœtal organ. . . . It has been mentioned above that the posterior segment of the yelk, in the fœtal chamber, is freely bathed by the blood of the parent. By the delimitation of the embryo, this segment has now become the posterior end of the placenta: at first, as a part of a spheroid, it naturally possessed a convex surface; but this disappears as soon as the first traces of embryonic development are visible. The posterior end of the placenta becomes flattened, and its centre acquires a depression, which penetrates deeper and deeper into its substance. The placenta loses its originally solid character, and (even before there is any marked change in the embryo) becomes rapidly metamorphosed into a cupola-like structure, whose internal cavity is connected by its posterior aperture with the circulatory apparatus of the parent, and may be regarded as a sinus for its blood. The inner walls, freely bathed by this blood, exhibit many irregular elevations, which for the most part run, like ribs, from the apex of the cupola to its entrance. Not uncommonly there is also a conical process, which projects from the roof of the cupola for a greater or less distance into the cavity."

Vogt (Bilder aus dem Thierleben, p. 79 *et seq.*) gives an essentially similar account of the development of the placenta of *Salpa pinnata* *. Eventually the fœtus makes its way through the wall of the atrium, and, carrying its placenta with it, lies free in that cavity, whence it must shortly be expelled.

On the face of the matter, there appears to be a close analogy between this process and the development of the fœtus of *Pyrosoma*; for the projection of the atrial wall, caused by ovisacs in which the blastoderm is just appearing, may be fairly compared with the commencing fœtal chamber; while, if there were only one ascidiozooid instead of four, its relation to the cyathozooid would be very similar to that which the embryo of *Salpa* has to its placenta. Nor is there wanting a very considerable resemblance in form and character between the cyathozooid and the placenta.

But so much remains to be done before the developmental history of *Salpa* can be said to be fully made out, that I do not know how far these apparent resemblances may be depended upon as affording evidence of real similarity between the developmental histories of *Pyrosoma* and of *Salpa*. Vogt, Müller, and Leuckart seem, as little as myself, to have endeavoured to trace the fate of the ovisac and of its epithelium. And yet, with the development of *Pyrosoma* before me, it is impossible to arrive at a conclusion in the absence of information on this head. The long retention of the fœtus of *Salpa* in connexion with the parent and nourished by its blood, in contrast to the early separation of the fœtus of *Pyrosoma* and the turning of its cyathozooid to account in another way, leads me to conceive that considerable differences will be found in the details of their development, though I suspect further inquiry will prove that, in essentials, they are very similar.

* On the other hand, the description and figures by H. Müller, in the 'Icones Zootomicæ' of Prof. J. V. Carus, tab. 18, lead me to suspect the existence of differences in the development of the placenta in this species.

EXPLANATION OF THE PLATES.

Plates XXX. and XXXI.

The following letters and figures have the same signification throughout.

a, the test; a^1, its oral; a^2, its cloacal fibrillated layer; a^3, labial processes of the ascidiozooids; a^4, lip or so-called sphincter of the cloacal aperture; a^5, cells of the embryonic test.

b, outer tunic.

c, inner tunic, or intestinal wall.

d, atrial tunic.

e, oral aperture.

f, tentacular membrane; f^1, hæmal tentacle.

g, g^1 anterior muscles; g^2, posterior or atrial muscles.

h, peripharyngeal ridge.

i, endostyle.

j, epipharyngeal folds.

k, hypopharyngeal band and sinus; k^1, languets; k^2, diapharyngeal band.

l, branchial sac; l^1, horizontal branchial bars; l^2, perpendicular branchial bars; l^3, stigmata.

m, alimentary canal; m^1, œsophageal aperture; m^2, œsophagus; m^3, stomach; m^4, intestine.

n, tubular organ, probably hepatic.

o, anus.

p, mid-atrium; p^1, lateral atria; p^2, atrial aperture.

r, heart; r^1, sinuses; r^2, stolons of the adult ascidiarium; r^3, vascular bands, connecting the branchial sac with the parietal sinus; r^4, stolons of the embryonic ascidiarium, or tetrazooid.

s, ovisac; s^1, its duct; s^2, lining of the ovisac.

t, testis; t^1, vas deferens; t^2, spermatozoa.

u, yelk; u^1, germinal vesicle; u^2, germinal spot; u^3, contents of the germinal vesicle.

w, bud; w^1, its peduncle.

x, alimentary or trophic blastema of the nascent bud; x^1, its generative blastema; x^2, its tegumentary blastema.

y, the circular cellular patch, probably a renal organ.

z, the ganglion; z^1, nerves; z^2, the ciliated sac; z^3, the tubercle.

æ, elæoblast.

en, embryonic endoplasts within the germinal vesicle.

bl, blastoderm.

cl, cloaca.

I. II. III. IV. V. Segments of the blastoderm. I. Cyathozooid. II.–V. Ascidiozooids.

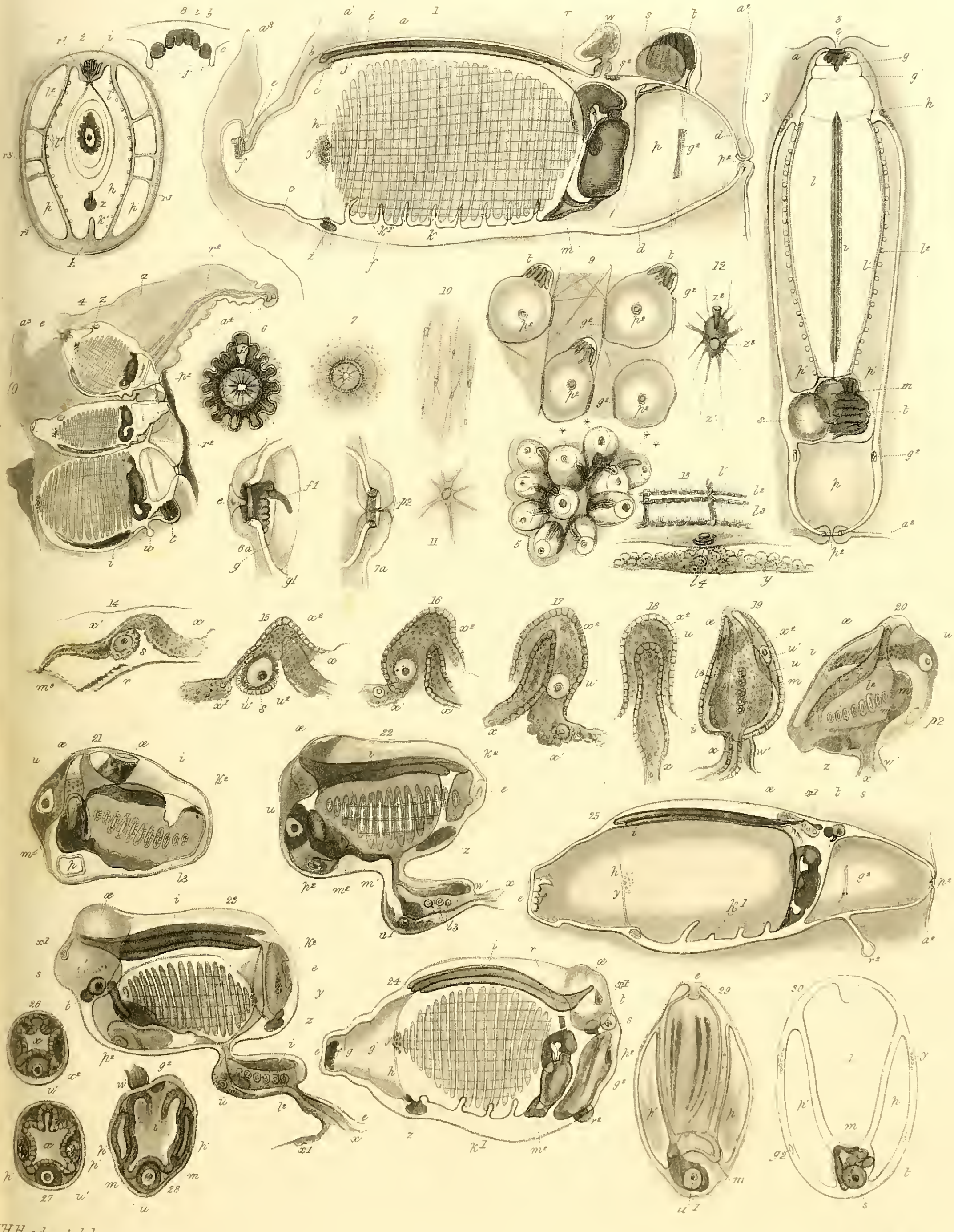
1, 2, 3, 4, isthmuses.

β, the mouth of the cyathozooid, as formed by the test, and which becomes the future lip or 'sphincter' of the cloacal aperture; β^1, aperture of the cyathozooid when separated from the foregoing.

γ, cavity of the cyathozooid.

δ, appendix of the cyathozooid.

θ, canal connecting the first isthmus with the cavity of the cyathozooid.



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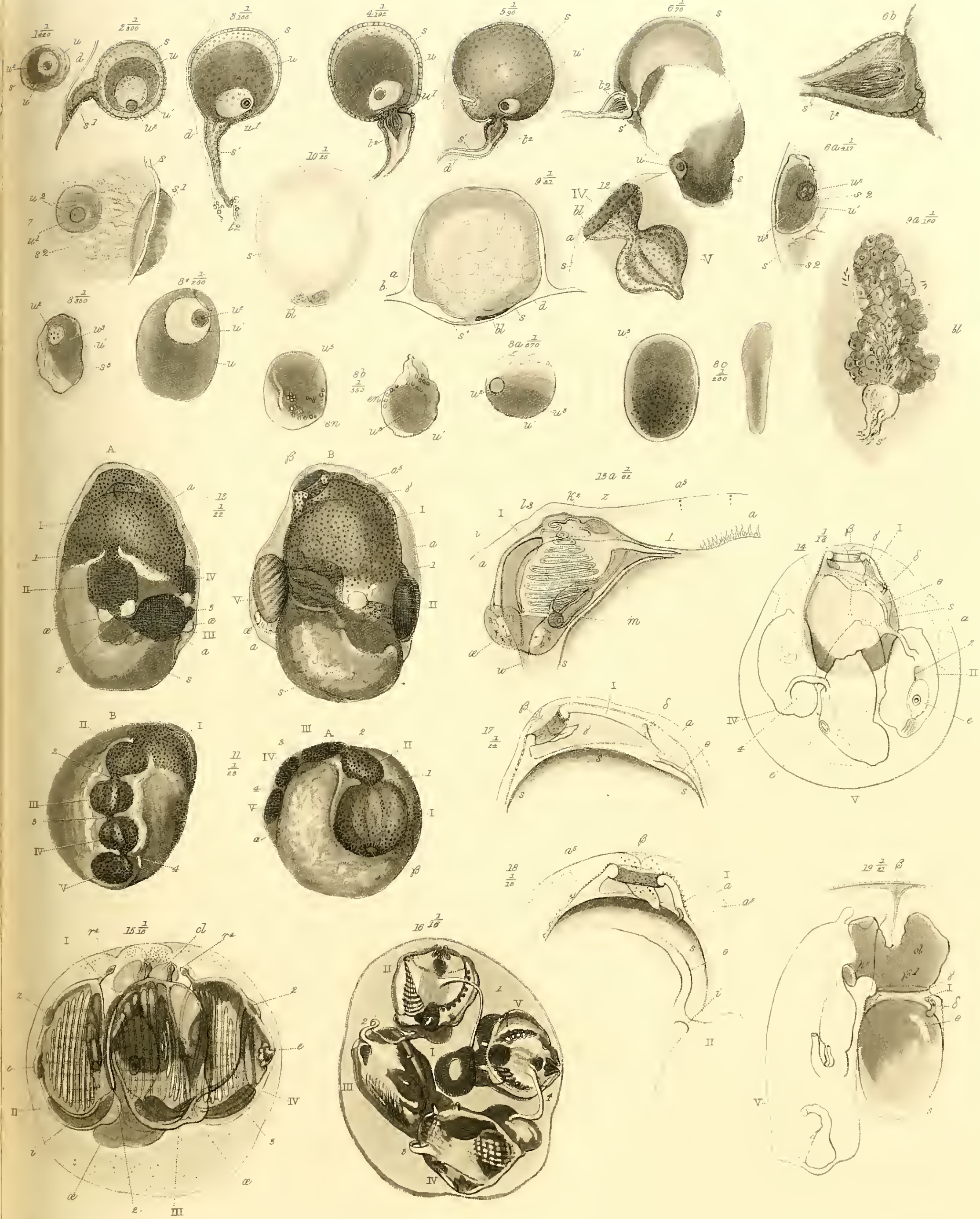

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G. Jarman sc.

Plate XXX.

Fig. 1. A side view of a single ascidiozooid from the middle of the ascidiarium of *Pyrosoma giganteum*.

Fig. 2. A transverse and vertical section of the middle of the branchial region of a similar ascidiozooid, exhibiting, in addition, the oral aperture, anterior muscles, peripharyngeal ridge, ganglia, and anterior end of the endostyle. There are more vascular bands (r^3) represented than would be seen in any one transverse section.

Fig. 3. A transverse and horizontal section of an ascidiozooid without any labial process. It should be understood that s and t lie altogether above the intestine, and hence do not interrupt the communication between p and p^1 p^1.

Fig. 4. A vertical section of the wall of the ascidiarium, near the cloacal aperture and including its lip.

Fig. 5. View of part of the closed end of the ascidiarium, showing the four ascidiozooids (* * * *) which form its apex.

Figs. 6 & 6*a*. The oral aperture viewed from within and from the side.

Figs. 7 & 7*a*. The atrial aperture viewed under the same aspects.

Fig. 8. A transverse and vertical section of the middle of the hæmal region of the branchial sac, showing the endostyle and the parts adjacent.

Fig. 9. Part of the wall of the middle of the ascidiarium viewed from within, or from the cloacal side.

Fig. 10. The cloacal fibrillated layer.

Fig. 11. A cell of the general substance of the test.

Fig. 12. The nervous ganglion viewed from above.

Fig. 13. A section of the body-wall of an adult ascidiozooid, taken through the 'urinary' organ. l^4 indicates a minute depression which I was at one time inclined to regard as an aperture into the parietal sinus over this organ; but I suspect it is only a nascent stigma.

Fig. 14. The youngest condition of a bud, before the external tunic is elevated.

Figs. 15–20. Successive stages of development of the buds, described in the text.

Fig. 21. A bud laid open by a vertical cut, and exhibiting an interior view of the branchial sac.

Fig. 22. A more advanced bud, with a second bud forming in its peduncle.

Fig. 23. A still more advanced terminal bud, a second median bud in about the same stage as fig. 20, and a third proximal bud developing in the peduncle and nearly in the same stage as fig. 17, all connected together.

Fig. 24. A bud naturally detached from its peduncle, and exhibiting a rudiment of the stolon, r^2.

Fig. 25. A bud so far advanced as to be connected with the cloaca by its atrial aperture, p^2.

Figs. 26 & 27. Very young buds, viewed from the side to which their apices are turned.

Figs. 28 & 29. More advanced buds viewed from the hæmal side.

Fig. 30. A still more advanced bud viewed from the hæmal side, and given partly in section, to compare with fig. 3.

Plate XXXI.

Figs. 1, 2, 3 & 4. Ovisacs containing complete ova in different stages of development. The fraction above each figure gives the greatest diameter in parts of an inch.

Fig. 5. An ovisac, torn at one point, but otherwise entire, and allowing the naked germinal vesicle to be seen through its wall.

Fig. 6. A similar ovisac opened with needles, and the torn lower portion, to which the germinal vesicle adheres, viewed from within.

Fig. 6 *a*. An enlarged view of the germinal vesicle.

Fig. 6 *b*. A similarly magnified view of the dilated end of the duct of the same specimen, showing the 'plug' of spermatozoa.

Fig. 7. A more advanced ovisac opened and viewed from within, showing the pale germinal vesicle covered by the epithelial coating of the sac.

Fig. 8*. An ovum extracted from a younger ovisac than the last.

Figs. 8–8*c*. Germinal vesicles containing the characteristic deposit of more advanced stages.

Fig. 8 *a*. A germinal vesicle with a very pale spot. Its contour is rather too well defined in the figure.

Fig. 8 *b*. Two views of the same germinal vesicle, whose spot has disappeared. The minute vesicular corpuscles, *en*, are visible.

Fig. 8 *c*. Front and lateral views of a germinal vesicle in a condition observed once.

Fig. 9. Ovisac with vesicular epithelial lining and commencing blastoderm (which is represented rather darker than in nature) *in situ* and causing the atrial tunic, *d*, to bulge as a rudimentary 'Brutsack' or fœtal chamber.

Fig. 9 *a*. The blastoderm of a similar specimen enlarged, and viewed through the *tunica propria* of the ovisac. To avoid confusion, the texture of the vesicular lining is omitted.

N.B. The figures 8, 8*, 8*a*, 8*b*, 8*c*, 9*a*, are drawn to the same scale.

Fig. 10. Fœtus, now free in the mid-atrium, with the blastoderm much enlarged and converted into an elongated patch.

Fig. 11. Two views of a fœtus with the blastoderm divided into five segments, of which the cyathozooid is the largest.

Fig. 12. The fourth ascidiozooid of a similar fœtus, seen in section, and the fifth from above.

Fig. 13. Two views of a fœtus whose ascidiozooids half encircle the base of its cyathozooid.

Fig. 13 *a*. A single ascidiozooid (the first) of a similar fœtus, seen from the side.

Fig. 14. A more advanced fœtus, to show the stage in which the ascidiozooids (left in outline) completely encircle the cyathozooid, but still lie below the level of the equator of the ovisac.

Fig. 15. One of the most advanced fœtuses observed. The remains of the conjoined cyathozooid and ovisac are hidden by the ascidiozooids.

Fig. 16. A similar fœtus viewed from above, to show the remains of the cyathozooid and the ovisac, as well as the connexion of this with the ascidiozooids, and of these with one another, by the elongated isthmuses.

Figs. 17 & 18. Lateral views of the cyathozooid in fœtuses $\frac{1}{24}$th and $\frac{1}{18}$th of an inch in diameter respectively.

Fig. 19. Lateral view of a fœtus $\frac{1}{21}$st of an inch in diameter, to show the manner in which the cloaca is developed by the separation of the test from the combined cyathozooid and ovisac.

Map to Illustrate
Dr. HOOKER'S
REGIONS OF ARCTIC VEGETATION.

The Isothermal Lines are taken from Doves Tables, printed for the Brit.h Association in 1853.
The Temperatures are in Fahr.t Scale.

XVII. *Outlines of the Distribution of Arctic Plants.*

By JOS. D. HOOKER, *M.D., F.R.S., &c.*

(With a Map. Plate XXXII.)

Read June 21st, 1860.

I SHALL endeavour in the following pages to comply, as far as I can, with a desire expressed by several distinguished Arctic voyagers, that I should draw up an account of the affinities and distribution of the flowering plants of the North Polar Regions. The method I have followed has been, first to ascertain the names and localities of all plants which appear on good evidence to have been found north of the arctic circle in each continent; then to divide the polar zone longitudinally into areas characterized by differences in their vegetation; then to trace the distribution of the arctic plants, and of their varieties and very closely allied forms, into the temperate and alpine regions of both hemispheres. Having tabulated these data, I have endeavoured to show how far their present distribution may be accounted for by slow changes of climate during and since the glacial period.

The arctic flora forms a circumpolar belt of 10° to 14° latitude, north of the arctic circle. There is no abrupt break or change in the vegetation anywhere along this belt, except in the meridian of Baffin's Bay, whose opposite shores present a sudden change from an almost purely European flora on its east coast, to one with a large admixture of American plants on its west.

The number of flowering plants which have been collected within the arctic circle is 762 (Monocot. 214; Dicot. 548). In the present state of cryptogamic botany it is impossible to estimate accurately the number of flowerless plants found within the same area, or to define their geographical limits; but the following figures give the best approximate idea I have obtained:—

Filices	28	Characeæ	2	Fungi	200?
Lycopodiaceæ	7	Musci	250	Algæ	100
Equisetaceæ	8	Hepaticæ	80	Lichenes	250

Total Cryptogams	925
„ Phænogams	762
	1687

Regarded as a whole, the arctic flora is decidedly Scandinavian; for Arctic Scandinavia, or Lapland, though a very small tract of land, contains by far the richest arctic flora, amounting to three-fourths of the whole; moreover upwards of three-fifths of the species, and almost all the genera, of Arctic Asia and America are likewise Lapponian, leaving far too small a percentage of other forms to admit of the Arctic Asiatic and American floras being ranked as anything more than subdivisions, which I shall here call districts, of one general arctic flora.

Proceeding eastwards from Baffin's Bay, there is, first, the Greenland district, whose flora is almost exclusively Lapponian, having an extremely slight admixture of American or Asiatic types: this forms the western boundary of the purely European flora. Secondly, the Arctic European district, extending eastward to the Obi river, beyond the Ural range, including Nova Zembla and Spitzbergen; Greenland would also be included in it, were it not for its large area and geographical position. Thirdly, the transition from the comparatively rich European district to the extremely poor Asiatic one is very gradual; as is that from the Asiatic to the richer fourth or West American district, which extends from Behring's Straits to the Mackenzie River. Fifthly, the transition from the West to the East American district is even less marked; for the lapse of European and West American species is trifling, and the appearance of East American ones is equally so: the transition in vegetation from this district, again, to that of Greenland is, as I have stated above, comparatively very abrupt.

The general uniformity of the arctic flora, and the special differences between its subdivisions may be thus estimated: the arctic Phænogamic flora consists of 762 species; of these, 616 are Arctic European, many of which prevail throughout the polar area, being distributed in the following proportions through its different longitudes:—

Arctic Europe . .	616:	Scandinavian forms	586;	Asiatic and American	30=1 : 19·57
„ Asia	233	„ „	189	„	44=1 : 4·2
„ W. America	364	„ „	254	„	110=1 : 2·3
„ E. America	379	„ „	269	„	110=1 : 2·4
„ Greenland .	207	„ „	195	„	12=1 : 16·2

This table places in a most striking point of view the anomalous condition of Greenland, which, though so favourably situated for harbouring an Arctic American vegetation, and so unfavourably for an Arctic European one, presents little trace of the botanical features of the great continent to which it geographically belongs, and an almost absolute identity with those of Europe. Moreover, the peculiarities of the Greenland flora are not confined to these; for a detailed examination shows that it differs from all other parts of the arctic regions in wanting many extremely common Scandinavian plants which advance far north in all the other polar districts, and that the general poverty of its flora in species is more due to an abstraction of arctic types than to a deficiency of temperature. This is proved by an examination of the temperate portion of the Greenland peninsula, which adds very few plants to the entire flora, as compared with a similar area south of any other arctic region; and these few are chiefly arctic plants and almost without exception Arctic Scandinavian species.

There is nothing in the physical features of the arctic regions, their oceanic or aerial currents, their geographical relations, nor their temperature, which, in my opinion, at all accounts for the exceptional character of the Greenland flora; nor do I see how it can be explained, except by assuming that extensive changes of climate, and of land and sea, have exerted great influence, first in directing the migration of the Scandinavian species over the whole polar zone, and afterwards in introducing the Asiatic and American species with which the Scandinavian are so largely associated in all the arctic districts except those of Europe and Greenland. It is inconceivable to me that so many Scandinavian plants should, under existing conditions of sea, land, and temperature, have not only found their way westward to Greenland, by migration across the Atlantic, but should have stopped short on its west coast, and not crossed to America; or that so many American types should terminate as abruptly on the west coast of Baffin's Bay, and not cross to Greenland and Europe; or that Greenland should contain actually much fewer species of European plants than have found their way eastwards from Lapland by Asia into Western and Eastern Arctic America; or that the Scandinavian vegetation should in every longitude have migrated across the tropics of Asia and America, whilst those typical plants of these continents which have found their way into the arctic regions, have there remained restricted to their own meridians.

It appears to me difficult to account for these facts, unless we admit Mr. Darwin's * hypotheses, first, that the existing Scandinavian flora is of great antiquity, and that previous to the glacial epoch it was more uniformly distributed over the polar zone than it is now; secondly, that during the advent of the glacial period this Scandinavian vegetation was driven southward in every longitude, and even across the tropics into the south temperate zone; and that on the succeeding warmth of the present epoch, those species that survived both ascended the mountains of the warmer zones, and also returned northward, accompanied by aborigines of the countries they had invaded during their southern migration. Mr. Darwin shows how aptly such an explanation meets the difficulty of accounting for the restriction of so many American and Asiatic arctic types to their own peculiar longitudinal zones, and for what is a far greater difficulty, the representation of the same arctic genera by most closely allied species in different longitudes. To this representation, and the complexity of its character, I shall have to allude when indicating the sources of difficulties I have encountered, whether in limiting the polar species, or in determining to what southern forms many are most directly referable. Mr. Darwin's hypothesis accounts for many varieties of one plant being found in various alpine and arctic regions of the globe, by the competition into which their common ancestor was brought with the aborigines of the countries it invaded: different races survived the struggle for life in different longitudes; and these races again, afterwards converging on the zone from which their ancestor started, present there a plexus of closely allied but more or less distinct varieties or even species, whose geographical limits overlap, and whose members very probably occasionally breed together.

Nor is the application of this hypothesis limited to this inquiry; for it offers a possible explanation of a general conclusion at which I had previously arrived † and shall have again to discuss here—viz. that the Scandinavian flora is present in every latitude of the globe, and is the only one that is so; and it also helps to explain another class of most interesting and anomalous facts in arctic distribution, at which I have now arrived from an examination of the vegetation of the several polar districts, and especially of that of Greenland.

* This theory of a southern migration of northern types being due to the cold epochs preceding and during the glacial, originated, I believe, with the late Edward Forbes; the extended one, of their transtropical migration, is Mr. Darwin's, and is discussed by him in his 'Origin of Species,' chap. xi.

† Introd. Essay to the 'Flora of Tasmania,' p. ciii.

A glance at the appended chart shows how this theory bears upon the Greenland flora, explaining the identity of its existing vegetation with that of Lapland, and accounting for its paucity of species, for the rarity of American species, of peculiar species, and of marked varieties of European species. If it be granted that the polar area was once occupied by the Scandinavian flora, and that the cold of the glacial epoch did drive this vegetation southwards, it is evident that the Greenland individuals, from being confined to a peninsula, would be exposed to very different conditions to those of the great continents. In Greenland many species would, as it were, be driven into the sea, that is, exterminated; and the survivors would be confined to the southern portion of the peninsula, and not being there brought into competition with other types, there could be no struggle for life amongst their progeny, and consequently no selection of better-adapted varieties. On the return of heat, these survivors would simply travel northwards, unaccompanied by the plants of any other country.

In Arctic America and Asia, on the other hand, where there was a free southern extension and dilatation of land for the same Scandinavian plants to occupy, these would multiply enormously in individuals, branching off into varieties and subspecies, and occupy a larger area the further south they were driven; and none need be altogether lost in the southern migration over plains, though many would in the struggle that ensued when they reached the mountains of those continents and were brought into competition with the alpine plants, which the same cold had caused to descend to the plains. Hence, on the return of warmth, many more Scandinavian species would return to Arctic America and Asia than survived in Greenland; some would be changed in form, because only the favoured varieties could have survived the struggle; some of the Alpine Siberian and Rocky Mountain species would accompany them to the arctic zone; while many arctic species would ascend those mountains, accompanying the alpine species in their reascent.

Again, as the same species may have been destroyed in most longitudes, or at most elevations, but not at all, we should expect to find some of those Arctic Scandinavian plants of Greenland which have not returned to Arctic America still lurking in remote alpine corners of that great continent; and we may account for *Draba aurea* being confined to Greenland and the Rocky Mountains, *Potentilla tridentata* to Greenland and Labrador, and *Arenaria Grœnlandica* to Greenland and the White Mountains of New Hampshire, by supposing that these were originally Scandinavian plants, which on the return of warmth were exterminated on the plains of the American continent, but found a refuge on its mountains, where they now exist.

It appears, therefore, to be no slight confirmation of the general truth of Mr. Darwin's hypothesis, that, besides harmonizing with the distribution of arctic plants within and beyond the polar zone, it can also be made, without straining, to account for that distribution and for many anomalies of the Greenland flora, viz., 1, its identity with the Lapponian; 2, its paucity of species; 3, the fewness of temperate plants in temperate Greenland, and the still fewer plants that area adds to the entire flora of Greenland; 4, the rarity of both Asiatic and American species or types in Greenland; and 5, the presence of a few of the rarest Greenland and Scandinavian species in enormously remote alpine localities of West America and the United States.

On the Local Distribution of Plants within the Arctic Circle.

The greatest number of plants occurring in any given arctic district is found in the European, where 616 flowering plants have been collected from the verge of the circle to Spitzbergen. From this region vegetation rapidly diminishes in proceeding eastwards and westwards, especially the latter. Thus, in Arctic Asia only 233 flowering plants have been collected; in Arctic Greenland, 207 species; in the American continent east of the Mackenzie River, 379 species; and in the area westwards from that river to Behring's Straits, 364 species.

A glance at the annual and monthly isothermal lines shows that there is little relation between the temperature and vegetation of the areas they intersect, beyond the general feature of the scantiness of the Siberian flora being accompanied by a great southern bend of the annual isotherm of 32° in Asia, and the greatest northern bend of the same isotherm occurring in the longitude of west Lapland, which contains the richest flora. On the other hand, the same isotherm bends northwards in passing from Eastern America to Greenland, the vegetation of which is the scantier of the two; and passes to the northward of Iceland, which is much poorer in species than those parts of Lapland to the southward of which it passes.

The June isothermals, as indicating the most effective temperatures in the arctic regions (where all vegetation is torpid for nine months, and excessively stimulated during the three others), might have been expected to indicate better the positions of the most luxuriant vegetation: but neither is this the case; for the June isothermal of 41°, which lies within the arctic zone in Asia, where the vegetation is scanty in the extreme, descends to 54° N. lat. in the meridian of Behring's Straits, where the flora is comparatively luxuriant; and the June isothermal of 32°, which traverses Greenland north of Disco, passes to the north both of Spitzbergen and the Parry Islands. In fact, it is neither the mean annual, nor the summer (flowering), nor the autumn (fruiting) temperature that determines the abundance or scarcity of the vegetation in each district, but these combined with the ocean temperature and consequent prevalence of humidity, its geographical position, and its former conditions both climatal and geographical. The relations between the isothermals and floras in each longitude being therefore special, and not general, I shall consider them further when defining the different arctic floras.

The northern limits to which vegetation extends varies in every longitude; and its extreme limits are still unknown; it may, indeed, reach to the pole itself. Phænogamic plants, however, are probably nowhere found far north of lat. 81°. 70 flowering plants are found in Spitzbergen; and Sabine and Ross collected 9 on Walden Island, towards its northern extreme, but none on Ross's Islet, 15 miles further to the north. Sutherland, a very careful and intelligent collector, found 23 at Melville Bay and Wolstenholme and Whale Sounds, in the extreme north of Baffin's Bay (lat. 76°, 77° N.). Parry, James Ross, Sabine, Beechey, and others, together found 60 species on Melville Island, and Lyall 50 on the islands north of Barrow Straits and Lancaster Sound. About 80 have been detected on the west shores of Baffin's Bay and Davis's Straits, between Pond Bay and Home Bay. To the north of Eastern Asia, again, Seemann collected only 4 species on

Herald Island, lat. 71½° N., the northernmost point attained in that longitude. On the west coast of Greenland, Scoresby and Sabine found only 50 between the parallels of 70° and 75° N.; whilst 150 inhabit the east coast, between the same parallels.

The differences between the vegetations of the various polar areas seem to be to a considerable extent constant up to the extreme limits of vegetation in each. Thus *Ranunculus glacialis* and *Saxifraga flagellaris*, which are all but absent in West Greenland*, advance to the extreme north in East Greenland and Spitzbergen. *Caltha palustris*, *Astragalus alpinus*, *Oxytropis Uralensis* and *nigrescens*, *Parrya arctica*, *Sieversia Rossii*, *Nardosmia corymbosa*, *Senecio palustris*, *Deschampsia cæspitosa*, *Saxifraga hieraciifolia* and *Hirculus*, all of which are absent in West Greenland, advance to Lancaster Sound and the polar American islands, a very few miles to the westward of Greenland.

On the other hand, *Lychnis alpina*, *Arabis alpina*, *Stellaria cerastioides*, *Potentilla tridentata*, *Cassiopeia hypnoides*, *Phyllodoce taxifolia*, *Veronica alpina*, *Thymus Serpyllum*, *Luzula spicata*, and *Phleum alpinum*, all advance north of 70° in West Greenland, but are wholly unknown in any part of Arctic Eastern America or the polar islands.

The most arctic plants of general distribution that are found far north in all the arctic areas are the following; all inhabit the Parry Islands, or Spitzbergen, or both :—

Ranunculus nivalis.
—— auricomus.
—— pygmæus.
Papaver nudicaule.
Cochlearia officinalis.
Braya alpina.
Cardamine bellidifolia.
—— pratensis.
Draba alpina.
—— androsacea.
—— hirta.
—— muricella.
—— incana.
—— rupestris.
Cochlearia anglica.
—— officinalis.
Silene acaulis.
Lychnis apetala.
Arenaria verna.
—— arctica.
Stellaria longipes.
Cerastium alpinum.
Potentilla nivea.
—— frigida.
Dryas octopetala.
Epilobium latifolium.
Sedum Rhodiola.
Chrysosplenium alternifolium.
Saxifraga oppositifolia.
—— cæspitosa.
—— cernua.
—— rivularis.
—— nivalis.
—— stellaris.
—— flagellaris.
—— Hirculus (East Greenland only).
Antennaria alpiua.
Erigeron alpinus.
Taraxacum Dens-leonis.
Cassiopeia tetragona.
Pedicularis hirsuta.
—— sudetica.
Oxyria reniformis.
Polygonum viviparum.
Empetrum nigrum.
Salix herbacea.
—— reticulata.
Luzula arcuata.
Juncus biglumis.
Carex fuliginosa (not yet found in Arctic Asia, but no doubt there).
—— aquatilis (do.).

* Both were found by Kane's Expedition, but by no previous one.

Eriophorum capitatum.
—— polystachyum.
Alopecurus alpinus.
Deyeuxia Lapponica.
Deschampsia cæspitosa (East Greenland only).
Phippsia algida.
Colpodium latifolium.
Poa flexuosa.
—— pratensis.
—— nemoralis.
Festuca ovina.

Of the above, *Saxifraga oppositifolia* is probably the most ubiquitous, and may be considered the commonest and most arctic flowering plant.

The following are also inhabitants of all the five arctic areas, but do not usually attain such high latitudes as the foregoing:—

Ranunculus Lapponicus.
Draba rupestris.
Viola palustris.
Honkeneya peploides.
Epilobium angustifolium.
—— alpinum.
Hippuris vulgaris.
Artemisia borealis.
Vaccinium uliginosum.
—— Vitis-idæa.
Ledum palustre.
Pyrola rotundifolia.
Polemonium cæruleum, and vars. (East Greenland only.)
Pedicularis Lapponica.
Armeria vulgaris.
Betula nana.
Salix lanata.
—— glauca.
—— alpestris.
Luzula campestris.
Carex vesicaria.
Eriophorum vaginatum.
Atropis maritima.

The absence of *Gentiana* and *Primula* in these lists is very unaccountable, seeing how abundant and very alpine they are on the Alps and Himalaya, and *Gentiana* on the South American Cordilleras also.

The few remaining plants, which are all very northern, and almost or wholly confined to the arctic zone, are the following. † indicates those species absolutely peculiar; †† the only peculiar genus.

Ranunculus Pallasii.
—— hyperboreus.
Trollius Asiaticus.
Corydalis glauca.
Cardamine purpurea.
Turritis mollis.
Cochlearia sisymbrioides.
Hesperis Pallasii.
†Braya pilosa.
Eutrema Edwardsii.
Parrya arctica.
†—— arenicola.
Odontarrhena Fischeriana.
Sagina nivalis.
Stellaria dicranoides.
Oxytropis nigrescens.
Sieversia Rossii.
Sieversia glacialis.
Rubus arcticus.
Parnassia Kotzebuei.
Saxifraga Eschscholtzii.
—— serpyllifolia.
†—— Richardsoni.
Cœnolophium Fischeri.
†Nardosmia glacialis.
Artemisia Richardsoniana.
—— glomerata.
†—— androsacea.
Erigeron compositus.
Chrysanthemum arcticum.
Pyrethrum bipinnatum.
†Saussurea subsinuata.
Campanula uniflora.
Gentiana arctophila.

Gentiana aurea.
Eutoca Franklinii.
Pedicularis flammea.
†Douglasia arctica.
†Monolepis Asiatica.
Betula fruticosa.
Salix speciosa.
†—— glacialis.
—— phlebophylla.
—— arctica.
Orchis cruenta.
Platanthera hyperborea.
Carex nardina.
—— glareosa.
—— rariflora.
Hierochloe pauciflora.
Deschampsia atropurpurea.
Phippsia algida.
Dupontia Fisheri.
Colpodium pendulinum.
—— fulvum.
—— latifolium.
††Pleuropogon Sabini.
†Festuca Richardsoni.

On the Distribution of Arctic Flowering Plants in various Regions of the Globe.

There is but one distinct genus confined to the arctic regions, the monotypic and local *Pleuropogon Sabini*; and there are but seven other peculiarly arctic species, together with one with which I am wholly unacquainted, viz. *Monolepis Asiatica.* The remaining 762 species are all of them found south of the circle; and of these all but 150 advance south of the parallel of 40° N. lat., either in the Mediterranean basin, Northern India, the United States, Oregon, or California; about 50 are natives of the mountainous regions of the tropics; and just 105 inhabit the south temperate zone.

The proportion of species which have migrated southwards in the Old and New World also bear a fair relation to the facilities for migration presented by the different continents. Thus,

Of 616 Arctic European species,
496 inhabit the Alps, and
450 cross them;
126 cross the Mediterranean;
26 inhabit South Africa.

Of 233 Arctic Asiatic species,
210 reach the Altai, Soongaria, &c.;
106 reach the Himalaya;
0 are found on the tropical mountains of Asia;
5 inhabit Australia and New Zealand.

Of 379 Arctic East American,
203 inhabit the United States (of which 21 are confined to the mountains).
34 inhabit tropical American mountains.
50 inhabit temperate south America.

Of 346 Arctic West American species,
274 are north temperate;
24 on tropical mountains;
37 in south temperate zone.

These tables present in a very striking point of view the fact of the Scandinavian flora being the most widely distributed over the globe. The Mediterranean, South African, Malayan, Australian, and all the floras of the New World have narrow ranges compared with the Scandinavian, and none of them form a prominent feature in any other continent than their own; but the Scandinavian not only girdles the globe in the arctic circle, and dominates over all others in the north temperate zone of the Old World, but intrudes conspicuously into every other temperate flora, whether in the northern or southern hemisphere, or on the Alps of tropical countries.

The severest test to which this observation could be put is that supplied by the Arctic

Scandinavian forms; for these belong to the remotest corner of the Scandinavian area, and should of all plants be the most impatient of temperate, warm, and tropical climates. The following will, approximately, express the result:—

Total Arctic Scandinavian forms	586	Cross Alps, &c.	480
In North United States and Canada, &c.	360	Reach South Africa	20
In Tropical America	40	Himalaya, &c.	300
In Temperate South America	70	Tropical Asia	20
In Alps of Middle Europe, Pyrenees, &c.	490	Australia, &c.	60

In one respect this migration is most direct in the American meridian, where more arctic species reach the highest southern latitudes. This I have accounted for (Flora Antarctica, p. 230) by the continuous chain of the Andes having favoured their southern dispersion.

But the greatest number of arctic plants are located in Central Europe, no fewer than 530 out of 762 inhabiting the Alps and Central and Southern Europe, of which 480 cross the Alps to the Mediterranean basin. Here, however, their further spread is apparently suddenly arrested; for though many doubtless are to be found in the Alps of Abyssinia and the western Atlas, these are few compared with what are found further east in Asia; and fewer still have found their way to South Africa.

The most continuous extension of Scandinavian forms is in the direction of the greatest continental extension; namely, that from the North Cape in Lapland to Tasmania*; for no less than 350 Scandinavian plants have been found in the Himalaya, and 53 in Australia and New Zealand; whereas there are scarcely any Himalayan and no Australian or Antarctic forms in Arctic Europe. Now that Mr. Darwin's hypotheses are so far accepted by many botanists, in that these concede many species of each genus to have had in most cases a common origin, it may be well to tabulate the generic distribution of arctic plants as I have done the specific; and this places the prevalence of the Scandinavian types of vegetation in a much stronger light:—

Scandinavian Arctic Genera in Europe	280	Cross Alps (approximately)	260
Found in North United States (approximately)	270	Found in South Africa (approximately)	110
„ Tropical American Mountains „	100	„ Himalaya, &c. „	270
„ Temperate South America „	120	„ Tropical Asia „	80
„ Alps „	280	„ Australia, &c. „	100

The most remarkable anomaly is the absence of *Primula* in Tropical America, that genus being found in Extra-tropical South America; and its absence in the whole southern temperate zone of the Old World, except the Alps of Java.

* The line which joins these points passes through Siberia, Eastern China, the Celebes Islands, and Australia, but the glacial migration has no doubt been due south from the arctic and north temperate regions in various longitudes to the Pyrenees, Alps, Carpathians, Caucasus, Asia Minor, Persian and North Indian mountains, &c. The further migration south to the distant and scattered alpine heights of the tropics, and thence to South Australia, Tasmania, and New Zealand, is, in the present state of our knowledge, to me quite unaccounted for. Mr. Darwin assumes for this purpose a cooled condition of the globe that must have been fatal to all such purely tropical vegetation as we are now familiar with.

Thalictrum, *Delphinium*, *Impatiens*, *Prunus*, *Circæa*, *Chrysosplenium*, *Parnassia*, *Bupleurum*, *Hieracleum*, *Viburnum*, *Valeriana*, *Artemisia*, *Vaccinium*, *Rhododendron*, *Pedicularis*, and *Salix*, are all arctic genera found on the tropical mountains of Asia (Nilghiri, Ceylon, Java, &c.), but not yet in the south temperate zones of Asia, and very few of them in Temperate South Africa.

There are, however, a considerable number of Scandinavian plants which are not found in the Alps of Middle Europe, though found in the Caucasus, Himalaya, &c.; and conversely there are several Arctic Asiatic and American plants found in the Alps of Central Europe, but nowhere in Arctic Europe. In other words, certain species extend from Arctic America through Central Asia and North India to Central Europe, which do not extend from Arctic America westward to Arctic Europe; and there are certain other species which extend from Arctic Europe to the Caucasus and Central Asia, which do neither exist on the Alps of Central Europe nor extend eastward to Arctic America: thus,

Common to Arctic Europe and Temperate Asia, &c., but not to Alps of Europe.

Ranunculus nivalis.
—— hyperboreus.
Trollius Asiaticus.
Cardamine bellidifolia.
Parrya macrocarpa.
—— arctica.
Draba alpina.
—— muricella.
—— hirta.
—— rupestris.
Eutrema Edwardsii.
Silene turgida.
Lychnis apetala.
Sagina nivalis.
Arenaria lateriflora.
—— arctica.
Stellaria borealis.
—— humifusa.
—— longipes.
—— crassifolia.
Rubus arcticus.
—— chamæmorus.
Rosa blanda.
Saxifraga rivularis.
—— nivalis.
—— flagellaris.
—— bronchialis.
Cœnolophium Fischeri.
Conioselinum Fischeri.
Ligusticum Scoticum.
Chærophyllum bulbosum.
Cornus suecica.
Galium triflorum.
Valeriana capitata.
Nardosmia frigida.
—— palmata.
Chrysanthemum arcticum.
Pyrethrum bipinnatum.
Artemisia borealis.
Antennaria alpina.
Senecio frigidus.
Ligularia Sibirica.
Aster Sibiricus.
—— Tataricus.
Mulgedium Sibiricum.
Campanula uniflora.
Cassiopeia hypnoides.
Cassandra calyculata.
Diapensia Lapponica.
Rhododendron Lapponicum.
Ledum palustre.
Gentiana detonsa.
Pleurogyne rotata.
Myosotis sparsiflora.
Eritrichium villosum.
Gymnandra borealis.
Castilleja pallida.
Veronica macrostemon.
Pedicularis Lapponica.
—— hirsuta.
—— Sudetica.
Pinguicula villosa.
Naumbergia thyrsiflora.
Primula stricta.
—— Sibirica.
Koenigia Islandica.
Betula alpestris.
Salix lanata.
—— myrtilloides.
—— polaris.
Picea orientalis.
Larix Ledebourii.
Platanthera obtusata.
Calypso borealis.
Sparganium natans.
Calla palustris.
Luzula arcuata.
Juncus biglumis.
Carex glareosa.
—— Norwegica.
—— festiva.
—— loliacea.
—— fuliginosa.
—— rariflora.
—— livida.
—— laxa.
—— capillaris.
—— salina.
—— vulgaris.
—— cæspitosa.
—— aquatilis.
—— globularis.
Blysmus rufus.

Alopecurus alpinus.
Deyeuxia deschampsioides.
—— Lapponica.
—— strigosa.
Deyeuxia Langsdorffii.
Hierochloe alpina.
Colpodium latifolium.
Colpodium pendulinum.
—— fulvum.
Dupontia Fisheri.

It is curious to remark how many of these boreal European plants, which are absentees in the Alps, have a very wide range, not only extending to the Himalaya and North China, but many of them all over Temperate North America; only one is found in the south temperate zone. In the present state of our knowledge we cannot account for the absence of these in the Alps; either they were not natives of Arctic Europe immediately previous to the glacial period, or if so, and they were then driven south to the Alps, they were afterwards there exterminated; or, lastly, they still inhabit the Alps under disguised forms, which pass for different species. Probably some belong to each of these categories. I need hardly remark that none inhabit Europe south of the Alps, or any part of the African continent.

The list of Arctic American and Asiatic species which do inhabit the Alps of Europe, but not Arctic Europe, is much smaller. Those marked † are Scandinavian, but do not enter the arctic circle.

Anemone patens.
—— alpina.
—— narcissiflora.
†Ranunculus sceleratus.
†Aconitum Napellus.
†Arabis petræa.
†Cardamine hirsuta.
Draba stellata.
†Thlaspi montanum.
†Lepidium ruderale.
†Sagina nodosa.
†Linum perenne.
Phaca alpina.
†Astragalus hypoglottis.
†Spiræa salicifolia.
†Potentilla fruticosa.
Potentilla sericea.
†Ceratophyllum demersum.
Bupleurum ranunculoides.
†Viburnum Opulus.
Galium rubioides.
†—— saxatile.
Ptarmica alpina.
Aster alpinus.
Gentiana prostrata.
Polygonum polymorphum.
Corispermum hyssopifolium.
Alnus viridis.
Pinus cembra.
†Sparganium simplex.
†Typha latifolia.
Carex ferruginea.
—— supina.
—— stricta.
†—— pilulifera.
†Scirpus triqueter.
Deyeuxia varia.
Spartina cynosuroides.
†Glyceria fluitans.
Hordeum jubatum.

Botanical Districts within the Arctic Circle.

The following are the prominent features, botanical, geographical, and climatal, of the five districts of the arctic zone:—

1. *Arctic Europe.*—The majority of its plants are included in the Lapland and Finland floras; and, owing to the temperature of the Gulf Stream, which washes its coasts, Lapland is by far the richest province in the arctic regions. The mean annual temperature at the polar circle, where it cuts the coast-line, is about 37°, and the June and September temperatures throughout Lapland are 40° and 37° respectively; thus rendering the climate favourable both to flowering and fruiting. Spitzbergen belongs to this flora, as do Nova Zembla and the arctic countries west of the river Obi, which forms its eastern boundary; for the Ural Mountains do not limit the vegetation, any more than do the Rocky Mountains in America. Gmelin observed more than a century ago that the river Obi in lower latitudes indicates the transition longitude from the European to the Asiatic flora.

Even in this small area, however, there are two floras, corresponding to the Arctic Norwegian and Arctic Russian. The latter, commencing at the White Sea, though comparatively excessively poor in species, contains nearly twenty that are not Lapponian, including *Braya rosea*, *Dianthus alpinus* and *Seguieri*, *Spiræa chamædrifolia*, *Saxifraga hieracifolia*, *Hieracleum Sibiricum*, *Ligularia Sibirica*, *Ptarmica alpina*, *Gentiana verna*, *Pleurogyne rotata*, and *Larix Sibirica*.

There are further several Scandinavian plants which cross the arctic circle on the east shores of the White Sea, but do not do so in Lapland, as *Athamanta Libanotis*, *Chrysanthemum Leucanthemum*, *Bidens tripartita*, and others.

Iceland and Greenland also botanically belong to the Arctic Lapland province, but I have here excluded both: the former because it lies to the south of the arctic circle; the latter because both its magnitude, position, and other circumstances, require that it should be treated of separately.

As far as I can ascertain, 616 species $\left(\begin{matrix}\text{Monocotyledons} \;.\;.\; 183 \\ \text{Dicotyledons} \ldots\ldots 433\end{matrix}\right\}=1:2\,3\Big)$ enter the arctic circle in this region, of which 70 advance into Spitzbergen; but no phænogamic plant is found in Ross' Islet beyond its northern extremity. The proportion of genera to species 266 : 616 | 1 : 2·3. Of these Arctic-European plants, 453 cross the Alps or Pyrenees to the Mediterranean basin, a few occur on the mountains of Tropical Africa (including *Luzula campestris* and *Deschampsia cæspitosa*), and 23 are found in South Africa.

No fewer than 264 species do not enter the arctic circle in any other longitude, and 184 are almost exclusively natives of the Old World, or of this and of Greenland; not being found in any part of North America; 24 are confined to Arctic Europe and Greenland.

The following Arctic European plants are of sporadic occurrence in N. America:—

Ranunculus acris, Rocky Mountains.
Arabis alpina, Greenland and Labrador.
Lychnis alpina, Greenland and Labrador.
Arenaria arctica, Greenland and Rocky Mountains.
——— *verna*, Greenland, Arctic Islands, and Rocky Mountains.
Alchemilla vulgaris, Greenland and Labrador.
Gnaphalium sylvaticum, Greenland and Labrador.
——— *supinum*, Greenland, Labrador, and U. States Mountains.
Vaccinium myrtillus, Rocky Mountains only.
Cassiopeia hypnoides, Greenland, U. States Mountains, and Labrador.
Phyllodoce taxifolia, Greenland, U. States Mountains, and Labrador.
Gentiana nivalis, Greenland and Labrador.
Veronica alpina, Greenland and U. States Mountains.
Bartsia alpina, Greenland and Labrador.
Pedicularis palustris, Labrador.
Primula farinosa, Labrador.
Salix phylicifolia, U. States Mountains.
—— *arbuscula*, Greenland and U. States Mountains.
Juncus trifidus, Greenland and U. States Mountains.
Carex capitata, Greenland and U. States Mountains.
Phleum alpinum, Greenland, U. States Mountains, and Labrador.
Calamagrostis lanceolata, Labrador.

There are besides a considerable number of Arctic European plants, which, in the New World, are confined to Greenland, being nowhere found in East America: these will be enumerated when treating of the Greenland flora.

The plants which are widely distributed in Temperate America or Asia, but almost exclusively Arctic in Europe, are the following:—

Ranunculus Pallasii, Asia and America.
Trollius Asiaticus, Asia.
Parrya macrocarpa, Asia and America.
——— *arctica*, Asia and America.
Stellaria longipes, Asia and America.
Potentilla emarginata, America.
Epilobium latifolium, Asia and America.
Sedum quadrifidum, Asia.
Saxifraga bronchialis, Asia and America.
Senecio resedæfolius, Asia and America.
Ligularia Sibirica, Asia.
Mulgedium Sibiricum, Asia.
Cassiopeia tetragona, Asia and America.
Gentiana detonsa, Asia and America.
Pleurogyne rotata, Asia and America.
Eritrichium aretioides, Asia and America.
Gymnandra Pallasii, Asia.
Castilleja pallida, Asia and America.
Veronica macrostemon, Asia.
Pedicularis flammea, America.
Pinguicula villosa, Asia and America.
Koenigia islandica, Asia and America.
Salix polaris, Asia and America.
Picea orientalis, Asia.
Larix Ledebourii, Asia.
Platanthera hyperborea, America.
——— *obtusata*, America.
Deyeuxia Deschampsioides, Asia and N.W. America.
Dupontia Fisheri, America.

The works upon which I have mainly depended for the habitats of the Arctic European plants are Wahlenberg's 'Flora Lapponica,' Ledebour's 'Flora Rossica,' Fries' 'Summa Vegetabilium Scandinaviæ,' and 'Mantissæ,' and various admirable treatises by Andersson, Nylander, Hartmann, Lindblöm, Wahlberg, Blytt, C. Martins, Ruprecht, and Schrenk.

For Spitzbergen plants I have depended on Hooker's enumeration of the Spitzbergen collections made during Parry's attempt to reach the north pole, Capt. Sabine's collection made in the same island, and on Lindblöm and Beilschmied's 'Flora von Spitzbergen' (Regensburg, Flora, 1842).

For the southern distribution of the Arctic European plants, I have further consulted Nyman's excellent 'Sylloge,' Ledebour's 'Flora Rossica,' Grisebach's 'Flora Rumelica,' Grenier and Godron's 'Flore de France,' Parlatore's 'Flora Italiana,' Koch's 'Synopsis Floræ Germaniæ,' Munby's 'Catalogue of Algerian Plants,' A. Richard's of those of Abyssinia, Visiani's 'Flora Dalmatica,' Delile's 'Flora Ægyptiaca,' Boissier's noble 'Voyage Botanique dans l'Espagne,' and Tchihatcheff's 'Asia Minor,' besides numerous local floras of the Mediterranean regions, Madeira, the Azores, and Canaries.

2. *Arctic Asia.*—This, which for its extent, contains by far the poorest flora of any on the globe, reaches from the Gulf of Obi eastwards to Behring's Straits, where it merges into the West American. The climate is marked by excessive mean cold; at the Obi the isotherm of 18° cuts the arctic circle in its S.E. course, and at the eastern extremity of the province the isotherm of 20° cuts the same circle, while the centre part of the district is all north of the isotherm of 9°. The whole of the district is hence far north of the isotherm of 32°, which descends to 52° N.L. in its middle longitude. The extremes of temperature are also very great; the June isotherm of 41° ascending eastward through its western half to the Polar Sea, whilst the September isotherm of 41° descends nearly to 60° N.L.; whence the low autumn temperature must present an almost insuperable obstacle to the ripening of seeds within this segment of the polar circle.

The warming influence of the Atlantic currents being felt no further east than the Obi, and the summer desiccation of the vast Asiatic continent, combine to render the climate of this region one of excessive drought as well as cold; whence it is in every way most unfavourable to vegetation of all kinds.

The total number of species hitherto recorded from this area is 233

$$\left(\begin{matrix}\text{Monocotyledons } 42 \\ \text{Dicotyledons } 191\end{matrix}\right\} = 1 : 4{\cdot}5\Bigg).$$

The proportion of genera to species is 1 : 2. Of the 233 species, 217 inhabit Siberia as far south as the Altai, or Japan, &c.; 104 extend southwards to the Himalaya or mountains of Persia; 4 are found on the mountains of the two Indian peninsulas, and 8 on those of Australia and New Zealand. All but the following 37 are European. Those marked with a † are almost exclusively arctic.

Delphinium Menziesii (West America).
†Cochlearia sisymbrioides (Boreal ditto).
Hesperis Pallasii (East and West America).
Odontarrhena Fischeriana.
Cardamine macrophylla.
†Arenaria macrocarpa (West America).
—— laricina.
†—— Rossii (Rocky Mountains).
Cerastium maximum (West America).
†Oxytropis nigrescens (Boreal E. and W. America).
Hedysarum Sibiricum.
†Sieversia glacialis (Boreal W. America).
Potentilla stipularis.
—— fragiformis.
Claytonia lanceolata.
†Sedum euphorbioides (Arctic Asia only).
Saxifraga Escholtzii (Boreal W. America).
Saxifraga serpyllifolia (W. America).
—— punctata (West America).
†Nardosmia glacialis (Arctic Asia only).
—— Gmelini.
†Artemisia Steveniana (Arctic Asia only).
—— glomerata (West America).
—— biennis (E. and W. America).
Osmothamnus fragrans.
Pedicularis capitata (E. and W. America).
—— euphrasioides (E. and W. America).
†Monolepis Asiatica (Arctic Asia only).
Rumex salicifolius (E. and W. America).
—— graminifolius.
Salix ovalifolia (West America).
Abies alba (E. and W. America.)
Larix Americana (E. and W. America).
Tofieldia coccinea (E. and W. America).
Fritillaria Kamtchatkensis (West America).
Carex concinna (West America).
Elymus mollis (E. and W. America).

Thus out of 37 non-European species, only 12 are confined to Asia, the remaining 25 being American. On the other hand, there are only 22 European species in Arctic Asia which are not also American; which scarcely establishes a nearer relationship between Arctic Asia with Europe than with America.

These are

Dianthus Seguieri.
—— superbus.
Silene inflata.
Arenaria uliginosa.
Phaca alpina.
Hedysarum obscurum.
Rubus Idæus.
Sedum quadrifidum.
Gaya simplex.
Leontodon autumnalis.
Hieracium alpinum.
Veronica longifolia.
Pedicularis Sceptrum.
Pinguicula alpina.
Polygonum Sibiricum.
Salix Lapponum.
—— nigricans.
—— hastata.

Picea orientalis.
Larix Ledebourii.
Cypripedium Calceolus.
Carex ferruginea.

In other words, of the 233 Asiatic species, 196 are common to Asia and Europe, 22 are confined to Asia and Europe, 25 are confined to Asia and America only; and 12 are confined to Asia, of which 3 are peculiar to the arctic circle.

The rarity of Gramineæ and especially of Cyperaceæ in this region is its most exceptional feature; only 21 of the 138 arctic species of these orders having hitherto been detected in it. Cryptogamic plants seem to be even more rare; *Woodsia ilvensis* and *Lastrea fragrans* being the only Filices hitherto enumerated. Further researches along the edge of the arctic circle would doubtless add more Siberian species to this flora, as the examination of the north-east extreme would add American species, and possibly lead to the flora of the country of the Tchutchis being ranked with that of West America.

The works which have yielded me most information regarding this flora, are Ledebour's 'Flora Rossica,' and the valuable memoirs of Bunge, C. A. Meyer, and Trautvetter, on the vegetation of the Taimyr and Boganida rivers; and on the plants of Jenissei river in Von Middendorff's Siberian 'Travels'. For their southern extension Trautvetter and Meyer's 'Flora Ochotensis,' also in Middendorff's 'Travels'; Bunge's enumeration of North China and Mongolian plants; Maximovicz's 'Flora Amurensis;' Asa Gray's paper on the botany of Japan (Mem. Amer. Acad. N.S. vi.); Karelin and Kiriloff's enumeration of Soongarian plants; Regel, Bach, and Herder on the East Siberian and Jakutsk collections of Paullowsky and Von Stubendorff. For the Persian and Indian distribution, I have almost entirely depended on the herbarium at Kew, and on Boissier's and Bunge's numerous works.

3. *Arctic West America.*—The district thus designated is analogous in position, and to a considerable extent in climate, to the Arctic European, but is much colder; as is indicated both by the mean temperature, and by the position of the June isotherm of 41°, which makes an extraordinary bend to the south, nearly to 52° N. L., in the longitude of Behring's Straits.

It extends from Cape Prince of Wales, on the east shore of Behring's Straits, to the estuary of the Mackenzie river, and as a whole it differs from the flora of the province to the eastward of it by its far greater number both of European and Asiatic species, by containing various Altai and Siberian plants which do not reach so high a latitude in more western meridians, and by some temperate plants peculiar to West America. This eastern boundary is, however, quite an artificial one; for a good many eastern plants cross the Mackenzie and advance westwards to Point Barrow, but which do not extend to Kotzebue's Sound; and a small colony of Rocky Mountain plants also spread eastwards and westwards along the shores of the Arctic Sea, which further tend to connect the floras; such are *Aquilegia brevistylis, Sisymbrium humile, Hutchinsia calycina, Heuchera Richardsonii, Crepis nana, Gentiana arctophila, Salix speciosa*; none of which are generally diffused arctic plants, or natives of any other parts of Temperate America but the Rocky Mountains.

The arctic circle at Kotzebue's Sound is crossed by the isotherm of 23°, and at the longitude of the Mackenzie by that of 12° 5′; whilst the June isotherm of 41° ascends obliquely from S.W. to N.E., from the Aleutian Islands to the mouth of the Mackenzie, and passes south of this province; the June and the September isotherms of 41° and 32° both traverse it obliquely, ascending to the N.E.

The vast extent of the Pacific Ocean and its warm northerly currents greatly modify the climate of West Arctic America, causing dense fogs to prevail, especially throughout the summer months, whilst the currents keep the ice to the north of Behring's Straits. The shallowness of the ocean between America and Asia, north of lat. 60°, together with the identity of the vegetation in the higher latitudes of these continents, suggests the probability of the land having been continuous at no remote epoch.

The number of phænogamic plants hitherto found in Arctic West America is 364

$$\left(\begin{matrix}\text{Monocotyledons } 76\\ \text{Dicotyledons } 288\end{matrix}\right\} = 1:3{\cdot}7\right).$$

The proportion of genera to species is 1 : 1·7. Of these 364 species, almost all but the littoral and purely arctic species are found in West Temperate North America or in the Rocky Mountains, 26 in the Andes of Tropical or Subtropical America, and 37 in Temperate or Antarctic South America. Comparing this flora with that of Temperate and Arctic Asia, I find that no less than 320 species are found on the north-western shores and islands of that continent, or in Siberia, many extending to the Altai and the Himalaya. A comparison with Eastern Arctic America shows that 281 are common to it, and the following 38 are found in Temperate, but not Arctic East America.

Anemone alpina.
—— Pennsylvanica.
Hutchinsia calycina (Rocky Mountains only and Asia).
Sisymbrium humile (R. M. and As.).
Draba oligosperma (Rocky Mountains only).
Lathyrus palustris (Europe, Asia, East and West America).
Spiræa salicifolia (Eur., As., E. & W. Am.).
Potentilla fruticosa (Eur., As., E. & W. Am.).
—— Pennsylvanica (Eur., As., E. & W. Am.).
Comarum palustre (Eur., As., E. & W. Am.).
Montia fontana (Eur., As., & W. Am.).
Saxifraga Sibirica (Asia and Labrador only).
—— Dahurica (Asia and Rocky Mounts. only).
—— bronchialis (Europe, Asia, & R. Mounts.).
Archangelica officinalis (Europe, Asia, America).
Ligusticum Scoticum (Eur., As., Am.).
Cornus Suecica (Eur., As., Am.).
Galium rubioides (Eur., As., Am.).
Senecio resedæfolius (Eur., As., Am.).
—— pseudo-Arnica (Asia and America).
Cassandra calyculata (Europe, Asia, America).
Gentiana arctophila (Rocky Mountains only).
—— prostrata (Europe, Asia, America).
—— tenella (Eur., As., Am.).
Veronica scutellata (Eur., As., Am.).
Pedicularis palustris (Eur., As., Am.).
Atriplex patula (Eur., As., Am.).
Corispermum hyssopifolium (Eur., As., Am.).
Corallorhiza innata (Eur., As., Am.).
Luzula spadicea (Eur., As., Am.).
—— spicata (Eur., As., Am.).
—— pilosa (Eur., As., Am.).
Juncus balticus (Eur., As., Am.).
Carex lagopina (Eur., As., Am.).
—— Gmelini (America only).
—— cryptocarpa (Europe, Asia, America).
—— stricta (Europe, America).
Hierochloe borealis (Europe, Asia, and America).

These, it will be seen, are for the most part north temperate plants, common in many parts of the globe, and which are only excluded from Eastern Arctic America by the greater rigour of its climate.

The best marked European and Asiatic species that are not found further east in Temperate or Arctic America are the following:

Anemone narcissiflora.	Spiræa chamædrifolia.	Atriplex littoralis.
Ranunculus Pallasii.	Pyrethrum bipinnatum.	Pinus cembra.
Aconitum Napellus.	Gentiana prostrata.	Carex Norwegica.
Parrya macrocarpa.	Eritrichium aretioides.	Deyeuxia strigosa.
Dianthus alpinus.	Pedicularis verticillata.	—— Langsdorffii.
Cerastium vulgatum.	Primula nivalis.	Colpodium fulvum.

Hence it appears that of the 364 species found in Arctic West America, 319 inhabit East America (arctic or temperate, or both), and 320 are natives of the Old World—a difference hardly sufficient to establish a closer affinity of this flora with one continent rather than with the other.

The species peculiar to this tract of land are:—

Braya pilosa.	Artemisia androsacea.	Salix glacialis.
Saxifraga Richardsoni.	Saussurea subsinuata.	

The rarity of monocotyledons, and especially of the glumaceous orders, is almost as marked a feature of this as of the Asiatic flora: of the 138 arctic species of *Glumaceæ* only 54 are natives of West Arctic America.

The materials for this flora are principally the plants of Chamisso, collected during Kotzebue's voyage, and described by himself and Schlechtendahl; Lay and Collie's collections, described in Beechey's voyage; the 'Flora Boreali-Americana;' and Seemann's plants, described in the 'Botany of the Herald.' Most of the above collections are from Behring's Straits. For the arctic coast flora I am mainly indebted to Richardson's researches, and to Pullen's and other collections enumerated by Seemann in his account of the flora of Western Eskimo Land. For the southern extension of the flora I have had recourse to the 'Flora Boreali-Americana;' Ledebour's 'Flora Rossica,' which includes the Sitcha plants; the American floras of Nuttall, Pursh, Torrey, Gray, &c.; and to the collections of Drs. Lyall and Wood formed in Vancouver's Island and British Columbia; for the Californian, Mexican, and Cordillera floras generally, to the herbarium at Kew, the works above mentioned, and the various memoirs of Torrey and of Gray on the plants of the American Surveying Expeditions.

4. *Arctic East America* (*exclusive of Greenland*).—This tract of land is analogous to the Arctic Asiatic in many respects of position and climate, but is very much richer in species. It extends from the estuary of the Mackenzie River to Baffin's Bay, and its flora differs from that of the western part of the continent, both in the characters mentioned in the notice of that province, and in possessing more East American species. The western boundary of this province is an artificial one; the eastern is very natural, both botanically and geographically; for Baffin's Bay and Davis' Straits (unlike Behring's Strait) have very deep water and different floras on their opposite shores.

The arctic circle is crossed in the longitude of the Mackenzie River by the isotherm of 12°, which thence trends south-eastward to the middle of Hudson's Bay; and in the longitude of Davis' Straits it is crossed by the isotherm of $18\frac{1}{2}$°. The June isotherm of 41°

descends obliquely from the shores of the Arctic Sea, near the mouths of the Mackenzie, to the northern parts of Hudson's Bay, south of the arctic circle; and the September isotherm of 41° is everywhere south of the circle. Hence the western parts of this province are very much warmer than the eastern; so much so, that the whole west coast and islands of Baffin's Bay lie north of a southern inflection of the June isotherm of 32°, which passes north of all the other polar islands; the Parry Islands have an analogous temperature of 40°. The warmth of the western portion of this tract is no doubt mainly due to the influence of the Pacific Ocean being felt across the continent of West America; though possibly also to the presence of a comparatively warm polar ocean, or to Atlantic currents crossing the pole between Nova Zembla and Spitzbergen, of which nothing certain is known *. Be this as it may, the comparative luxuriance of the flora of Melville Island is a well-known fact, and one inexplicable by considerations of temperature, if unaccompanied by a humid atmosphere. The whole region is of course far north of the isotherm of 32°, which, in the longitude of its middle district, descends to Lake Winnipeg, in lat. 52°.

That portion of this province which is richest in plants is the tract which intervenes between the Coppermine and Mackenzie Rivers; east of this, vegetation rapidly diminishes, as also to the northward. The flora of the Boothian Peninsula, surrounded as it is with glacial straits, and placed centrically among the arctic islands, is perhaps the poorest of any part of the area; those of Banks' Land and Melville Island to the N.W. being considerably richer, as are those of the shores of Lancaster's Sound and Barrow's Strait, and the shores of Baffin's Bay to the north and east †.

The phænogamic flora of Arctic East America contains 379 species

$$\left(\begin{matrix}\text{Monocotyledons.}\ 92\\ \text{Dicotyledons..}\ 287\end{matrix}\right\} = 1:3{\cdot}1\Big).$$

The proportion of genera to species is 1 : 2·0. Of these 379 species, 323 inhabit Temperate North America, east of the Rocky Mountains; 35 the Cordillera; and 49 Temperate or Antarctic South America. Comparing this flora with that of Europe, I find that 239 (or two-thirds) species are common to the arctic regions of both continents, whilst but little more than one-third of the Arctic European species are Arctic East American. Of 105 non-European species in Arctic East America, 32 are Asiatic; leaving 73 species confined to America, of which the following are furthermore confined to the eastward of the Rocky Mountains and Mackenzie River:—

Corydalis glauca.	Lathyrus ochroleucus.	Vaccinium Canadense.
Sarracenia purpurea.	Rubus triflorus.	Dracocephalum parviflorum.
Viola cucullata.	Prunus Virginiana.	Douglasia arctica.
Silene Pennsylvanica.	Heuchera Richardsoni.	Elæagnus argentea.
Arenaria Michauxii.	Cornus stolonifera.	Urtica dioica.
Polygala Senega.	Grindelia squarrosa.	Salix cordata.

* It is a well-known fact that the temperature always rises rapidly with the north (as well as other) winds over all this Arctic American area.

† Details of these florulas will be found in the volume of the 'Linnean Journal,' under the notice of Dr. Walker's Collections, made during the voyage of the *Fox*.

Populus tremuloides.
Picea nigra.
Spiranthes gracilis.
Cypripedium acaule.
Carex oligosperma.
Pleuropogon Sabini.

Of these *Douglasia* and *Pleuropogon* are the only ones absolutely peculiar to Arctic East America. It is a noticeable fact that not one of them is found in any part of Greenland. Compared with Greenland, the Arctic East American flora is rich; containing, besides those just enumerated, no less than 165 other species not found in Greenland. The following are found on the arctic islands, and many of them on the west coast of Baffin's Bay, but not in West Greenland:—

Caltha palustris.
Parrya arctica.
Merkia physodes.
Stellaria crassifolia.
Astragalus alpinus.
Oxytropis campestris.
—— Uralensis.
—— nigrescens.
Sieversia Rossii.
Saxifraga hieracifolia.
—— Virginiensis.
—— Hirculus (East Greenland only).
Valeriana capitata.
Nardosmia corymbosa.
Ptarmica vulgaris.
Chrysanthemum arcticum.
Artemisia vulgaris.
Senecio frigidus.
—— palustris.
—— pulchellus.
Solidago Virga-aurea.
Aster salsuginosus.
Crepis nana.
Saussurea alpina.
Andromeda polifolia.
Arctostaphylos alpina.
Kalmia glauca.
Phlox Sibirica.
Castilleja pallida.
Pedicularis capitata.
—— versicolor.
Androsace septentrionalis.
—— Chamæjasme.
Salix phlebophylla.
Lloydia serotina.
Hierochloe pauciflora.
Deschampsia cæspitosa (East Greenland only).
Glyceria fluitans.
Pleuropogon Sabini.
Bromus purgans.
Elymus mollis.

There are thus no fewer than 184 of the 379 Arctic East American species (fully half) which are absent in West Greenland, whilst only 105 (much less than one-third) are absent in Europe. This alone would make the limitation of species in the meridian of Baffin's Bay more decided than in any other arctic longitude; and I shall show that it is rendered still more decisive by the number of Arctic Greenland plants that do not cross to Arctic East America.

Of the 379 Arctic East American species only 56 are not found in Temperate East America, of which two are absolutely confined to this area; two others (*Parrya arenicola* and *Festuca Richardsoni*) to Arctic East and West America; 25 are found in Temperate West America, and about 20 are Rocky Mountain species, and not found elsewhere in Temperate America.

For our knowledge of this flora I am principally indebted to the 'Flora Boreali-Americana,' and to Richardson's* botanical appendix to Franklin's first voyage—and his 'Boat Journey through Rupert's Land.' I have also examined the materials upon which the above works were founded, and the collections of almost every subsequent journey and voyage, up to those of Dr. Walker in the 'Fox.' To enumerate the numerous botanical appendices to voyages, and separate opuscules to which these have given rise, from Ross' first voyage to the present time, would be out of place here. I have endeavoured to embody in the

* I am indebted to Sir John Richardson for some corrections to this list, which account for a few discrepancies between his lists of Arctic American plants and my own; these refer chiefly to genera and species introduced into his lists, but here excluded.

essay the information gleaned from all of them. For the southern distribution of these plants in the United States, &c., I have had recourse primarily to Asa Gray's excellent 'Manual of the Botany of the Northern United States,' to Chapman's 'Flora of the S.E. States,' and to the reports on the Botany of various Exploring Expeditions.

5. *Arctic Greenland.*—In area Arctic Greenland exceeds any other arctic district except the Asiatic, but ranks lowest of all in number of contained species. In many respects it is the most remarkable of all the provinces, containing no peculiar species whatever, scarcely any peculiarly American ones, and but a scanty selection of European. A further peculiarity is that the flora of its temperate regions is extremely poor, and adds very few species to the whole flora, and, with few exceptions, only such as are arctic in Europe also. Being the only arctic land that contracts to the southward, forming a peninsula, which terminates in the ocean in a high northern latitude, Greenland offers the key to the explanation of most of the phenomena of arctic vegetation; and as I have already made use of it for this purpose, I shall be more full in my description of its flora than of any other.

The east and west coasts of Greenland differ in many important features; the eastern is the largest in extent, the least indented by deep bays, is perennially encumbered throughout its entire length by icefields and bergs, which are carried south by a branch of the arctic current that sets between Iceland and Greenland; and is hence excessively cold, barren, and almost inaccessible. The west coast, again, is generally more or less free from pack ice from Cape Farewell (lat. 60°) to north of Upernævik in lat. 73°. It is washed by a southerly current, which is said to carry drift timber from the Siberian rivers into its fiords, and enjoys a far milder climate, and consequently has a more luxuriant vegetation. A somewhat similar contrast is exhibited between West Greenland and the opposite shores of Baffin's Bay, against which latter the northerly arctic current from Lancaster Sound drives great masses of polar ice, derived from the regions beyond that estuary, and to which the bergs that float away from the glaciers in the Greenland fiords are also drifted. It is important to bear in mind these features of the two shores of Greenland and of Baffin's Bay and Davis' Straits, because they may in some degree explain their differences of vegetation. There is also another difference between the polar islands and Greenland, inasmuch as the former are for the most part low, without mountains or extensive glaciers; while the latter is exceedingly mountainous, with valleys along the shore terminating in glacier-headed fiords, and the coast is bound by glaciers of prodigious extent from Melville Bay northwards to Smith's Sound.

The isothermal lines in Greenland all follow one course, from S.W. to N.E., running more parallel to one another in this meridian than in any other. The isotherm of 32° passes through the southern extremity of the peninsula, and that of 5° through its north extreme at Smith's Sound. The June isotherm of 41° skirts its east coast, and that of 32° passes north of Disco; the June temperature of Disco is hence as low as that of the north of Spitzbergen, of middle Nova Zembla, and of the extreme north of Asia, and yet Disco contains quadruple their number of plants. The autumn cold is very great; the September isotherm of 32° crossing the arctic circle on the west coast; and to this the scantiness of the flora may to some extent be attributed.

The Arctic Greenland flora contains 206 species, according to Lange's catalogue (in Rincke's 'Greenland'); or 207, according to my materials $\left(\begin{matrix}\text{Monocot. } 67\\ \text{Dicot. . } 140\end{matrix}\right\} = 1:2{\cdot}1\Big)$: the proportion of genera to species being 1 : 2.

Of these 207 species the following 11 alone are not European:—

Anemone Richardsonii (Asiatic).
Turritis mollis (Asiatic).
Vesicaria arctica (American only).
Draba aurea (Rocky Mts. and Labrador only).
Hesperis Pallasii (Asia and America).
Arenaria Grænlandica (Mts. of U. S.).
Potentilla tridentata (Labrador only).
Saxifraga triscuspidata (Labrador only).
Erigeron compositus (American only).
Pedicularis euphrasioides (Asia).
Salix arctica (Asia).

On the other hand, no less than 57 Arctic Greenland species are absent in Arctic East America, and the following 36 Arctic Europe and Greenland species are either absent in all parts of Eastern Temperate America, or are extremely local there:—

Arabis alpina (Labrador only).
Lychnis alpina (do.).
Lychnis dioica (absent).
Spergula nivalis (do.).
Arenaria uliginosa (absent).
—— ciliata (do.).
Stellaria cerastioides (do.).
Alchemilla alpina (do.).
—— vulgaris (Labrador only).
Sibbaldia procumbens (United States only).
Rubus saxatilis (absent).
Potentilla verna (Labrador only).
Sedum villosum (absent).
Saxifraga Cotyledon (Labrador and Rocky Mountains only).
Galium saxatile (absent).
Gnaphalium sylvaticum (Labrador only).
—— supinum, *L.* (do. and White Mountains).
Cassiopeia hypnoides (Labrador only).
Phyllodoce taxifolia (do. and White Mountains).
Gentiana nivalis (Labrador only).
Thymus serpyllum (absent).
Veronica alpina (White Mountains only).
—— saxatilis (absent).
Euphrasia officinalis (N. U. States).
Bartsia alpina (Labrador only).
Rumex acetosella (absent).
Salix Arbuscula (do.).
Peristylus albidus (do.).
Carex capitata (White Mountains only).
—— microglochin (absent).
—— microstachya (do.).
—— pedata (do.).
Elyna caricina (Rocky Mountains only).
Phleum alpinum (Labrador and White Mountains only).
Calamagrostis lanceolata (Labrador only).
Deschampsia alpina (absent).

When it is considered how extremely common most of these plants are throughout Europe and Northern Asia, and that some of them inhabit also N.W. America, their absence in Eastern America is even more remarkable than their presence in Greenland.

Another singular feature of both Arctic and Temperate Greenland is its wanting a vast number of Arctic plants which are European, and found also in America. The following is a list of most of these, excluding about 15, which are water-plants, or species whose range is limited. The letter I. placed before a species signifies that it is Icelandic, and I have introduced it to show not only how many are absent from this island also, but how many are present. The letter S. indicates that the species is found in the south temperate or antarctic circle. The asterisk * indicates that the species is arctic both in East America and Europe.

Anemone alpina.
—— nemorosa.
—— narcissiflora.
* Ranunculus Purshii.
* I. Caltha palustris.
* Aconitum Napellus.
Actæa spicata.
Nuphar luteum.
Nasturtium amphibium.
S. Barbarea præcox.
S. Turritis glabra.
Thlaspi montanum.
Sisymbrium Sophia.
* I. Erysimum lanceolatum.
Arabis hirsuta.
I. S. Cardamine hirsuta.
* Parrya arctica.
I. Draba muralis.
I. Subularia aquatica.
* I. Drosera rotundifolia.
I. —— longifolia.
I. Viola tricolor.
* I. Arenaria lateriflora.
* Stellaria longifolia.
I. —— crassifolia
Linum perenne.
Geranium Robertianum.
Hypericum 4-angulum.
Oxalis acetosella.
* Phaca frigida.
* Astragalus alpinus.
* —— hypoglottis.
* Oxytropis campestris.
—— Uralensis.
Lathyrus palustris.
Spiræa salicifolia.
S. Geum urbanum.
I. —— rivale.
* Rubus arcticus.
Potentilla fructicosa.
—— Pennsylvanica.
—— argentea.
* I.S. Fragaria vesca.
I. Sanguisorba officinalis.
Rosa cinnamomea.
—— blanda.
* Circæa alpina.
* I. S. Epilobium tetragonum.
* I.S. Epilobium alsinæfolium.
S. Lythrum salicaria.
* Ribes rubrum.
* —— alpinum.
* I. Parnassia palustris.
Saxifraga Sibirica.
* —— hieraciifolia.
—— bronchialis.
* Bupleurum ranunculoides.
Conioselinum Fischeri.
Cicuta virosa.
* I. Carum carui.
Adoxa moschatellina.
Viburnum Opulus.
Lonicera cærulea.
* Linnæa borealis.
* I. Galium boreale.
—— rubioides.
I. —— trifidum.
S. —— aparine.
* Valeriana capitata.
* Nardosmia frigida.
* Chrysanthemum arcticum.
I. Pyrethrum nodosum.
—— bipinnatum.
* Artemisia vulgaris.
S. Bidens bipartita.
Tanacetum vulgare.
Antennaria Carpatica.
* Senecio resedæfolius.
* —— frigidus.
* —— palustris.
* —— campestris.
—— aurantiacus.
* Solidago Virgaurea.
* Aster Sibiricus.
* —— alpinus.
S. Erigeron acris.
S. Sonchus arvensis.
I. Hieracium boreale.
* Saussurea alpina.
I. Vaccinium myrtillus.
* Andromeda polifolia.
Cassandra calyculata.
* I. Arctostaphylos alpina.
* I. Pyrola secunda.
* I. Gentiana amarella.
I. —— tenella.
* Myosotis sylvatica.
—— palustris.
I. —— arvensis.
* Scutellaria galericulata.
I. S. Prunella vulgaris.
Glechoma hederaceum.
S. Stachys palustris.
* Gymnandra Pallasii.
* Castilleja pallida.
I. S. Veronica officinalis.
S. —— scutellata
I. S. —— serpyllifolia.
Melampyrum pratense.
—— sylvaticum.
* I. Pedicularis palustris.
* —— versicolor.
Scrophularia nodosa.
Utricularia vulgaris.
* Pinguicula villosa.
Glaux maritima.
Trientalis Europæa.
* Androsace septentrionalis.
* —— Chamæjasme.
Naumbergia thyrsiflora.
I. S. Primula farinosa.
I. Plantago major.
—— lanceolata.
S. Chenopodium album.
I. S. Atriplex patula.
Corispermum hyssopifolium.
* Polygonium Bistorta.
I. —— amphibium.
* Myrica Gale.
I. Betula alba.
I. —— pumila.
I. Alnus incana.
I. Salix pentandra.
I. —— myrtilloides.
I. Triglochin maritimum.
Scheuzeria palustris.
Veratrum album.
* Lloydia serotina.
* Allium schænoprasum.
* Smilacina bifolia.
* Platanthera obtusata.
* Calypso borealis.
Godyera repens.

Cypripedium guttatum.
Calla palustris.
Typha latifolia.
Narthecium ossifragum.
Luzula maxima.
S Juncus communis.
I. —— articulatus.
I. —— bulbosus.
—— stygius.
Carex pauciflora.
—— tenuiflora.
S. —— stellulata.
I. —— chordorrhiza.
—— teretiuscula.
—— paradoxa.
S. Carex Buxbaumii.
I. —— limosa.
S. —— Magellanica.
—— ustulata.
—— livida.
I. —— pallescens.
—— maritima.
I. —— cæspitosa.
I. —— acuta.
—— stricta.
—— filiformis.
I. S. Eleocharis palustris.
S. —— acicularis.
S. Scirpus triqueter.
S. —— lacustris.
Eriophorum alpinum.
Rhynchospora alba.
Alopecurus pratensis.
I. Milium effusum.
S. Phalaris arundinacea.
I. S. Phragmites communis.
* I. Hierochloe borealis.
* —— pauciflora.
* I. Catabrosa aquatica.
* I.S. Glyceria fluitans.
* I. Atropis distans.
I. Festuca elatior.
S. Bromus ciliaris.
I. S. Triticum caninum.
S. Hordeum jubatum.

Altogether there are absent in Greenland upwards of 230 Arctic European species, which are all of them American plants. The most curious feature of this list is the absence throughout Greenland of the genera *Spiræa*, *Senecio*, *Astragalus*, *Trifolium*, *Phaca*, *Oxytropis*, *Androsace*, *Aster*, *Myosotis*, *Rosa*, *Ribes*, *Thlaspi*, *Sisymbrium*, *Geranium*, &c., and of such ubiquitous arctic species as *Fragaria vesca*, *Caltha palustris* *, *Barbarea præcox*. It is remarkable that *Astragalineæ* are also absent from Spitzbergen and Iceland.

Iceland possesses 432 species $\left(\begin{matrix}\text{Monocot. } 157\\ \text{Dicot. . . } 275\end{matrix}\right)$, amongst which I find about 120 Arctic European plants that do not enter Greenland; whereas only 50 of the European plants that inhabit Greenland are absent in Iceland. The more remarkable desiderata of Iceland are *Astragalineæ*, *Anemone*, *Aconitum*, *Braya*, *Turritis*, *Artemisia*, and *Androsace*; *Alopecurus alpinus*, *Luzula arcuata*, *Hierochloe alpina*, *Rubus chamæomorus*, *Cassiopeia tetragona*, *Arnica montana*, *Antennaria dioica*, and *Chrysosplenium alternifolium*. On the other hand, Iceland contains of arctic genera absent in Greenland; *Caltha* (one of the most common plants about Icelandic dwellings), *Cakile*, *Geranium*, *Trifolium*, *Spiræa*, *Senecio*, and *Orchis*.

But perhaps the most remarkable fact of all connected with the Greenland flora is that its southern and temperate districts, which present a coast of 400 miles, extending south to lat. 60° N.L., do not add more than 74 species to its flora, and these are almost unexceptionably Arctic European plants; and inasmuch as these additional species increase the proportion of Monocotyledons to Dicotyledons of the whole flora, Greenland as a whole is botanically more arctic in vegetation than Arctic Greenland alone is!

The only American forms which Temperate Greenland adds to its flora are, *Ranunculus Cymbalariæ*, *Pyrus Americana*, a very trifling variety of the European *Aucuparia*, *Viola Muhlenbergii*, a mere variety of *V. canina*, *Arenaria Grœnlandica*, a plant elsewhere

* This is the more remarkable because it forms a conspicuous feature in Iceland, and is a frequent native of all the Arctic American coasts and islands.

found only on the White Mountains of New Hampshire, and *Parnassia Kotzebuei*, a species which is scarcely different from *palustris*.

The only plants which are not members of the arctic flora elsewhere, and which are confined in Greenland to the temperate zone, besides the above American plants, are *Blitum glaucum*, *Potamogeton marinus*, *Sparganium minimum*, and *Streptopus amplexifolius*: the rest will all be found in the column of the arctic plant catalogue devoted to Greenland, where S. signifies that the species is found south only of the arctic circle in that country.

On the other hand Temperate Greenland adds very materially to the number of European Arctic species that do not enter Eastern America (Arctic or Temperate), amongst which the most remarkable are

Cerastium viscosum.	Galium palustre.	Betula alpestris.
Vicia cracca.	Leontodon autumnale.	Juncus trifidus.
Rubus saxatilis.	Hieracium murorum.	—— squarrosus.
Sedum annuum.	—— alpinum.	Anthoxanthum odoratum.
Galium uliginosum.	Gentiana aurea.	Nardus stricta.

Another anomalous feature in the Greenland flora is the presence, on the East Arctic coast, of some species not found on the west, nor in the temperate southern end of the peninsula. These are :—

Lychnis dioica (Arctic Europe).
Saxifraga Hirculus (abundant in all extreme arctic latitudes but West Greenland).
Polemonium cæruleum (all arctic longitudes but West Greenland).
Deschampsia cæspitosa (all arctic longitudes, but also absent in Spitzbergen).

For data connected with the Greenland flora, I am mainly indebted to the collections of the various polar voyagers in search of a north-west passage, especially to Drs. Lyall's and Sutherland's; to Lange's catalogue in Rincke's 'Greenland'; and to the notices of Vahl, Greville, Sir William Hooker, &c., on the plants collected by Sabine, Scoresby, Ross, Jameson, Graah, and Vahl, &c.; to Sutherland's appendix to Penny's voyage and Durand's to Kane's voyage.

There is a curious affinity between Greenland and certain localities in America, which concerns chiefly a few of the European plants common to these countries. First, there are in Labrador, or on the Rocky Mountains, or White Mountains of New Hampshire, a certain number of European plants found nowhere else in the American continent. They are :—

Ranunculus acris (Rocky Mountains).	Gentiana nivalis (Labrador).
Arabis alpina (Labrador).	Veronica alpina (White Mountains).
Lychnis alpina (Labrador).	Bartsia alpina (Labrador).
Sibbaldia procumbens (Rocky Mountains).	Salix Arbuscula (White Mountains).
Potentilla verna (Labrador).	Luzula spicata (White Mountains).
Montia fontana (Labrador).	Juncus trifidus (White Mountains).
Gnaphalium sylvaticum (Labrador).	Carex capitata (White Mountains).
—— supinum (Labrador & White Mountains).	Kobresia scirpina (Rocky Mountains).
Cassiopeia hypnoides (Labr. & White Mounts.).	Phleum alpinum (White Mountains & Labrador).
Phyllodoce taxifolia (Labr. & White Mounts.).	Calamagrostis lanceolata (Labrador).

There are also three plants peculiar to Greenland and Labrador, or the White or Rocky Mountains, which have not hitherto been found elsewhere. They are:—

Draba aurea (Rocky Mountains).
Arenaria Grænlandica (White Mountains and Labrador).
Potentilla tridentata (Labrador).

On the Arctic Proportions of Species to Genera, Orders, and Classes.

The observations which have hitherto been made on this subject, are almost exclusively based on data collected on areas too small to yield general results. Especially in determining the influence of temperature in regulating the proportions of the great group of flowering plants, it is of the highest importance to take comprehensive areas, both because of the wider longitudinal dispersion of some orders, especially the Monocotyledons, and the effects of local conditions, such as bog land, which determine the overwhelming preponderance of *Cyperaceæ* in some arctic provinces compared with others.

The proportion of genera to species in the whole arctic phænogamic flora is 323 : 762, or 1 : 2·3. $\frac{\text{Monocot. } 1:2{\cdot}8}{\text{Dicot. } 1:2{\cdot}2}$; and that of orders to species 1 : 10·8; in the several provinces as follows:—

	Gen.	Gen. to Sp.	Orders.	Ord. to Sp.
Arctic Europe	277	1 : 2·3	64	1 : 9·6
„ Asia	117	1 : 2·0	38	1 : 6·1
„ West America	172	1 : 2·1	48	1 : 7·6
„ East America	193	1 : 2·5	56	1 : 6·8
„ Greenland	104	1 : 2·0	38	1 : 5·5

Thus Europe presents the most continental character in its arctic flora, and West America the most insular; which may be attributable to the same cause in both; namely, the uniformity or variety of type. In West America we have, as in an oceanic island, a great mixture of types (Asiatic, European, East and West American) and paucity of species; in Europe the contrary. The proportions of species to orders are still more various; but here, again, Europe takes the lead decidedly.

The proportions of genera and orders to species of all Greenland differ but little from those of its arctic regions; whereas the contrast between Arctic Europe and this, together with Norway as far south as 60° N. lat., is very much greater. This is in accordance with the observation I have elsewhere made, that the whole of Greenland is comparatively poorer in species than Arctic Greenland is.

	Gen. Sp.	Ord. Sp.		Gen. Sp.	Ord. Sp.
Arctic Scandinavia	1 : 2·3	— 1 : 9·6	Arctic Greenland	1 : 2·0	— 1 : 5·5
All Scandinavia	1 : 2·8	— 1 : 11·6	All Greenland	1 : 2·3	— 1 : 6·6

The proportions of Monocotyledons to Dicotyledons are:—

Arctic Flora	1 : 2·6
Arctic Europe	1 : 2·3
„ Asia	1 : 4·5
„ West America	1 : 3·8
„ East America	1 : 3·1
„ Greenland	1 : 2·1
All Greenland	1 : 2·0

The Proportion of largest Orders to the whole Flora.

	Gram. & Cyp.	Salicin.	Polygon.	Scroph.	Eric. & Vaccin.	Comp.	Saxif.	Ros.	Leg.	Caryop.	Crucif.	Ranun.
Arctic Flora	1 : 5·6	1 : 30·5	1 : 50·2	1 : 27·1	1 : 33·1	1 : 10·0	1 : 26·2	1 : 17·3	1 : 24·6	1 : 15·0	1 : 14·1	1 : 17·7
,, Europe	1 : 5·2	1 : 38·4	1 : 56·0	1 : 23·7	1 : 30·8	1 : 12·3	1 : 34·2	1 : 21·2	1 : 30·8	1 : 15·4	1 : 17·7	1 : 24·6
,, Asia	1 : 10·6	1 : 16·6	1 : 23·3	1 : 16·6	1 : 21·2	1 : 9·6	1 : 15·5	1 : 19·4	1 : 29·1	1 : 14·5	1 11·6	1 : 21·2
,, W. America.	1 : 6·7	1 : 24·3	1 : 52·0	1 : 33·0	1 : 22·7	1 : 9·6	1 : 19·1	1 : 16·6	1 : 28·0	1 : 15·9	1 : 18·9	1 : 17·3
,, E. America.	1 : 5·8	1 : 27·0	1 : 76·0	1 : 34·5	1 : 23·7	1 : 10·5	1 : 21·0	1 : 23·7	1 : 27·0	1 : 17·2	1 : 11·9	1 : 18·9
,, Greenland...	1 : 3·8	1 : 29·6	1 : 51·7	1 : 23·0	1 : 17·3	1 : 20·7	1 : 17·2	1 : 20·7	0 : 207·0	1 : 10·3	1 : 10·9	1 : 23·0
All Greenland	1 : 3·7	1 : 34·0	1 : 42·7	1 : 24·9	1 : 21·4	1 : 15·0	1 : 27·2	1 : 19·8	1 : 149·6	1 : 12·4	1 : 12·0	1 : 27·2

The great differences between these proportions show how little confidence can be placed in conclusions drawn from local floras. *Ericeæ* is the only order which is more numerous proportionally to other plants in every province than in the entire arctic flora, and *Cruciferæ* is the only one that approaches it in this respect; and *Leguminosæ* is the only one which is less numerous proportionally in them all. East and West America agree most closely of any two provinces; then (excluding *Leguminosæ*) all Greenland and Europe; next Arctic Greenland and all Greenland.

The greatest differences are between Arctic Europe and Asia, and Arctic Asia and West America; they are less between Arctic Greenland and Asia (excluding *Leguminosæ*); they are great between Arctic Greenland and East America; and as great between all Greenland and Arctic America.

The proportion formerly deduced by Brown, &c., for the high arctic regions was a much smaller one; the Monocotyledons being in comparison with the Dicotyledons 1 : 5; and this still holds for some isolated, very arctic localities, as North-east Greenland; whereas Spitzbergen presents the same proportion as all the arctic regions, 1 : 2·7; the Parry Islands 1 : 2·3; the west coast of Baffin's Bay, from Pond's Bay to Home Bay, 1 : 3·3; and the extreme arctic plants mentioned at p. 257., 1 : 3. Of the prevalent arctic plants mentioned at p. 256, the proportion is 1 : 3·4.

I have dwelt more at length on these numerical proportions than their slight importance seems to require; my object being to show how little mutual dependence there is amongst the arctic florulas. Each has profited but little through contiguity with its coterminous districts; though all bear the impress of being members of one northern flora.

On Grouping the Forms, Varieties, and Species of Arctic Plants for purposes of Comparative Study.

Considering the limited extent of the arctic zone, the poverty of its flora, which is almost confined to 14° of latitude in the longitudes most favourable to vegetation, and to only 10° in the Asiatic area, and the number of able botanists who have studied it, it might be supposed that the preliminary task of identifying the species, and tracing their distribution within and beyond the arctic circle would have been short and simple; but this is not the case; for owing to the number of local floras, voyages, travels, and scientific periodicals that have to be consulted, to the variability of the species, and the consequent difficulty of settling their limits, and to the impossibility of reconciling the divergent opinions of my predecessors regarding them, I have found this a very tedious and unsatisfactory operation.

Of all these sources of doubt and error, the most perplexing has been the well-known variability of polar plants; and in the existing state of the controversy upon Mr. Darwin's hypothesis, it requires to be treated circumspectly. In several genera, I have not only had to decide whether to unite for purposes of distribution dubious or spurious arctic species, but also how far I should go in examining and uniting cognate forms from other countries, which, if included, would materially affect the distribution of the species. These questions became in many instances so numerous and complicated, that I have often resorted to the plan of treating several very closely allied species and varieties as one aggregate or collective species. This appears at first sight to be an evasive course; but as it offered the only satisfactory method of solving the difficulty, I was obliged, after many futile attempts to find a better, to resort to it, and hence I feel called upon to enter more fully into my reasons for doing so; premising that all my attempts to treat each variety, form, and subspecies as a distinct plant, involved the discussion of a multitude of details from which any generalization was hopeless; the results in every case defeated the object of this paper.

Of the plants found north of the arctic circle, very few are absolutely or almost exclusively confined to frigid latitudes (only about 50 out of 762 are so); the remainder, as far as their southern dispersion is concerned, may be referred to two classes; one consisting of plants widely diffused over the plains of Northern Europe, Asia, and America, of which there are upwards of 500; the other of plants more or less confined to the Alps of these countries, and still more southern regions, of which there are only about 200. *Glyceria fluitans*, *Atropis maritima*, and *Senecio campestris* are good examples of the first, as being high arctic and boreal but not alpine; while most of the species of *Saxifraga*, *Draba*, and *Androsace*, are examples of the second*. Both these classes abound in species, the limitation of which within the arctic circle, and the identification of whose varieties with those of plants of more southern countries, present great difficulties.

Those plants of the temperate plains which enter the arctic regions are often species of large, widely dispersed, and variable genera, most or all of whose species are very difficult of limitation; as *Ranunculus*, of which the arctic species *auricomus*, *aquatilis*, and *acris*, are each the centre of a nœud of allied temperate species or varieties, as to whose limits no two botanists are agreed; and the same applies to the species of *Viola*, *Stellaria*, *Arenaria*, and *Hieracium*. This has often led to the grouping of names of plants considered as synonymous by some authors, varieties by others, and good species by a third class. Furthermore, such genera are often represented in the temperate regions of two or more continents (and some of them in the south temperate zone also) by closely allied groups of intimately related species. This always complicates matters extremely; for an arctic species, being generally in a reduced or stunted state, may be equally similar to alpine or reduced forms of what in two or more of these geographically sundered groups

* Conversely the only arctic genus unknown in the Alps of the middle temperate zone is *Pleuropogon*, and the only alpine genera containing several species which inhabit the highest Alps of the north temperate zone, but not the polar regions, are *Soldanella* in Europe, *Swertia* in Europe and the Himalaya, &c.

may rank as good species, and its affinities and distribution be consequently open to doubt. Thus under the arctic *Stellaria longipes* are included five other arctic forms (*læta, Edwardsii, peduncularis, hebecalyx* and *ciliatosepala*); but amongst these forms some specimens approach closely the American *S. longifolia*, Muhl, or slight varieties of it; while others resemble the European *S. Friesiana*, Ser., others *S. graminea*, others certain Tasmanian forms, and others, again, Chilian. My own impression is, that some of these may prove but slight modifications of one common, very widely dispersed plant, between all whose varieties no constant definable characters will eventually be found; but in the present state of science I have abstained from including any of them, because to prove this or disprove it, the whole genus wants a far longer and closer study than it has yet received or than I can give it. *Arenaria verna* and its forms offer a very parallel case, and these I have included more largely, because I have the published opinion of many botanists to bear me out in doing so. *Viola epipsila, palustris* and *blanda*, are thus included, though they are more constant and have to a considerable extent different distributions; because I have found no differences of any moment between their normal forms, because such as exist seem to me to be too slight to attach specific value to; and because, though well distinguished by Scandinavian botanists, they have not been so carefully collected and studied in other parts of the arctic zone. *Viola canina, Fragaria vesca*, and *Sanguisorbia officinalis*, afford other examples: all these arctic plants affect the temperate plains rather than the mountains of the northern hemisphere.

Turning to those arctic plants that chiefly affect the Alps of the temperate or tropical zones, their limitation is quite as difficult; alpine plants being as proverbially variable as arctic. Many alpine plants are now considered to be only altered forms of lowland ones; and this affects the estimated distribution of every arctic species that is identified with an alpine one. As an example, *Saxifraga exilis* is a very slight variety of *S. cernua*; both are arctic and alpine plants, but *S. cernua* is considered by some botanists to be an alpine form of the lowland *S. granulata*, whose limits and distribution are very difficult to settle; because it apparently passes into several oriental forms, which have been distinguished as species. In this case I have not included *S. granulata* with *S. cernua*; because the latter is everywhere easily distinguished as a well-marked plant, having a restricted range both in area and in elevation, which *S. granulata* does not share. At the same time I am in favour of a hypothesis that would give these a common origin previous to the glacial epoch.

Other reasons for adopting the system of including very closely allied species are the following:—When species have been founded in error; this generally arises from their authors having imperfect specimens, or too limited a series of them; various species founded by Brown on the first Arctic American collections come under this category, as do Adams' Arctic Siberian species; the genera *Ranunculus, Draba, Arenaria*, and *Potentilla*, offer many examples: when the species, besides belonging to very variable genera, are apparently identical both in the herbarium and according to their descriptions, and present the same or a continuous distribution; of this *Trientalis, Senecio, Aster, Erigeron, Mertensia, Sedum, Claytonia, Turritis*, and many others, afford examples.

It may be asked what useful scientific results can be obtained from the study of a flora whose specific limits are in so vague a condition? the answer is, that though much is uncertain, all is not so; and that if the species thus treated conjointly really express affinities far closer than those which exist between those treated separately, a certain amount of definite information, useful for my purpose, is obtained; and it is a matter of secondary importance to me whether the plants in question are to be considered species or varieties. Again, if, with many botanists, we consider these closely allied varieties and species as derived by variation and natural selection from one parent form at a comparatively modern epoch, we may with advantage, for certain purposes, regard the aggregate distribution of the very closely allied species as that of one plant. When sufficient materials shall have been collected from all parts of the arctic and sub-arctic areas, we may institute afresh the inquiry into their specific identity or difference, by selecting examples from physically differing distant areas, and comparing them with others from intermediate localities. An empirical grouping of allied plants for the purposes of distribution may thus lead to a practical solution of difficulties in the classification and synonymy of species.

My thus grouping names must not therefore be regarded as a committal of myself to the opinion that the plants thus grouped are not to be held as distinct species; I simply treat of them under one name, because for the purposes of this essay it appears to me advisable to do so. Every reflecting botanist must acknowledge that there is no more equivalence amongst species than there is amongst genera; and I have elsewhere* endeavoured to show that, for all purposes of classification, species must be treated as groups analogous to genera, differing in the number of distinguishable forms they include, and of individuals to which these forms have given origin, and in the amount of affinity both between forms and individuals. My main object is to show the affinities of the polar plants, and I can best do this by keeping the specific idea comprehensive. It is always easier to indicate differences than to detect resemblances, and if I were to adopt extreme views of specific difference, I should make some of the polar areas appear to be botanically very dissimilar from others with which they are really most intimately allied, and from which I believe them to have derived almost all their species. A glance at my catalogue will show that, had I ranked as different species the few Greenland forms of European plants (called generally by the trivial name *Grœnlandica*), I should have made that flora appear not only more different from the European than it really is,but from the American also; and that the differences thus introduced would be of opposite values, and hence deceptive, in every case when the European species (of which the *Grœnlandica* is often not even a variety or distinct form) was not also common to America.

I wish it then to be clearly understood that the catalogue here appended is intended to include every species hitherto found within the arctic circle, together with those most closely allied forms which I believe to have branched off from one common parent within a comparatively recent geological epoch, and that immediately previous to the glacial period or since then. Further, I desire it to be understood that I claim no originality in bringing these closely allied forms together; from the appended notes, it will be seen that there is scarcely one of them that has not been treated as a synonym,

* Essay on the Australian Flora; introductory to the Flora Tasmanica, p. v. &c.

variety, subspecies, form, or lusus, by one or more very able and experienced botanists, some of them by many. Furthermore, it is curious to observe how much the botanists of each country do to a considerable extent agree amongst themselves as to the specific identity or difference of the same forms—the Scandinavian agreeing with Fries, the German with Koch, and the American with Hooker's 'Flora Boreali-Americana'; also to observe, that in all these cases the authors I quote are independent observers, and not copyers or followers. I think this fact indicates that the same plant presents a different aspect (probably obliterated in drying) in each country. This observation is consonant with what we know of the tendency of all species to run into local varieties in isolated areas, which varieties are often appreciable to the eye or to the touch, but are not expressable by words.

Of the 762 species enumerated, I have compared arctic or boreal specimens of all but a few which I have indicated in the appended notes, and in most cases I have compared specimens from all the southern areas indicated; but I do not pretend to have made such a critical study of all the grouped species, or of all those belonging to difficult genera (as *Draba*, *Poa*, &c.), as to enable me to say that I have given all their distribution, or satisfied myself of all their affinities and differences. There are, on the contrary, fully 60 genera out of the 323 arctic ones enumerated, each of which requires careful monographing, and months of study before the limits, systematic and geographical, of its common European species can be ascertained. In two of the largest and most difficult of these I have been indebted to others; namely, to Dr. Boott, who has revised my list of Carices, and to Dr. Andersson of Stockholm, who has drawn up that of the Salices: each has extensively modified the conclusions of his predecessors in arctic botany; quite as much or more so than I have done in any genus, and I have every confidence in their judgment. Colonel Munro has twice revised the list of grasses with a like result. In these important genera, therefore, the groups express the opinions of these acute botanists as to the limits of the species.

With regard to the probable completeness of our knowledge of the flowering plants of the arctic zone, I think it is pretty certain that there are few or no new species to be discovered. The collectors in the numerous voyages undertaken since 1847 in search of the Franklin expedition have not added one species to the flora of the Arctic American islands, and but one to that of Arctic Greenland. The Lapponian region is, of course, as well known as any on the globe; but further east, and especially in Arctic Siberia, much remains to be done; not perhaps in the discovery of new plants, but in ascertaining the southern limits of various Siberian ones that probably cross the arctic circle. Of Arctic Continental America the same may be said.

The method which I adopted in finally arranging the materials for geographical purposes was the following. I took Wahlenberg's 'Flora Lapponica,' Fries' 'Summa Vegetabilium Scandinaviæ,' Ledebour's 'Flora Rossica,' Hooker's 'Flora Boreali-Americana,' and Lange's 'Plants of East Greenland,' which together embrace in outline almost everything we know of arctic botany, geographical, systematic and descriptive. I put together from these all the matter they contained, and arranged it both botanically and geographically into a 'Systema,' which I studied with an Admiralty north circumpolar chart; and by this means arrived at a general idea of the position and extent of the centres of vegetation within the polar circle. I then again went through the catalogue with the herbarium, with every work treating on arctic plants that was accessible to me, and lastly revised it, verifying the habitats, comparing specimens from each province, adding new localities from more recent floras, catalogues, and voyages; tracing the extra-arctic distribution of the species, and noting all points requiring further investigation.

Tabulated View of Arctic Flowering Plants and Ferns, with their Distribution.

In the appended table of the distribution of arctic plants I have included every species which I know or believe has been found to extend north of $66\frac{1}{2}°$ N. lat. Of these, some few may but just cross the polar circle, and hence be scarcely entitled to the term arctic; but, on the other hand, there are no doubt temperate species which are entitled to be so considered, but which have not yet been recorded from so high a latitude. This remark applies especially to Arctic Siberia, and possibly also in a less degree to Arctic America, where however Richardson's* conscientious researches, conducted with the view of tracing the polar limits of plants, along the valleys of the great rivers Coppermine and Mackenzie, must have left little of importance to be added or corrected. A cross in a column indicates that the species is naturalized.

The columns showing the distribution of each species are so arranged and filled up as to express in the most simple manner the rather complicated directions of migration of each species or group of species. The leading idea, it will be observed, is to demonstrate the influence exerted by the glacial epoch, and the columns selected and letters introduced are intended to express the apparent results of this influence on each species, such letters indicating physical obstacles to migrations which the species has or has not overcome. I have hence avoided all further complication than appeared to me necessary to illustrate the conclusions I have arrived at. It would have been easy to have expressed in greater detail the southern and eastern distribution of the species, subspecies, and varieties in the European column for instance; but I could not have done so in like manner for the same plants in the Asiatic, nor for any but a few species in the West American columns.

When the species, subspecies, or varieties grouped under one in these columns shall have been disentangled in other countries as they have been in Scandinavia, and when their exact geographical limits also shall be ascertained as accurately in other countries as they have been in Scandinavia, then the time will have arrived for a history of the origin as well as the direction of migration of arctic plants throughout the circle and elsewhere. Meanwhile, as before explained, this essay pretends to no more than laying the foundations of this inquiry on a satisfactory basis.

The globe is divided into five principal areas; or rather the species are traced in five directions, as follows:—

I. Arctic Distribution.—1. *Arctic European,* from Lapland eastward to the Gulf of Obi. An S. in this column indicates that the plant attains the extreme northern limits of phænogamic vegetation in this district—viz., Spitzbergen. 2. *Arctic Asia,* from the Obi to Behring's Straits. 3. *Arctic Western America,* from Behring's Straits eastward to the Mackenzie River. 4. *Arctic Eastern America,* from the Mackenzie to Baffin's Bay. An M. in this column signifies that the plant extends to the islands north of Lancaster Sound, and to the Parry Islands, including Melville Island, the best explored of them. 5. *Arctic Greenland.* An S. in this column implies that the species has been found south only of the arctic circle in Greenland; and E. that it is found on the east coast only, the only explored portions of which lie to the north of lat. 70°.

II. North and Central European and North Asiatic Distribution.—From the arctic circle

* Sir John Richardson has had the kindness to revise the list of arctic plants appended to the 2nd vol. of his 'Boat Voyage through Rupert's Land,' &c.; and I have his authority for excluding any genera and species which appear there, and which are not included in my catalogue.

to the Alps and Pyrenees, Carpathians, Balkan, and Tauria (inclusive) in Europe, and to the Caucasus, Altai and Soongaria (inclusive) in Asia. 1. *Europe to the Alps.* Here A. implies that the plant inhabits the Alps, or Pyrenees, or Caucasus; and N. that it is a more northern plant, not advancing south of Germany or Central Russia, in many cases not south of Scandinavia. 2. *Asia to the Altai, Soongaria and Dahuria*; the eastern limit of this zone is supposed to be the Jablonoi range, and the western, the Obi River. 3. *Eastern Asia,* from Behring's Straits to the south of Japan, including Mantchuria, Kamtschatka, the peninsula of Ochotsk, North China, and the neighbouring islands of Japan. This district presents a transition zone between the Asiatic and American floras, and were it better explored might possibly be incorporated with the latter, in the higher latitudes at any rate.

III. American Distribution.—1. *North-west America* includes the band of country from the Rocky Mountains to the Pacific. This is for the most part a very mountainous area, presenting two floras, —the Columbian, which extends south to the Oregon; and the Californian, which extends north to that river, and inland to a considerably higher but still unknown latitude. Being unable to define the limits of these two floras, I have not indicated to which the arctic plants belong, but here, as in the following column, an R. indicates that the species inhabits the Rocky Mountains. 2. *North-east America.* This includes all temperate North America, from the Rocky Mountains to the Atlantic. In this column the letter C. indicates that the species is Canadian, but does not enter the United States; L. that it is confined to Labrador, R. to the Rocky Mountains, and W. that in the United States it has been only found on the White Mountains of New Hampshire, or on other high mountains of the Eastern States. 3. *Tropical America.* With few exceptions the arctic plants found in this province are confined to the temperate and alpine regions of the Cordillera from Mexico to Peru inclusive. M. signifies that it has been found in, but not south of, Mexico. 4. Includes Extra-tropical South America and its islands.

IV. South Europe and Africa.—1. *Europe south of the Alps, Asia Minor, the Canary Islands, and Africa north of the tropic.* In this column are included the plants of the Spanish and Italian peninsulas, Dalmatia, &c., Greece, and both Turkeys. Of these countries, Asiatic Turkey, or Asia Minor, should perhaps have been ranked in the Asiatic column with Persia, &c.; but it contains so very many European plants that are not found further east, that I have included it here. The letter A. in this column indicates that the plant actually crosses the Mediterranean to North Africa, and is found in Algeria, Egypt, the Canary Islands, or the mountains of Abyssinia*. 2. *South Africa,* from the Cape of Good Hope to the tropic.

V. Central and South Asiatic Distribution.—1. *Persia, Tibet, and the Himalaya Mountains.* In this column the letter H. indicates that the species inhabits the Himalaya or Tibet. 2. *Tropical Asia.* This includes all India south of the Himalaya, and especially the Khasia mountains of Eastern Bengal, the mountains of both peninsulas of India, of Ceylon, and of Java. 3. The last column is confined to Australia, New Zealand, and the antarctic islands to their south.

The map that accompanies this paper is reduced from the latest Admiralty chart of the north polar regions (that of 1860), by permission of Captain Washington, R.N., Hydrographer of the Admiralty. The isothermal lines are taken from Professor Dove's work 'On the Temperature of the Globe,' translated by Major-General Sabine, and printed by the British Association for the Advancement of Science in 1853. I have selected what appeared to me the seven most instructive isotherms; namely, the annuals of 0° 5′ Fahr., 5° and 32°; the two June isotherms of 32° and 41°, and the two September isotherms of 32° and 41°; these two months answering respectively to the flowering and fruiting seasons within the arctic circle.

* So few Arctic European plants have been found in Tropical Africa, that I have not devoted a column to it. About twenty, however, have been identified either by Achille Richard, by the namers of the Schimper's and Kotschy's plants, or by myself in the Hookerian Herbarium. Even on Clarence Peak, a mountain on the isolated island of Fernando Po, 10,600 feet high, arctic plants have been found by Mann, the collector for Kew, *Deschampsia cæspitosa, Luzula campestris, Galium aparine,* and *Limosella aquatica,* together with two other boreal species, *Sanicula Europæa* and *Brachypodium sylvaticum.*

TABULAR VIEW OF THE DISTRIBUTION OF ARCTIC PLANTS.

DICOTYLEDONES.

I. **Ranunculaceæ.**

	I. Arctic.					II. N. Europ. and Asiatic.			III. American.				IV.		V.		
	Europe.	Asia.	W. America.	E. America.	Greenland.	Europe to Alps, &c.	Asia to Altai, &c.	N. E. Asia and Japan.	N. W. America.	N. E. America.	Tropical America.	Extra-tropical S. America.	S. Europ., N. Afric., Asia Minor.	S. Africa.	Persia, Tibet, Himalaya, &c.	Tropical Asia.	Australia and New Zealand.
THALICTRUM dioicum, *L.*	..	..	1	1	..	..	..	..	1	1							
alpinum, *L.* (*alp.*)	1	1	1	..	1	A	1	1	1	C	..	..	1	..	H		
minus, *L.*	1	..	..	..	..	A	1	1	..	..	..	..	1	1	H		
Kemense, *Fr.*																	
flavum, *L.*	1	..	..	..	..	A	1	1	..	..	..	..	1				
rariflorum, *Fr.*																	
strictum, *Led.*																	
ANEMONE patens, *L.*	..	..	1	1	..	A	1	1	1	1	..	..	1				
Nuttalliana, *DC.*																	
parviflora, *Mich.*	..	..	1	1	..	..	..	..	..	1	..	..	..	..	1		
Richardsoni, *Hk.*	..	..	1	1	1	..	1	1	1	C							
Vahlii, *Horn.*																	
alpina, *L.* (*alp.*)	..	..	1	..	..	A	..	..	1	1	..	..	1				
nemorosa, *L.*	1	..	..	..	..	A	1	1	1	1	..	..	1				
ranunculoides, *L.*	1	..	..	..	..	A	1	1	..	..	..	..	1	..	1		
vernalis, *L.*	1	..	..	..	..	A											
decapetala, *L.*	..	..	1	1	..	..	..	..	1	1	..	1					
multifida, *Poir.*																	
Pennsylvanica, *L.*	..	..	1	1	..	..	1	1	1	1							
narcissiflora, *L.* (*alp.*)	..	..	1	..	..	A	1	1	1	..	..	..	1	..	H		
RANUNCULUS aquatilis, *L.*	1	..	1	1	1	A	1	1	1	1	1	1	A	1	H	..	1
confervoides, *Fr.*																	
Pallasii, *Schl.*	1	1	1	..	..	..	..	1	1	L							
glacialis, *L.* (*alp.*)	1S	..	..	..	1	A	..	1	1	..	..	..	1				
Chamissonis, *Schl.*																	
Flammula, *L.*	1	..	1	1	S	A	1	1	1	1	..	..	A	..	1		
reptans, *L.*																	
Cymbalaria, *Psh.* (*alp.*)	..	..	..	1	S	..	1	1	1	1	1	1	..	..	H		
auricomus, *L.*	1	1	1	M	1	A	1	1	1	1	..	..	1	..	H		
affinis, *Br.*																	
sceleratus, *L.*	..	..	..	1	..	A	1	1	..	1	..	×	1	×	H	1	
Purshii, *Rich.*	..	..	1	1	..	N	1	1	1	1	..	..	..	..	1		
nivalis, *L.* (*alp.*)	1S	1	1	M	1	N	1	1	1	1	..	..	..	..	H		
frigidus, *DC.*																	
Eschscholtzii, *Schl.*																	
sulphureus, *Sol.*																	
repens, *L.*	1	..	..	..	..	A	1	1	1	1	..	..	A	..	1		
polyanthemos, *L.*	1	..	..	..	..	A	1	..	..	..	..	..	1	..	1		
nemorosus, *DC.*																	
acris, *L.*	1	1	..	..	S	A	1	1	1	1	..	..	1	..	1	..	×
glabriusculus, *Rupr.*																	
Lapponicus, *L.* (*alp.*)	1	1	1	1	1	N	1	1	1	C							
hyperboreus, *Rottb.* (*alp.*)	1	1	..	..	1	N	1	1	1	R	..	..	..	..	H		
pygmæus, *Wahl.*	1S	1	1	M	1	A	1	1	1	R	..	..	..	..	?		
Sabinii, *Br.*																	
hispidus, *Mich.*	..	..	..	1	..	..	..	..	1	C							
Pennsylvanicus, *L.*	..	..	1	1	..	..	..	..	1	1							
Ficaria, *L.*	1	..	..	..	..	A	..	..	1	..	..	..	A	..	1		
CALTHA palustris, *L.*	1	1	1	M	..	A	1	1	1	1	..	..	1	..	H		
natans, *Pall.*																	
radicans, *Forst.*																	
arctica, *Br.*																	

	I. Arctic.					II. N. Europ. and Asiatic.			III. American.				IV.		V.		
DICOTYLEDONES.	Europe.	Asia	W. America.	E. America.	Greenland.	Europe to Alps, &c.	Asia to Altai, &c.	N. E. Asia and Japan.	N. W. America.	N. E. America.	Tropical America.	Extra-tropical S. America.	S. Europ., N. Afric., Asia Minor.	S. Africa.	Persia, Tibet, Himalaya, &c.	Tropical Asia.	Australia and New Zealand
Ranunculaceæ (*continued*).																	
DELPHINIUM Menziesii, *DC.*	..	1	1	..	..	..	..	..	1								
Middendorffii, *Trautv.*																	
elatum, *L.* (*alp.*)	1	..	..	..	..	A	1	1	..	R	..	..	1	..	1		
intermedium, *Ait.*																	
ACONITUM Napellus, *L.*	..	..	1	..	..	A	1	1	1	..	..	..	1	..	H		
lycoctonum, *L.*	1	..	..	..	..	A	1	1	..	..	..	..	1	..	H		
COPTIS trifolia, *Sal.* (*alp.*)	..	1	..	..	S	N	1	1	1	1							
AQUILEGIA canadensis, *L.*	..	..	..	1	..	..	1	1	1	1							
formosa, *Fisch.*																	
brevistylis, *Hook.*	..	..	..	1	..	..	..	..	..	CR							
ACTÆA spicata, *L.*	1	..	..	..	..	A	1	1	1	1	..	..	1	..	H		
rubra, *Willd.*																	
arguta, *Nutt.*																	
alba, *Big.*																	
TROLLIUS Europæus, *L.*	1	..	..	..	..	A	..	..	..	..	..	..	1				
Asiaticus, *L.*	1	..	..	..	..	N	1	1									
II. **Papaveraceæ.**																	
PAPAVER alpinum, *L.*	1S	1	1	M	1	A	1	1	1	1	..	..	..	..	H		
nudicaule, *auct.*																	
CORYDALIS glauca, *Psh.*	..	..	..	1	..	..	..	..	..	1							
pauciflora. *Pers.*	..	..	1	1	..	..	1	1	1								
fabacea, *Ehr.*	1	..	..	..	..	A	..	1	..	..	..	..	1				
CHELIDONIUM majus, *L.*	1	..	..	..	..	A	1	1	..	..	..	..	A				
III. **Nymphæaceæ.**																	
NYMPHÆA alba, *L.*	1	..	..	..	..	A	1	..	..	..	..	..	A	..	H		
NUPHAR lutea, *Sm.*	1	..	..	..	..	A	1	1	1	1	..	..	1	..	1		
intermedia, *Led.*																	
pumila, *Sm.*																	
Kalmiana, *Mich.*																	
IV. **Saraceniaceæ.**																	
SARACENIA purpurea, *L.*	..	..	..	1	..	..	..	..	..	1							
V. **Cruciferæ.**																	
NASTURTIUM palustre, *DC.*	1	..	1	1	S	A	1	1	1	1	1	1	1	..	H	..	1
amphibium, *Br.*	1	..	..	..	..	A	1	1	..	1	..	..	1	..	1		
BARBAREA vulgaris, *Br.*	1	..	..	1	..	A	..	1	1	1	..	1	A	..	H	..	1
præcox, *Br.*																	
stricta, *Fr.*																	
TURRITIS glabra, *L.*	1	..	..	..	..	A	1	1	1	1	..	..	1	..	H	..	1
mollis, *Hook.*	..	..	1	1	1	..	1	..	1	C							
patula, *Gr.*																	
retrofracta, *Hk.*																	
Arabis Holböllii, *Horn.*																	
ARABIS hirsuta, *L.*	1	..	..	1	..	A	1	1	1	1	..	..	1				
alpina, *L.* (*alp.*).	1	1	..	..	1	A	..	1	..	L	..	..	1	..	H		
petræa, *Lamk.* (*alp.*)	..	1	1	1	1	A	1	1	1	1							
lyrata, *DC.*																	
Sisymbrium humifusum, *J. Vahl.*																	
thaliana, *L.*	1	..	..	..	..	A	1	..	..	×	..	..	A	..	H		
CARDAMINE bellidifolia, *L.* (*alp.*)	1S	1	1	M	1	N	1	1	1	W.L							
Lenensis, *Ad.*																	
microphylla, *Willd.*																	
hirsuta, *L.*	..	..	..	1	..	A	..	1	1	1	1	1	1	1	H	1	1
sylvatica, *Link.*																	
amara, *L.*	1	..	..	..	..	A	1	..	..	..	..	..	1	..	H		

DICOTYLEDONES.	I. Arctic.					II. N. Europ. and Asiatic.			III. American.				IV.		V.		
Cruciferæ *(continued).*	Europe.	Asia.	W. America.	E. America.	Greenland.	Europe to Alps, &c.	Asia to Altai, &c.	N. E. Asia and Japan.	N. W. America.	N. E. America.	Tropical America.	Extra-tropical S. America.	S. Europ., N. Afric., Asia Minor.	S. Africa.	Persia, Tibet, Himalaya, &c.	Tropical Asia.	Australia and New Zealand.
CARDAMINE pratensis, *L.*	1S	1	1	1	1	A	1	1	1	1	..	..	1	..	H	..	1
digitata, *Rich.*																	
purpurea, *C. & S.*	..	..	1	..	..	..	..	1	1								
macrophylla, *Willd.*	..	1	..	..	..	..	1	1	..	..	..	..	..	..	H		
PARRYA macrocarpa, *Br.* (*alp.*)	1	1	1	..	..	..	1	1	1	..	..	..	..	..	H		
arctica, *Br.* (*alp.*).	S	..	..	M	..	..	1	1									
arenicola	..	..	1	1													
Eutrema arenicola, *Hk.*																	
VESICARIA arctica, *Rich.*	..	..	..	1	1	..	..	..	R	C	..	1					
DRABA alpina, *L.* (*alp.*).	1S	1	1	1	1	N	1	1	1	R	..	..	..	..	H		
algida, *Ad.*																	
pilosa, *DC.*																	
aspera, *Ad.*																	
Adamsii, *Led.*																	
glacialis, *Ad.*																	
pauciflora, *Br.*																	
micropetala, *Hk.*																	
? trichella, *Fr.*																	
androsacea, *Wahl.* (*alp.*).	1S	1	1	M	1	A	1	1	1	R	..	..	1	..	H		
Lapponica, *DC.*, an *Willd.*?																	
Wahlenbergii, *Hartm.*																	
lactea, *Adams.*																	
nivalis, *DC.*, non *Lilj.*																	
crassifolia, *Grah.*																	
? Martinsiana, *J. Gay.*																	
oligosperma, *Hk.*																	
corymbosa, *Br.*																	
muricella, *Wahl.* (*alp.*)	1S	1	1	1	1	N	1	1	1	R L							
nivalis, *Lilj.*, non *DC.*																	
stellata, *Jacq.*, non *DC.*	..	..	1	1	..	A	1	..	1								
Johannis, *Host.*																	
hirta, *L.* (*alp.*).	1S	1	1	1	1	N	1	1	1	1							
oblongata, *Br.*																	
Dovrensis, *Fr.*																	
arctica, *Vahl.*																	
incana, *L.*	1S	1	1	1	1	A	1	1	1	1	..	1	..	..	H		
contôrta, *Ehr.*																	
confusa, *Ehr. & DC.*																	
Magellanica, *Lam.*																	
? borealis, *DC.*																	
rupestris, *Br.* (*alp.*).	1	1	1	1	1	N	1	..	..	R							
altaïca, *Bunge.*																	
aurea, *Vahl*	..	..	..	..	1	..	..	..	..	R L							
muralis, *L.*	1	..	..	..	..	A	1	..	..	C	..	..	A	..	1		
COCHLEARIA sisymbrioides, *DC.*	..	1	..	..	..	..	..	1	1								
Danica, *L.*	1	..	1	1	1	A											
Anglica, *L.*	1S	1	1	1	1	N	..	1	1	L							
oblongifolia, *DC.*																	
fenestrata, *Br.*																	
officinalis, *L.*	1S	1	1	M	1	A	..	1	1	L							
Pyrenaica, *DC.*																	
Grœnlandica, *L.*																	
arctica, *Schl.*																	
Wahlenbergii, *Rupr.*																	
Lenensis, *Adams.*																	
HESPERIS Pallasii, *T. & G.* (*alp.*).	..	1	1	1	1	..	..	1	1								
Hookeri, *Led.*; pygmæa, *Hook.*																	
minima, *Torr. & Gr.*																	

	I. Arctic.					II. N. Europ. and Asiatic.			III. American.				IV.		V.		
DICOTYLEDONES.	Europe.	Asia.	W. America.	E. America.	Greenland.	Europe to Alps, &c.	Asia to Altai, &c.	N. E. Asia and Japan.	N. W. America.	N. E. America.	Tropical America.	Extra-tropical S. America.	S. Europ., N. Afric., Asia Minor.	S. Africa.	Persia, Tibet, Himalaya, &c.	Tropical Asia.	Australia and New Zealand.
Cruciferæ (*continued*).																	
ODONTARRHENA Fischeriana, *C. A. M.*	..	1	..	..	..	..	1										
SISYMBRIUM Sophia, *L.*	1	1	1	1	..	A	1	1	1	1	..	1	A	..	1		
sophioides, *Fisch.*																	
canescens, *Nutt.*	..	..	1	1	..	..	..	..	1	1	1	1					
brachycarpum, *Rich.*																	
humile, *C. A. M.* (*alp.*).	..	..	1	1	..	..	1	..	..	R	..	..	..	..	H		
salsugineum, *Pall.*	..	..	1	1	..	..	1	1	..	..	..	..	..	..	H		
Turritis diffusa, *Hook.*																	
ERYSIMUM hieraciifolium, *L.*	1	..	1	1	..	A	..	1	1	1	..	..	1	..	H		
lanceolatum, *Br.*																	
alpinum, *Fr.*																	
cheiranthoides, *L.*	1	..	..	1	..	A	1	1	1	1	..	..	1	..	1		
BRAYA alpina, *Sternb.* (*alp.*)	1S	1	1	1	1	A	1	..	..	R	..	..	..	..	H		
glabella, *Rich.*																	
Platypetalum purpurascens, *Br.*																	
dubium, *Br.*																	
rosea, *Bunge*	1	..	1	..	..	..	..	1	..	..	..	..	..	..	H		
pilosa, *Hook.*	..	..	1														
EUTREMA Edwardsii, *Br.*	1S	1	..	M	1	..	1	1									
HUTCHINSIA calycina, *Desv.* (*alp.*).	..	..	1	..	..	..	1	1	1	R							
THLASPI montanum, *L.*	..	..	1	1	..	A	..	..	..	C							
arvense, *L.*	1	..	..	..	..	A	..	1	..	×	..	..	1	..	H	1	
CAPSELLA bursa-pastoris, *L.*	1	..	..	..	S	A	..	1	..	×	..	×	A	..	H	1	×
LEPIDIUM ruderale, *L.*	..	..	..	1	..	A	..	1	1	×	..	1	A	1	H	1	1
CAKILE maritima, *L.*	1	..	..	..	..	A	..	..	..	1	..	..	A				
SINAPIS arvensis, *L.*	1	..	..	..	..	A	..	..	..	×	..	..	A	..	1	×	×
RAPHANUS Raphanistrum	1	..	..	..	..	A	..	1	..	×	..	..	A	..	1	×	×
BRASSICA Rapa, *L.*	1	..	..	..	..	A	..	1	..	×	..	..	A	..	H	×	×
campestris, *L.*																	
SUBULARIA aquatica, *L.*	1	..	..	..	..	A	..	..	..	1							
VI. **Droseraceæ.**																	
DROSERA rotundifolia, *L.*	1	..	1	1	..	A	1	1	1	1	..	..	1				
longifolia, *L.*	1	..	..	..	..	A	..	.	..	1	..	..	1				
intermedia, *Hayn.*	1	..	..	..	..	A	..	..	..	1	1	..	1				
VII. **Violarieæ.**																	
VIOLA palustris, *L.*	1	1	1	1	1	A	1	1	1	1	..	..	1				
epipsila, *Led.*																	
blanda, *Willd.*																	
microceras, *Rupr.*																	
canina, *L.*	1	..	..	..	S	A	1	1	1	1	..	..	A	..	1		
sylvatica, *Fr.*																	
montana, *L.* (*Fr.*)																	
flavicornis, *Sm.*																	
lactea, *Sm.*																	
Muehlenbergii, *Torr.*																	
sylvestris, *Lam.*																	
arenaria, *DC.*																	
tricolor, *L.*	1	..	..	..	..	A	1	..	..	1	..	..	A	..	1		
arvensis, *DC.*																	
bicolor, *Pursh.*																	
biflora, *L.* (*alp.*).	1	1	..	..	..	A	1	1	1	..	..	..	1	..	H		
cucullata, *Ait.*	..	..	..	1	..	..	..	..	..	1							
elatior, *Fr.*	1	..	..	..	..	A	1	..	..	..	..	..	1				

DICOTYLEDONES.	I. Arctic.					II. N. Europ. and Asiatic.			III. American.				IV.		V.		
VIII. Caryophylleæ.	Europe.	Asia.	W. America.	E. America.	Greenland.	Europe to Alps, &c.	Asia to Altai, &c.	N. E. Asia and Japan.	N. W. America.	N. E. America.	Tropical America.	Extra-tropical S. America.	S. Europ., N. Afric., Asia Minor.	S. Africa.	Persia, Tibet, Himalaya, &c.	Tropical Asia.	Australia and New Zealand.
DIANTHUS alpinus, *L.* (*alp.*)	1	..	1	..	..	A	1	1	1	..	..	..	1				
repens, *Willd.*																	
Seguieri, *Vill.*	1	1	..	..	..	A	1	1	..	..	..	..	1	..	H		
dentosus, *Fisch.*																	
superbus, *L.*	1	1	..	..	..	A	1	1	..	..	..	..	1	..	1		
SILENE acaulis, *L.* (*alp.*)	1S	1	1	1	1	A	..	..	1	W	..	..	1				
inflata, *L.*	1	1	..	..	..	A	..	1	..	×	..	..	A	..	H		
paucifolia, *Led.*																	
maritima, *L.*	1	..	..	..	..	A	..	..	..	..	..	..	1				
turgida, *MB.*	1	..	..	..	..	..	1										
Tatarica, *Pers.*	1	..	..	..	..	N	1	..	..	..	..	1	1	..	1		
rupestris, *DC.*	1	..	..	..	..	A	1	..	..	..	..	..	1				
Pennsylvanica, *Mich.*	..	..	..	1	..	..	..	..	..	1							
nutans, *DC.*	1	..	..	..	..	A	1	..	..	..	..	..	1	..	1		
LYCHNIS apetala, *L.* (*alp.*)	1S	1	1	M	1	N	1	1	1	L	..	1	..	..	H		
affinis, *Vahl.*																	
triflora, *Br.*																	
Vahlii, *Rupr.*																	
angustiflora, *Rupr.*																	
Magellanica, *Lam.*																	
pauciflora, *Fisch.*																	
dioica, *L.*	1	..	..	..	E	A	1	..	..	..	..	..	1	..	1		
sylvestris, *Schk.*																	
pratensis, *Rohl.*																	
alpina, *L.* (*alp.*)	1	1	..	..	1	A	1	..	1	L	..	..	1				
Flos-Cuculi, *L.*	1	..	..	..	..	A	1	..	..	..	..	..	1				
SPERGULA arvensis, *L.*	1	..	..	..	..	A	1	..	1	×	..	..	A	..	..	..	×
SAGINA procumbens, *L.*	1	..	..	..	S	A	1	..	1	1	..	1	A	..	H	..	1
nodosa, *E. M.*	..	..	1	1	S	A	1	..	1	1							
nivalis, *Fr.*	1	..	..	..	1	N	1										
cæspitosa, *Vahl.*																	
intermedia, *Fenzl.*																	
Linnæi, *Presl*	1S	..	1	1	1	A	1	..	1	..	1	1	1				
saxatilis, *Wimm.*																	
ARENARIA lateriflora, *DC.*	1	..	1	1	..	N	1	1	1	1							
formosa, *Fisch.* (*alp.*)	..	..	1	1	..	..	1										
nardifolia, *Led.*																	
uliginosa, *Schl.*	1	1	..	..	1	A											
Lapponica, *Spr.*																	
Alsine stricta, *Wahl.*																	
Rossii, *Br.*	..	1	1	1	..	..	..	..	..	R							
Michauxii, *Fenzl*	..	..	..	1	..	..	..	..	..	1							
stricta, *Mich.*																	
verna, *L.*	1S	1	1	M	1	A	1	1	1	R	..	..	1	..	1		
propinqua, *Rich.*																	
hirta, *Wormsk.*																	
rubella, *Br.*																	
quadrivalvis, *Br.*																	
Giesekii, *Horn.*																	
arctica, *Stev.* (*alp.*)	1S	1	1	1	1	N	1	1	1	R							
Pumilio, *Br.*																	
biflora, *Wahl.*																	
serpyllifolia, *L.*	1	..	..	..	..	A	1	1	..	×	..	..	A	..	H	1	
macrocarpa, *Psh.* (*alp.*)	..	1	1	..	..	..	..	1	1								
ciliata, *L.* (*alp.*)	1S	..	..	..	1	N	..	..	1	..	..	..	1				
Norvegica, *Gunn.*																	
laricina, *Crantz* (*alp.*)	..	1	..	..	..	..	1	1									
ARENARIA Grœnlandica, *Spr.*	..	..	..	..	1	..	..	..	..	L W							

	I. Arctic.					II. N. Europ. and Asiatic.			III. American.				IV.		V.		
DICOTYLEDONES. **Caryophylleæ** (*continued*).	Europe.	Asia.	W. America.	E. America.	Greenland.	Europe to Alps, &c.	Asia to Altai, &c.	N. E. Asia and Japan.	N. W. America.	N. E. America.	Tropical America.	Extra-tropical S. America.	S. Europ., N. Afric., Asia Minor.	S. Africa.	Persia, Tibet, Himalaya, &c.	Tropical Asia.	Australia and New Zealand.
Honkeneja peploides, *Ehr.*	1	1	1	1	1	A	1	1	1	1	..	..	1				
Merkia physodes, *Fisch.*	..	..	1	1	..	..	..	1	1								
Lepigonium salinum, *Fr.*	1	..	1	1	1	A	1	1	1	1	..	1	A	1	H	1	1
Stellaria borealis, *Big.* (*alp.*)	1	..	1	1	1	N	1	1	1	1	..	..	..	..	H		
crispa, *Cham.*																	
humifusa, *Rottb.* (*alp.*)	1S	..	1	1	1	N	1	1	1	1							
longipes, *Goldie* (*alp.*)	1S	1	1	M	1	..	1	1	1	1							
peduncularis, *Bge.*																	
læta, *Rich.*																	
Edwardsii, *Br.*																	
hebecalyx, *Fenzl.*																	
ciliatosepala, *Trautv.*																	
uliginosa, *Murr.*	1	..	..	1	1	A	1	1	1	1	..	..	1	..	H	1	1
nemorum, *L.*	1	..	..	..	..	A	1	..	..	..	1	1	1				
media, *L.*	1	..	1	1	1	A	1	1	1	×	1	1	A	1	H	1	1
graminea, *L.*	1	..	..	..	..	A	1	..	..	..	..	..	1	..	H		
dicranoides, *Fenzl*	..	..	1	..	..	..	..	1	1								
longifolia, *Fries* (*alp.*)	1	..	1	1	..	A	1	1	1	1	1						
alpestris, *Fr.*																	
longifolia, *Mühl.*																	
cerastioides, *L.* (*alp.*)	1	..	..	..	1	A	1	..	..	..	..	..	1	..	1		
crassifolia, *Ehr.*	1	..	..	1	..	N	1	1	1								
Cerastium alpinum, *L.* (*alp.*)	1S	1	1	M	1	A	1	1	1	..	..	..	1				
viscosum, *L.*	1	..	..	..	S	A	1	1	×	×	..	×	A	1	H	×	×
semidecandrum, *L.*																	
vulgatum, *L.*	1S	..	1	..	S	A	1	1	1	×	..	×	A	..	H	×	×
Fischerianum, *Ser.*																	
Behringianum, *C. & S.*																	
maximum, *L.* (*alp.*)	..	1	1	..	..	..	1	1	1								
arvense, *L.*	1	..	..	..	..	A	1	1	1	1	..	1	1	..	H		
IX. **Balsamineæ.**																	
Impatiens fulva, *DC.*	..	..	..	1	..	..	..	..	1	1							
X. **Lineæ.**																	
Linum perenne, *L.*	..	..	1	1	..	A	..	1	1	C	..	..	1	..	1		
catharticum, *L.*	1	..	..	..	..	A	..	..	..	..	..	..	1	..	1		
XI. **Geraniaceæ.**																	
Geranium sylvaticum, *L.*	1	..	..	..	..	A	1	1	..	..	..	..	1				
Robertianum, *L.*	1	..	..	..	..	A	1	..	..	1	..	1	A	..	1		
XII. **Hypericineæ.**																	
Hypericum perforatum, *L.*	1	..	..	..	..	A	1	1	..	1	..	..	A	..	H		
quadrangulum, *L.*	1	..	..	..	..	A	1	..	..	..	..	..	1				
XIII. **Elatineæ.**																	
Elatine Hydropiper, *L.*	1	..	..	..	..	A	..	..	..	..	..	..	1				
XIV. **Tamariscineæ.**																	
Myricaria Germanica, *L.* (*alp.*)	1	..	..	..	..	A	..	..	..	..	..	..	1	..	H		
XV. **Oxalidæ.**																	
Oxalis Acetosella, *L.*	1	..	..	..	..	A	1	1	1	1	..	..	A	..	H		
XVI. **Polygaleæ.**																	
Polygala Senega, *Willd.*	..	..	..	1	..	..	..	..	..	1							
vulgaris, *L.*	1	..	..	..	..	A	..	..	..	..	..	..	1				

	I. Arctic.					II. N. Europ. and Asiatic.			III. American.				IV.		V.		
DICOTYLEDONES. XVII. **Leguminosæ.**	Europe.	Asia.	W. America.	E. America.	Greenland.	Europe to Alps, &c.	Asia to Altai, &c.	N. E. Asia and Japan.	N. W. America.	N. E. America.	Tropical America.	Extra-tropical S. America.	S. Europ., N. Afric., Asia Minor.	S. Africa.	Persia, Tibet, Himalaya, &c.	Tropical Asia.	Australia and New Zealand.
Phaca frigida, *L.* (*alp.*)	1	1	1	1	..	A	1	1	1	C							
alpina, *Wulf* (*alp.*)	..	1	..	..	..	A	1	1	..	..	..	..	1				
aboriginorum, *Hk.*	..	..	..	1	..	..	..	..	1	C							
Astragalus alpinus, *L.* (*alp.*)	1	1	1	M	..	A	1	1	1	C	..	..	1				
hypoglottis, *L.*	..	..	1	1	..	A	1	1	1	C	..	..	1	..	1		
oroboides, *Horn.* (*alp.*)	1	..	..	..	..	A	1										
Oxytropis campestris, *DC.* (*alp.*)	1	1	1	1	..	A	1	1	1	C	..	..	1	..	1		
borealis, *DC.*																	
Middendorfii, *Trautv.*																	
sordida, *Pers.*; polaris, *Seem.*																	
Uralensis, *DC.* (*alp.*)	1	1	1	M	..	A	1	1	1	C	..	..	1				
arctica, *Br.*																	
nigresceus, *Fisch.* (*alp.*)	..	1	1	1	..	..	1	1	1								
deflexa, *DC.* (*alp.*)	..	..	1	1	..	..	1	1	1	C							
Lapponica, *Gaud.* (*alp.*)	1	..	..	..	..	A	..	..	..	..	..	..	1	.	H		
Hedysarum obscurum, *L.* (*alp.*)	1	1	..	..	..	A	1	1	..	..	..	..	1				
Sibiricum, *Poir.*	..	1	..	..	..	..	1	1	..	..	..	..	..	..	1		
boreale, *Nutt.*	..	..	1	1	..	..	..	..	1	1							
M'Kenziei, *Rich.*	..	..	1	1	..	..	..	1	1	C							
Trifolium medium, *L.*	1	..	..	..	..	A	..	..	..	×	..	..	1	..	1		
pratense, *L.*	1	..	..	..	..	A	1	×	×	..	..	..	A	..	H	..	×
repens, *L.*	1	..	..	..	..	A	1	×	×	×	..	..	A	..	1	..	×
Lotus corniculatus, *L.*	1	..	..	..	..	A	1	1	..	..	..	×	A	..	H	..	1
Ervum hirsutum, *L.*	1	..	..	..	..	A	1	..	×	..	..	..	1	..	H	1	×
Orobus vernus, *L.*	1	..	..	..	..	A	1	1	..	..	..	..	1	..	1		
Lathyrus palustris, *L.*	1	..	1	..	..	A	1	1	1	1	..	..	1	..	1		
maritimus, *L.*	1	..	1	1	S	A	1	1	1	1	..	1	1				
pratensis, *L.*	1	..	..	..	..	A	1	..	..	..	..	..	1	..	H		
ochroleucus, *Hook.*	..	..	..	1	..	..	..	..	..	1							
Vicia sylvatica, *L.*	1	..	..	..	..	A	1	..	..	..	..	..	1	..	1		
Americana, *Mühl.*	..	..	1	1	..	..	..	..	1	1							
Sepium, *L.*	1	..	..	..	..	A	1	..	..	..	..	..	1				
Cracca, *L.*	1	..	..	..	S	A	1	1	..	..	..	..	1	..	H		
Anthyllis vulneraria, *L.*	1	..	..	..	..	A	..	..	..	...	..	..	A				
Lupinus perennis, *L.*	..	..	1	1	..	..	..	..	1	1							
XVIII. **Rosaceæ.**																	
Spiræa chamædrifolia, *L.*	1	..	1	..	..	A	1	1	1	..	..	..	1	..	H		
betulæfolia, *Pall.*	..	..	1	..	..	..	1	1	1	..	..	..	..	..	H		
salicifolia, *L.*	..	..	1	..	..	A	1	1	..	1							
Ulmaria, *L.*	1	..	..	..	..	A	1	..	..	..	..	..	×	..	1		
pectinata, *T. & G.*	..	..	1	..	..	..	..	..	1								
Alchemilla alpina, *L.* (*alp.*)	1	..	..	..	1	A	..	..	..	..	..	..	1				
vulgaris, *L.*	1	..	..	..	1	A	1	..	..	L	..	..	1	..	1	1	1
Dryas octopetala, *L.* (*alp.*)	1S	1	1	M	1	A	1	1	1	C	..	..	1				
integrifolia, *Vahl.*																	
Drummondii, *Rich.* (*alp.*)	..	..	..	1	..	..	1	..	..	C							
Geum urbanum, *L.*	1	..	..	1	..	A	1	1	1	1	..	1	1	..	H	..	1
strictum, *Ait.*																	
rivale, *L.*	1	..	..	..	..	A	1	..	..	1	..	..	1				
Sieversia Rossii, *Br.*	..	..	1	M	..	..	..	1	1								
humilis, *Br.*																	
glacialis, *Br.* (*alp.*)	..	1	1	..	..	..	1	1									
Sibbaldia procumbens, *L.* (*alp.*)	1	..	..	..	1	A	1	1	1	WL	..	..	1	..	H		
Rubus arcticus, *L.* (*alp.*)	1	1	1	1	..	N	1	1	1	C							
propinquus, *Rich.*; acaulis, *Mich.*																	
castoreus, *Læstd.*																	

DICOTYLEDONES.

Rosaceæ (*continued*).

	I. Arctic.					II. N. Europ. and Asiatic.			III. American.				IV.		V.		
	Europe.	Asia.	W. America.	E. America.	Greenland.	Europe to Alps, &c.	Asia to Altai, &c.	N. E. Asia and Japan.	N. W. America.	N. E. America.	Tropical America.	Extra-tropical S. America.	S. Europ., N. Afric., Asia Minor.	S. Africa.	Persia, Tibet, Himalaya, &c.	Tropical Asia.	Australia and New Zealand.
Rubus Chamæmorus, *L.* (*alp.*)	1	1	1	1	S	N	1	1	..	1							
Idæus, *L.*	1	1	..	..	..	A	1	1	1	..	..	..	1				
saxatilis, *L.* (*alp.*)	1	..	1	..	S	A	1	1	..	1	..	..	1	..	H		
triflorus, *Hook.*																	
saxatili-castoreus, *Fr.*																	
Potentilla fruticosa, *L.* (*alp.*)	..	..	1	..	1	A	1	1	1	1	..	..	..	..	1		
stipularis, *L.*	..	1	..	..	..	..	1	1									
Tormentilla, *Sibth.*	1	..	..	..	..	A	1	..	..	..	..	..	1	..	1		
sericea, *L.*	..	..	1	..	..	A	1	1	1	1	..	..	A	..	H		
Pennsylvanica, *L.*																	
rubricaulis, *Lehm.*																	
anserina, *L.*	1	..	1	1	1	A	1	1	1	1	1	1	1	..	H	..	1
nivea, *L.* (*alp.*)	1S	1	1	M	1	A	1	1	1	C	..	..	..	..	H		
Vahliana, *L.*																	
pulchella, *Br.*																	
Jamesoniana, *Grev.*																	
Keilhaui, *Som.*																	
frigida, *Grev.*																	
Grœnlandica, *Br.*																	
villosa, *Pall.*	..	..	1	..	..	..	..	1	1								
biflora, *Lehm.*	..	..	1	1	..	..	1	1	1								
frigida, *Vill.* (*alp.*)	1S	1	1	M	1	A	1	1	R	WL							
Robbinsiana, *Oakes.*																	
emarginata, *Psh.*																	
nana, *Lehm.*																	
fragiformis, *Willd.*	..	1	..	..	..	..	1	1									
verna, *L.* (*alp.*)	1	1	..	..	1	A	1	1	1	L	.	..	1	..	H		
aurea, *L.*																	
crocea, *Schl.*																	
maculata, *Lehm.*																	
Salisburgensis, *Hœnke.*																	
alpestris, *Hall.*																	
multifida, *L.* (*alp.*)	1	..	..	..	..	A	1	1	..	..	..	..	1				
argentea, *L.*	1	.	..	..	..	A	..	..	..	1	..	..	1				
tridentata, *L.*	..	..	..	..	1	..	..	..	..	L							
Comarum palustre, *L.*	1	1	1	..	S	A	1	1	1	1	..	..	1	..	1		
Fragaria vesca, *L.*	1	..	..	1	..	A	1	1	1	1	1	..	A	..	H		
Sanguisorba officinalis, *L.*	1	..	1	1	..	A	1	1	1	1	..	..	1	..	1		
media, *L.*																	
polygama, *Nyl.*																	
Canadensis, *L.*																	
tenuifolia, *Fisch.*																	
Rosa cinnamomea, *L.*	1	..	1	1	..	A	1	1	1	C	..	..	A	..	1		
majalis, *Hermm.*																	
blanda, *Ait.*	1	1	1	1	..	N	1	1	1	1							
acicularis, *Lindl.*																	
Carelica, *Fr.*																	
fraxinifolia, *Lindl.*																	
villosa, *L.*	1	..	..	..	..	A	1	..	..	..	..	..	1				
tomentosa, *Sm.*																	
Cotoneaster vulgaris, *L.*	1	..	..	..	..	A	1	..	..	..	..	..	1	..	H		
Pyrus Aucuparia, *L.*	1	..	..	..	S	A	1	1	1	1	..	..	1	..	1		
Americana.																	
sambucifolia, *Ch. & Sch.*																	
Prunus Padus, *L.*	1	..	..	..	..	A	1	1	..	..	..	..	1	..	H		
Virginiana, *DC.*	..	..	..	1	..	..	..	..	..	1							
spinosa, *L.*	1	..	..	..	..	A	..	..	..	..	..	..	1				
Amelancheir Canadensis, *Torr. & Gray*	..	..	1	1	..	..	..	..	1	1							
alnifolia, *Nutt.*																	

	I. Arctic.					II. N. Europ. and Asiatic.			III. American.				IV.		V.		
DICOTYLEDONES.	Europe.	Asia.	W. America.	E. America.	Greenland.	Europe to Alps, &c.	Asia to Altai, &c.	N. E. Asia and Japan.	N. W. America.	N. E. America.	Tropical America.	Extra-tropical S. America.	S. Europ., N. Afric., Asia Minor.	S. Africa.	Persia, Tibet, Himalaya, &c.	Tropical Asia.	Australia and New Zealand.
XIX. Onagrarieæ.																	
CIRCÆA alpina, *L.*	1	..	..	..	..	A	1	1	1	1	..	..	1	..	H		
EPILOBIUM angustifolium, *L.*	1	1	1	1	1	A	1	1	1	1	..	..	1	..	H		
latifolium, *L.* (*alp.*)	1	1	1	M	1	..	1	1	1	L	..	..	..	..	H		
montanum, *L.*	1	..	..	..	..	A	1	1	..	..	..	..	1	..	H		
tetragonum, *L.*	1	..	..	..	..	A	1	1	1	1	?	1	A	?	H	..	1
alpinum, *L.*	1	1	1	1	1	A	1	1	1	W	..	1	1	..	H	..	
alsinifolium, *Vill.*																	
Hornemanni, *Reich.*																	
origanifolium, *Lam.*																	
palustre, *L.*	1	1	1	1	S	A	1	1	1	1	..	..	A	..	H		
lineare, *Mühl.*																	
XX. Halorageæ.																	
CALLITRICHE verna, *L.*	1	..	1	1	S	A	1	1	1	1	..	1	A	..	H	..	1
autumnalis, *L.*																	
MYRIOPHYLLUM spicatum, *L.*	1	..	..	1	..	A	1	1	..	1	..	1	A	..	1		
alterniflorum, *DC.*	1	..	..	1	S	A	..	1	..	..	..	..	A				
HIPPURIS vulgaris, *L.*	1	1	1	1	1	A	1	1	1	1	..	1	1	..	H		
montana, *Led.*																	
maritima, *Hellen.*																	
CERATOPHYLLUM demersum, *L.*	..	..	1	1	..	A	1	1	1	1	1	1	A	1	H	1	1
submersum, *L.*																	
XXI. Lythrarieæ.																	
LYTHRUM Salicaria, *L.*	1	..	..	..	..	A	1	1	..	1	..	1	A	1	1	..	1
XXII. Portulaceæ.																	
CLAYTONIA lanceolata, *Psh.* (*alp.*)	..	1	1	..	..	..	1	1	1								
arctica, *Ad.*																	
sarmentosa, *C. A. M.*																	
MONTIA fontana, *L.*	1	..	1	..	1	A	1	1	1	L	1	1	A	..	..	..	1
rivularis, *Gmel.*																	
XXIII. Crassulaceæ.																	
SEDUM Rhodiola, *DC.* (*alp.*)	1S	1	1	1	1	A	1	1	1	C	..	..	1	..	H		
elongatum, *Led.*																	
villosum, *L.* (*alp.*)	1	..	..	..	1	A	..	..	..	..	..	..	1				
quadrifidum, *Pall.* (*alp.*)	1	1	..	..	..	..	1	..	..	..	..	..	..	..	H		
annuum, *L.*	1	..	..	..	S	A	1	..	..	..	..	..	1	..	1		
acre, *L.*	1	..	..	..	..	A	1	..	..	..	..	..	A				
euphorbioides, *Schl.*	..	1	..	..	..	..	1										
XXIV. Grossularieæ.																	
RIBES lacustre, *Pursh.*	..	..	1	1	..	..	..	..	1	1							
rubrum, *L.*	1	1	1	1	..	A	1	1	1	1	..	..	1	..	H		
propinquum, *Turc.*																	
alpinum, *L.*	1	..	..	..	..	A	1	1	..	L	..	..	1				
nigrum, *L.*	1	..	..	..	..	A	1	1	..	..	..	..	1	..	H		
Hudsonianum, *Rich.*	..	..	1	1	..	..	..	..	1	C							
XXV. Saxifrageæ.																	
MITELLA nuda, *L.*	..	..	..	1	..	..	1	1	1	1							
CHRYSOSPLENIUM alternifolium, *L.*	1S	1	1	M	1	A	1	1	1	C	..	..	1	..	H		
tetrandrum, *Lund.*																	
PARNASSIA palustris, *L.*	1	1	1	1	..	A	1	1	1	1	..	..	1	..	H		
obtusiflora, *Rupr.*																	
Kotzebuei, *C. & S.*	..	..	1	1	S	..	..	1	1	L							

	I. Arctic.					II. N. Europ. and Asiatic.			III. American.				IV.		V.		
DICOTYLEDONES. **Saxifrageæ** (*continued*).	Europe.	Asia.	W. America.	E. America.	Greenland.	Europe to Alps, &c.	Asia to Altai, &c.	N. E. Asia and Japan.	N. W. America.	N. E. America.	Tropical America.	Extra-tropical S. America.	S. Europ., N. Afric., Asia Minor.	S. Africa.	Persia, Tibet, Himalaya, &c.	Tropical Asia.	Australia and New Zealand.
SAXIFRAGA Cotyledon, *L.* (*alp.*)	1	..	..	..	1	A	..	..	..	R C	..	..	1	..	1		
Aizoon, *Jacq.*																	
oppositifolia, *L.* (*alp.*)	1S	1	1	M	1	A	1	1	1	C	..	..	1	..	H		
Eschscholtzii, *Sternb.*	..	1	..	..	..	..	..	1	1								
biflora, *L.* (*alp.*)	1	..	..	..	..	A	..	..	..	..	..	..	1				
cæspitosa, *L.* (*alp.*)	1S	1	1	M	1	A	1	1	1	C	1	1	1	..	1		
venosa, *Haw.*																	
Grœnlandica, *L.*																	
exarata, *Vill.*																	
uniflora, *Br.*																	
muscoides, *Wulf.*																	
sileniflora, *Sternb.*																	
Magellanica, *Poir.*																	
tridactylites, *L.*	1	..	..	..	..	A	1	..	..	..	..	..	A	..	1		
adscendens, *L.* (*alp.*)	1	..	..	..	..	A	..	..	..	R	..	..	1				
controversa, *Sternb.*																	
cernua, *L.* (*alp.*)	1S	1	1	M	1	A	1	1	1	R	..	..	..	..	H		
exilis, *DC.*																	
Sibirica, *L.*	..	..	1	..	..	..	1	1	..	L	..	..	..	..	H		
granulata, *L.*	1	..	..	..	..	A	1	..	..	..	..	..	A	..	H		
bulbifera, *L.*																	
rivularis, *L.*	1S	1	1	M	1	N	1	1	..	W L							
hyperborea, *Br.*																	
Richardsoni, *Hk.*	..	..	1														
nivalis, *L.* (*alp.*)	1S	1	1	M	1	N	1	1	1	R L							
coriacea, *Ad.*																	
Virginiensis, *Mich.*	..	..	..	1	..	..	..	..	1	1							
reflexa, *Hk.*																	
hieraciifolia, *W. & K.* (*alp.*)	1S	1	1	1	..	A	1	1	1								
Dahurica, *Pall.* (*alp.*)	..	..	1	..	..	..	1	1	1	R							
stellaris, *L.* (*alp.*)	1S	1	1	M	1	A	1	1	1	W L	..	..	1				
comosa, *Poir.*																	
foliolosa, *Br.*																	
Hirculus, *L.*	1S	1	1	M	E	A	1	1	1	C	..	..	..	..	H		
propinqua, *Br.*																	
flagellaris, *Willd.* (*alp.*)	1S	1	1	M	1	..	1	1	1	R	..	..	..	..	H		
bronchialis, *L.* (*alp.*)	1	1	1	..	..	..	1	1	1	R	..	..	..	..	1		
serpyllifolia, *Psh.*	..	1	1	..	..	..	..	1	1								
tricuspidata, *Retz.*	..	..	1	M	1	..	..	1	1	C							
aizoides, *L.* (*alp.*)	1S	..	..	1	1	A	..	..	R	C	..	..	1				
punctata, *L.* (*alp.*)	..	1	1	1	..	..	1	1	1	R							
æstivalis, *Fisch.*																	
HEUCHERA Richardsonii, *Br.* (*alp.*)	..	..	..	1	..	..	..	..	..	R							
XXVI. **Umbelliferæ.**																	
CENOLOPHIUM Fischeri, *Koch*	1	..	..	..	..	N	1										
BUPLEURUM ranunculoides, *L.* (*alp.*)	..	..	1	1	..	A	1	1	1	..	..	..	1				
CONIOSELINUM Fischeri, *Wimm.* (*alp.*)	1	..	1	1	..	N	1	1	1	L	..	..	..	..	1		
Tartaricum, *Fisch.*																	
Selinum Gmelini, *De Bray.*																	
ARCHANGELICA officinalis, *DC.*	1	1	1	..	1	A	1	1	1	1	..	..	1	..	1		
littoralis, *Fr.*																	
Norvegica, *Tab.*																	
atropurpurea, *Hoffm.*																	
Physolophium saxatile, *Turc.*																	
Cœlopleurum Gmelini, *Led.*																	
Pleurospermum Gmelini, *Bong.*																	
ANGELICA sylvestris, *L.*	1	..	..	..	..	A	1	1	..	..	..	..	1	..	1		

	I. Arctic.					II. N. Europ. and Asiatic.			III. American.				IV.		V.		
DICOTYLEDONES.	Europe.	Asia.	W. America.	E. America.	Greenland.	Europe to Alps, &c.	Asia to Altai, &c.	N. E. Asia and Japan.	N. W. America.	N. E. America.	Tropical America.	Extra-tropical S. America.	S. Europ., N. Afric., Asia Minor.	S. Africa.	Persia, Tibet, Himalaya, &c.	Tropical Asia.	Australia and New Zealand.
Umbelliferæ (*continued*).																	
LIGUSTICUM Scoticum, *L.*	1	..	1	..	S	N	1	1	1	1							
ATHAMANTA Libanotis, *L.*	1	..	..	..	..	A	1	..	..	..	..	..	1	..	H		
arctica, *Nym.*																	
sibirica, *L.*																	
CICUTA virosa, *L.*	1	..	..	1	..	A	1	1	1	C	..	..	1				
maculata, *DC.*	..	..	..	1	..	..	..	..	1	1							
CARUM Carui, *L.*	1	..	..	..	..	A	1	1	1	1	..	..	1	..	H		
PEUCEDANUM palustre, *Mœnch.*	1	..	..	..	..	A	1	..	..	..	..	..	1				
HERACLEUM Sibiricum, *L.*	1	..	..	..	..	A	1	1	..	..	..	..	1				
arcticum, *Rupr.*																	
GAYA simplex, *Gaud.* (*alp.*)	1	1	..	..	..	A	1	1	..	..	..	..	1	..	1		
Pachypleurum alpinum, *Led.*																	
SESELI divaricatum, *Pursh*	..	..	1	1	..	..	..	..	..	1							
ANTHRISCUS sylvestris, *L.*	1	..	..	..	..	A	1	1	..	..	..	..	1	..	1		
CHÆROPHYLLUM bulbosum, *L.*	1	..	..	..	..	N	1	..	..	..	..	..	..	..	1		
XXVII. Corneæ.																	
ADOXA moschatellina, *L.*	1	..	..	1	..	A	1	1	R	C	..	..	1	..	H		
CORNUS stolonifera, *Mich.*	..	..	..	1	..	..	..	..	..	1	M						
Canadensis, *L.*	..	..	1	1	..	..	..	1	1	1							
Suecica, *L.* (*alp.*)	1	..	1	..	1	N	1	1	1	C							
XXVIII. Caprifoliaceæ.																	
VIBURNUM Opulus, *L.*	..	..	1	1	..	A	1	1	1	1	..	..	1	..	1		
Oxycoccos, *Psh.*																	
LONICERA cærulea, *L.*	1	..	1	1	..	A	1	1	1	1	..	..	1				
Xylosteum, *L.*	1	..	..	..	..	A	1	..	..	..	..	..	1	..	1		
LINNÆA borealis, *L.*	1	..	1	1	..	A	1	1	1	1	..	..	1				
XXIX. Rubiaceæ.																	
GALIUM boreale, *L.*	1	..	1	1	..	A	1	1	1	1	..	..	1	..	H		
rubioides, *L.*	..	..	1	..	..	A	1	1	1	C	..	..	1				
uliginosum, *L.*	1	..	..	..	S	A	1	..	..	..	..	..	1				
triflorum, *Muhl.*	1	..	..	..	S	N	..	1	1	1							
trifidum, *L.*	1	..	..	1	..	A	1	1	1	1							
Claytoni, *Mich.*																	
palustre, *L.*	1	..	..	..	S	A	1	..	..	..	..	..	A	..	1		
Aparine, *L.*	1	..	..	..	..	A	1	1	1	1	M	1	A	..	H		
infestum, *W. & K.*																	
saxatile, *L.*	..	..	..	..	1	A	1	..	..	..	..	..	1				
XXX. Valerianeæ.																	
VALERIANA capitata, *Willd.*	1	1	1	1	..	N	1	1	1	R							
officinalis, *L.*	1	..	..	..	..	A	1	1	..	..	..	..	1	..	H		
XXXI. Dipsaceæ.																	
KNAUTIA arvensis, *Coult.*	1	..	..	..	..	A	1	..	..	..	..	..	A				
SCABIOSA succisa, *L.*	1	..	..	..	..	A	1	..	..	..	..	..	1				
XXXII. Compositæ.																	
TUSSILAGO Farfara, *L.*	1	..	..	..	..	A	1	..	..	×	..	..	1	..	H		
NARDOSMIA frigida, *Hk.* (*alp.*)	1	1	1	M	..	N	1	1	..	C							
corymbosa, *Hk.*																	
sagittata, *Hk.*																	
glacialis, *Led.*	..	1															
Gmelini, *DC.*	..	1	..	..	..	..	1	1									

2 R 2

	I. Arctic.					II. N. Europ. and Asiatic.			III. American.				IV.		V.		
DICOTYLEDONES. **Compositæ** (*continued*).	Europe.	Asia.	W. America.	E. America.	Greenland.	Europe to Alps, &c.	Asia to Altai, &c.	N. E. Asia and Japan.	N. W. America.	N. E. America.	Tropical America.	Extra-tropical S. America.	S. Europ., N. Afric., Asia Minor.	S. Africa.	Persia, Tibet, Himalaya, &c.	Tropical Asia.	Australia and New Zealand.
NARDOSMIA lævigata, *DC.*	1	..	..	..	..	N	1										
straminea, *Cass.*																	
palmata, *Hk.* (*alp.*)	..	..	1	1	..	..	..	1	1	1							
ACHILLEA Millefolium, *L.*	1	..	1	1	S	A	1	1	1	1	1	..	1	..	H		
PTARMICA alpina, *DC.*	..	1	1	1	..	A	1	1	1	C	..	..	1				
Sibirica, *Led.*																	
borealis, *Bong.*																	
speciosa, *DC.*																	
multiflora, *Hk.*																	
oxyloba, *DC.*																	
CHRYSANTHEMUM arcticum, *L.*	1	1	1	1	..	..	1	1	1	L							
Sibiricum, *Turc.*																	
integrifolium, *Richd.*	..	..	1	1													
Leucanthemum, *L.*	1	..	..	..	..	A	1	..	..	×	..	..	1	..	1		
PYRETHRUM inodorum, *Sm.*	1	1	1	1	..	A	1	1	1	C	..	..	1	..	1	..	×
ambiguum, *Led.*																	
pulchellum, *Turc.*																	
bipinnatum, *L*	1	1	1	..	..	..	1										
ARTEMISIA vulgaris, *L.*	1	1	1	1	..	A	1	1	1	1	M	..	A	..	H		
var. Tilesii, *Led.*																	
arctica, *Less.* (*alp.*)	..	..	1	..	..	N	1	1	1	R							
Chamissoniana, *Bess.*																	
Norvegica, *Fr.*																	
glomerata, *Led.*	..	1	1	..	..	..	..	1	1								
globularia, *Cham.*																	
androsacea, *Seem.*	..	..	1														
Richardsoniana, *Bess.*	..	..	1	..	..	..	1	..	..	R							
cæspitosa, *Bess.*																	
biennis, *Willd.*	..	1	1	1	..	..	..	1	1	1	..	..	1	..	H		
desertorum, *Spr.*	..	..	..	1	..	..	1	1	1	1	..	..	..	..	H		
Canadensis, *Mich.*																	
Steveniana, *Bess.*	..	1															
borealis, *Pall.* (*alp.*)	1	1	1	1	1	..	1	1	1	1							
HELENIUM autumnale, *Hk.*	..	..	1	1	..	..	..	..	1	1							
BIDENS tripartita, *L.*	1	..	..	..	..	A	1	1	..	1	..	..	1	..	H	..	1
connata, *Muhl.*																	
TANACETUM vulgare, *L.*	1	..	..	..	..	A	1	1	..	×	..	..	1				
ANTENNARIA alpina, *L.* (*alp.*)	1	1	1	M	1	N	1	1	1	C							
dioica, *Br.*	1	..	1	1	1	A	1	1	1	1	..	..	1	..	1		
hyperborea, *Don.*																	
Carpathica, *Wahl.* (*alp.*)	1	1	..	..	..	A	..	..	R	C	..	..	1				
GNAPHALIUM sylvaticum, *L.*	1	1	..	..	1	A	1	1	..	L	..	..	1	..	1		
Norvegicum, *Gunn.*																	
supinum, *L.* (*alp.*)	1	..	..	..	1	A	..	..	..	WL	..	..	1				
uliginosum, *L.*	1	..	..	..	S	A	1	1	1	1	..	..	1	..	H		
pilulare, *Wahl.*																	
ARNICA montana, *L.* (*alp.*)	1	..	1	M	1	A	1	1	1	C	..	..	1	..	1		
Chamissonis, *Less.*																	
angustifolia, *Vahl.*																	
alpina, *Læst.*																	
SENECIO aureus, *L.*	..	..	1	1	..	..	..	..	1	1							
vulgaris, *L.*	1	..	..	..	..	A	1	..	..	×	..	..	A	..	×		
resedæfolius, *Less.*	1	1	1	..	..	..	1	1	1	C							
frigidus, *Less.*	1	1	1	1	..	N	1	1	1	L							
palustris, *L.*	1	1	1	M	..	A	1	1	1	1	..	..	1	..	1		
arcticus, *Rupr.*																	
Cineraria congesta, *Br.*																	

DICOTYLEDONES.	I. Arctic.					II. N. Europ. and Asiatic.			III. American.				IV.		V.		
Compositæ (*continued*).	Europe.	Asia.	W. America.	E. America.	Greenland.	Europe to Alps, &c.	Asia to Altai, &c.	N. E. Asia and Japan.	N. W. America.	N. E. America.	Tropical America.	Extra-tropical S. America.	S. Europ., N. Afric., Asia Minor.	S. Africa.	Persia, Tibet, Himalaya, &c.	Tropical Asia.	Australia and New Zealand.

Senecio campestris, *L.*	1	..	1	1	..	A	1	1	1	1	..	..	1	..	1		
lugens, *Rich.*																	
Hookeri, *T. & G.*																	
aurantiacus, *DC.*																	
integrifolius, *Nutt.*																	
Cineraria alpina, *Fr.*																	
nemorensis, *L.*	1	..	..	..	..	A	1	1	..	..	..	..	1	..	1		
octoglossus, *DC.*																	
pseudo-Arnica, *Less.*	..	..	1	..	..	..	1	1	1	C							
Ligularia Sibirica, *L.*	1	..	..	..	..	N	1	1	..	..	..	..	..	..	1		
Solidago Virga-aurea, *L.*	1	..	1	1	..	A	1	1	1	1	.	..	A	..	H		
multiradiata, *Ait.*																	
Canadensis	..	..	..	1	..	..	..	..	1	1							
Aster Tripolium, *L.*	1	..	..	..	..	A	1	1	..	..	..	..	A	..	1		
Sibiricus, *L.*	1	1	1	1	..	..	1	1	1	L							
Richardsonii, *Spr.*																	
montanus, *Richn.*																	
salsuginosus, *Rich.* (*alp.*)	..	..	1	1	..	..	..	..	1	1							
pygmæus, *Lindl.*																	
Tataricus, *L. f.*	1	..	..	..	..	N	1	1	1	..	..	..	1	..	1		
alpinus, *L.* (*alp.*)	..	..	1	1	..	A	1	1	..	R	..	..	1	..	1		
flaccidus, *Bunge.*																	
multiflorus, *Ait.*	..	..	..	1	..	..	..	..	1	1							
falcatus, *Lindl.*																	
Erigeron compositus, *Pursh* (*alp.*)	..	..	1	1	1	..	..	..	1	R							
trifidus, *Hook.*																	
acris, *L.*	1	..	..	..	..	A	1	1	1	1	..	..	1	..	H		
elongatus, *Led.*																	
politus, *Fr.*																	
glabratus, *Hk.*																	
alpinus, *L.* (*alp.*)	1S	1	1	1	1	A	1	1	1	R	..	1	1	..	H		
uniflorus, *L.*																	
pulchellus, *DC.*																	
Philadelphicus, *L.*	..	..	..	1	..	..	..	..	1	1							
purpureus, *Ait.*																	
Grindelia squarrosa, *Duval*	..	..	..	1	..	..	..	..	..	1							
Taraxacum Dens-leonis, *Desf.*	1S	1	1	M	1	A	1	1	1	1	..	1	A	..	H	..	1
ceratophorum, *DC.*																	
palustre, *DC.*																	
Scorzonera, *Reich.*																	
phymatocarpum, *J. Vahl.*																	
Lapsana communis, *L.*	1	..	..	..	..	A	..	..	..	×	..	..	1	..	H		
Troximon glaucum, *Nutt.*	..	..	1	1	..	..	..	..	1	C							
Crepis tectorum, *L.*	1	..	..	..	..	A	1	1	..	..	..	..	1	..	1		
nana, *Rich.* (*alp.*)	..	..	1	1	..	..	1	1	1	R							
chrysantha, *Froel.*	1	..	..	..	..	A	1	?									
Sonchus arvensis, *L.*	1	..	..	1	..	A	1	..	..	×	..	..	A	..	H	1	1
maritimus, *L.*																	
Leontodon autumnalis, *L.*	1	1	..	..	S	A	1	..	..	×	..	..	1	..	1	..	×
Keretinus, *Nyl.*																	
Apargia Taraxaci, *Sm.*																	
Mulgedium pulchellum, *Nutt.*	..	..	1	1	..	..	..	..	1	C							
alpinum, *Less.*	1	..	..	..	..	A	1	..	..	..	..	..	1				
Sibiricum, *Less.*	1	..	..	..	..	N	1	1	..	..	..	..	..	..	1		
Hieracium murorum, *L.*	1	..	..	..	1	A	1	..	..	C	..	..	1	..	H		
cæsium, *Fr.*																	
nigrescens, *Fr.*																	
vulgatum, *Fr.*																	
atratum, *Fr.*																	

DICOTYLEDONES.	I. Arctic.					II. N. Europ. and Asiatic.			III. American.				IV.		V.		
Compositæ (*continued*).	Europe.	Asia.	W. America.	E. America.	Greenland.	Europe to Alps, &c.	Asia to Altai, &c.	N. E. Asia and Japan.	N. W. America.	N. E. America.	Tropical America.	Extra-tropical S. America.	S. Europ., N. Afric., Asia Minor.	S. Africa.	Persia, Tibet, Himalaya, &c.	Tropical Asia.	Australia and New Zealand.
HIERACIUM Auricula, *L.*	1	..	..	..	..	A	1	..	..	..	..	..	1				
dubium, *L.*																	
alpinum, *L.* (*alp.*)	1	1	..	..	S	A	1	1	..	..	..	..	1				
triste, *Willd.*																	
umbellatum, *L.*	1	..	1	1	S	A	1	1	..	1	..	..	1	..	H		
crocatum, *Fr.*																	
boreale, *Fr.*	1	..	..	..	..	A	1	1	..	C	..	..	1	..	1		
æstivum, *Fr.*																	
paludosum, *L.*	1	..	..	..	..	A	1	..	..	..	..	..	1				
SAUSSUREA alpina, *L.* (*alp.*)	1	1	1	1	..	A	1	1	1	C	..	..	1				
nuda, *DC.*																	
mouticola, *Rich.*																	
angustifolia, *DC.*																	
subsinuata, *Led.*	..	..	1	..	..	..	1	..	1								
CARDUUS crispus, *L.*	1	..	..	..	..	A	1	1	..	..	..	..	1	..	H		
CIRSIUM palustre, *Scop.*	1	..	..	..	..	A	1	..	..	..	..	..	1				
heterophyllum, *All.*	1	..	..	..	..	A	1	..	..	..	..	..	1	..	1		
XXXIII. **Campanulaceæ.**																	
CAMPANULA rotundifolia, *L.*	1	..	1	1	1	A	1	1	1	1	..	..	A	..	1		
linifolia, *Hænk.*																	
Scheuchzeri, *Vill.*																	
uniflora, *L.* (*alp.*)	1	..	1	M	1	N	..	1	1	L							
dasyantha, *M.B.*	..	..	1	..	..	..	1	1									
lasiocarpa, *A.DC.*	..	..	1	..	..	..	..	1	1								
latifolia, *L.*	1	..	..	..	..	A	..	..	..	..	..	..	1	..	H		
XXXIV. **Vaccinieæ.**																	
VACCINIUM uliginosum, *L.*	1	1	1	1	1	A	1	1	1	1	..	..	1	..	1		
pubescens, *Wormsk.*																	
Oxycoccos, *L.* (*alp.*)	1	1	1	1	S	A	1	1	1	1	..	..	1				
microcarpum, *Rupr.*																	
Vitis Idæa, *L.* (*alp.*)	1	1	1	1	1	A	1	1	1	1	..	..	1				
Myrtillus, *L.*	1	..	..	..	..	A	1	1	R	..	..	..	A	..	1		
Canadense, *Kalm*	..	..	..	1	..	..	..	..	..	1							
XXXV. **Ericeæ.**																	
CASSIOPEIA hypnoides, *L.* (*alp.*)	1	1	..	..	1	N	1	1	1	WL							
tetragona, *L.* (*alp.*)	1S	1	1	1	1	..	1	1	1	L							
ANDROMEDA polifolia, *L.*	1	1	1	1	..	A	1	1	1	1							
CASSANDRA calyculata, *Don* (*alp.*)	1	..	1	..	..	N	1	1	1	1							
ARCTOSTAPHYLOS Uva-ursi, *Spr.*	1	..	1	1	1	A	1	1	1	1	..	..	1				
alpina, *Spr.* (*alp.*)	1	1	1	1	..	A	1	1	1	W	..	..	1				
CALLUNA vulgaris, *L.*	1	..	..	..	..	A	1	..	..	..	..	..	1				
DIAPENSIA Lapponica, *L.* (*alp.*)	1	..	1	1	1	N	1	1	1	W							
LOISELEURIA procumbens, *L.* (*alp.*)	1	..	1	1	1	A	1	1	1	1	..	..	1				
RHODODENDRON Lapponicum, *L.* (*alp.*)	1	..	1	1	1	N	1	..	1	W							
KALMIA glauca, *L.*	..	..	1	1	..	..	..	..	1	1							
OSMOTHAMNUS fragrans, *DC.* (*alp.*)	..	1	..	..	..	..	1	..	..	..	..	..	..	..	H		
LEDUM palustre, *L.*	1	1	1	1	1	N	1	1	1	1	..	..	..	..	1		
Grœnlandicum, *Retz.*																	
latifolium, *Ait.*																	
dilatatum, *Ait.*																	
PHYLLODOCE taxifolia, *Sol.* (*alp.*)	1	..	..	..	1	A	1	1	1	WL							
PYROLA minor, *L.*	1	..	1	1	1	A	1	1	1	1	..	..	1				
secunda, *L.*	1	1	1	1	..	A	1	1	1	1	M	..	1				

DICOTYLEDONES.	I. Arctic.					II. N. Europ. and Asiatic.			III. American.				IV.		V.		
Ericeæ (*continued*).	Europe.	Asia.	W. America.	E. America.	Greenland.	Europe to Alps, &c.	Asia to Altai, &c.	N. E. Asia and Japan.	N. W. America.	N. E. America.	Tropical America	Extra-tropical S. America.	S. Europ., N. Afric., Asia Minor.	S. Africa.	Persia, Tibet, Himalaya, &c.	Tropical Asia.	Australia and New Zealand.
PYROLA rotundifolia, *L.*	1	1	1	1	1	A	1	1	1	1	M	..	1	..	H		
chlorantha, *Sw.*																	
elliptica, *Nutt.*																	
grandiflora, *Rad.*																	
Grœnlandica, *Horn.*																	
media, *Sw.*	1	..	..	..	..	A	..	1									
XXXVI. Gentianeæ.																	
GENTIANA campestris, *L.*	1	..	..	..	..	A	1	..	..	..	..	..	1				
amarella, *L.*	1	..	1	1	..	A	1	1	1	1	M	..	1	..	1		
lingulata, *Ag.*; acuta, *Mich.*																	
arctophila, *Griseb.* (*alp.*)	..	..	1	..	..	..	..	..	..	R							
aurea, *L.*	1	..	..	..	S	N											
involucrata, *Rottb.*																	
glauca, *Pall.*	..	..	1	..	..	..	1	1	1								
propinqua, *Rich.*	..	..	1	1	..	..	..	..	1	1							
prostrata, *Hænke* (*alp.*)	..	..	1	..	..	A	1	1	1	..	1	1					
detonsa, *Fr.* (*alp.*)	1	..	1	1	S	..	1	1	1	1	M	..	1	..	H		
tenella, *Fr.* (*alp.*)	1	1	1	..	..	A	1	1	1	1	..	..	1	..	H		
verna, *L.* (*alp.*)	1	..	..	..	..	A	1	1	..	..	..	..	1	..	1		
æstiva, *R. & S.*																	
nivalis, *L.* (*alp.*)	1	..	..	..	1	A	1	1	..	L	..	..	1				
PLEUROGYNE rotata, *Gr.* (*alp.*)	1	..	1	1	1	N	1	1	1	1							
MENYANTHES trifoliata, *L.*	1	1	..	..	1	A	1	1	1	1	..	..	1	..	H		
XXXVII. Hydrophylleæ.																	
EUTOCA Franklinii, *Br.*	..	..	1	1	..	..	..	..	..	1							
XXXVIII. Polemoniaceæ.																	
POLEMONIUM cæruleum, *L.*	1	1	1	1	E	A	1	1	1	C	M	..	1	..	H		
capitatum, *Eschsch.*																	
pulchellum, *Bge.*																	
humile, *W.*																	
PHLOX Sibirica, *L.* (*alp.*)	..	..	1	1	..	..	1	1	1								
Richardsoni, *Hk.*																	
XXXIX. Boragineæ.																	
MYOSOTIS sylvatica, *Hoffm.*	1	1	1	1	..	A	1	1	1	..	..	..	A	..	H		
alpestris, *Sm.*																	
sparsiflora, *Pohl*	1	..	..	..	..	N	1	..	..	..	..	..	..	..	1		
cæspitosa, *Schltz.*	1	..	..	..	..	A	1	..	..	..	..	..	A	..	H		
palustris, *L.*	1	..	..	..	..	A	1	..	..	1	..	..	1				
arvensis, *L.*	1	..	..	..	..	A	1	1	1	1	..	..	A	1	1		
intermedia, *Link.*																	
ERETRICHIUM villosum, *Bge.* (*alp.*)	1	1	1	..	..	..	1	1	..	..	..	..	..	..	H		
aretioides, *A. DC.*																	
latifolium, *Rupr.*																	
MERTENSIA maritima, *Don*	1	..	1	1	1	N	..	1	1	1							
denticulata, *Don*	..	..	1	1	..	..	1	1	1	1							
paniculata, *Don.*																	
corymbosa, *Lehm.*; pilosa, *DC.*																	
Virginica, *DC.*	..	..	..	1	..	..	..	..	..	1							
Drummondii, *Don.*																	
ECHINOSPERMUM deflexum, *Lehm.*	1	..	..	..	..	A	1	1	..	×	..	..	1				
ASPERUGO procumbens, *L.*	1	..	..	..	..	A	1	..	..	..	..	..	A	..	H	..	×
XL. Labiatæ.																	
MENTHA arvensis, *L.*	1	..	..	..	..	A	1	1	..	×	..	..	1	..	H		
Lapponica, *Wahl.*																	

DICOTYLEDONES.	I. Arctic.					II. N. Europ. and Asiatic.			III. American.				IV.		V.		
Labiatæ (*continued*).	Europe.	Asia.	W. America.	E. America.	Greenland.	Europe to Alps, &c.	Asia to Altai, &c.	N. E. Asia and Japan.	N. W. America.	N. E. America.	Tropical America.	Extra-tropical S. America.	S. Europ., N. Afric., Asia Minor.	S. Africa.	Persia, Tibet, Himalaya, &c.	Tropical Asia.	Australia and New Zealand.
ORIGANUM vulgare, *L.*	1	..	..	..	..	A	1	..	..	..	..	..	A	..	H		
THYMUS Serpyllum, *L.*	1	..	..	..	1	A	1	1	..	×	..	..	1	..	H		
DRACOCEPHALUM parviflorum, *Nutt.*	..	..	..	1	..	..	..	..	..	1							
SCUTELLARIA galericulata, *L.*	1	..	..	..	..	A	1	1	1	1	..	..	1	..	H		
PRUNELLA vulgaris, *L.*	1	..	..	..	..	A	1	1	1	1	..	..	A	..	H	1	1
GALEOPSIS versicolor, *L.*	1	..	..	..	..	A	1	1	..	×	..	..	1	..	H		
Tetrahit, *L.*																	
GLECHOMA hederacea, *L.*	1	..	..	..	..	A	1	1	..	×	..	..	1				
STACHYS sylvatica, *L.*	1	..	..	..	..	A	1	..	..	..	..	..	1	..	H		
palustris, *L.*	1	..	..	1	..	A	1	1	1	1	..	..	1	..	H		
AJUGA pyramidalis, *L.*	1	..	..	..	..	A	..	..	..	..	..	..	1				
XLI. Orobancheæ.																	
BOSCHNIAKIA glabra, *C. A. M.*	..	..	1	1	..	..	1	1	1	1							
XLII. Scrophularineæ.																	
LINARIA vulgaris	1	..	..	..	..	A	1	1	..	×	..	..	1				
LIMOSELLA aquatica, *L.*	1	..	..	..	S	A	1	1	1	1	..	1	1	1	H	..	1
GYMNANDRA borealis, *Pall.* (*alp.*)	1	1	1	1	..	..	1	1	1	..	..	..	..	..	H		
Pallasii, *C. & S.*																	
Stelleri, *C. & S.*																	
CASTILLEJA pallida, *Kth.* (*alp.*)	1	1	1	1	..	..	1	1	1	WL	..	..	..	..	1		
septentrionalis, *Lindl.*																	
VERONICA alpina, *L.* (*alp.*)	1	1	..	..	1	A	1	1	1	W	..	..	1				
officinalis, *L.*	1	..	..	..	..	A	1	1	..	1	..	..	1				
longifolia, *L.*	1	1	..	..	..	A	1	1	..	..	..	..	1				
chamædrys, *L.*	1	..	..	..	..	A	1	..	..	×	..	..	1	..	1		
scutellata, *L.*	1	..	1	..	..	A	1	1	1	1	..	..	A	..	1	..	1
macrostemon, *Bge.*	1	..	..	..	..	..	1	..	..	..	..	..	..	..	H		
serpyllifolia, *L.*	1	..	..	1	..	A	1	1	1	1	1	1	1	..	H	..	1
borealis, *Læst.*																	
saxatilis, *L.* (*alp.*)	1	..	..	..	1	A	1	..	..	..	..	..	1				
fruticulosa, *L.*																	
MELAMPYRUM pratense, *L.*	1	..	..	..	..	A	1	..	..	1	..	..	1				
Americanum, *Mich.*																	
sylvaticum, *L.*	1	..	..	..	..	A	1	..	..	1	..	..	1				
EUPHRASIA officinalis, *L.*	1	..	..	..	1	A	1	1	..	1	..	..	1	..	H		
RHINANTHUS Crista-galli, *L.*	1	..	..	1	S	A	..	1	1	1	..	..	1				
minor, *Ehr.*																	
BARTSIA alpina, *L.* (*alp.*)	1	1	..	..	1	A	..	..	..	L	..	..	1				
PEDICULARIS capitata, *Ad.*	..	1	1	1	..	..	1	1	1								
Sceptrum, *L.*	1	1	..	..	..	A	1	1	..	..	..	..	..	..	1		
verticillata, *L.* (*alp.*)	1	1	1	..	..	A	1	1	1	..	..	..	1	..	H		
amœna, *Ad.*																	
palustris, *L.*	1	..	1	..	..	A	1	1	1	L	..	..	1	..	1		
borealis, *Stev.*																	
Lapponica, *L.* (*alp.*).	1	1	1	1	1	N	1	1	..	L							
euphrasioides, *Stev.* (*alp.*)	..	1	1	1	1	..	1	1	1	L							
hirsuta, *L.* (*alp.*)	1S	1	1	1	1	N	..	..	..	L							
lanata, *Willd.*																	
Sudetica, *L.* (*alp.*)	1	1	1	M	1	N	1	1	1	L							
arctica, *Br.*																	
Kanei, *Durand.*																	
Langsdorffii, *Fisch.*																	
flammea, *L.* (*alp.*)	1	1	..	1	1	..	..	..	R	L							
versicolor, *Wahl.* (*alp.*)	1	1	1	1	..	A	1	1	1	..	..	..	..	..	H		
SCROPHULARIA nodosa, *L.*	1	..	..	..	..	A	1	..	1	1	..	..	1	..	1		

DICOTYLEDONES.	I. Arctic.					II. N. Europ. and Asiatic.			III. American.				IV.		V.		
	Europe.	Asia.	W. America.	E. America.	Greenland.	Europe to Alps, &c.	Asia to Altai, &c.	N. E. Asia and Japan.	N. W. America.	N. E. America.	Tropical America.	Extra-tropical S. America.	S. Europ., N. Afric., Asia Minor.	S. Africa.	Persia, Tibet, Himalaya, &c.	Tropical Asia.	Australia and New Zealand.
XLIII. Lentibularineæ.																	
UTRICULARIA vulgaris, *L.*	1	..	..	1	..	A	1	1	1	1	..	..	A				
minor, *L.*	1	..	..	1	..	A	1	1	1	..	..	..	1	..	H		
intermedia, *Ehr.*																	
PINGUICULA vulgaris, *L.*	1	..	..	1	1	A	1	1	1	1	..	..	1				
villosa, *L.*	1	..	1	1	..	N	1	1	1	L							
alpina, *L.* (*alp.*)	1	1	..	..	..	A	1	..	..	..	..	..	1	..	H		
XLIV. Primulaceæ.																	
DODECATHEON Meadia, *L.*	..	..	1	1	..	..	..	1	1	1							
integrifolium, *Mich.*																	
frigidum, *C. & S.*																	
CORTUSA Matthioli, *L.*	1	..	..	..	..	A	1	1	..	..	..	..	1	..	H		
GLAUX maritima, *L.*	1	..	..	..	..	A	1	1	1	1	..	..	1	..	H		
TRIENTALIS Europæa, *L.*	1	..	..	..	..	A	1	1	1								
latifolia, *Hook.*; arctica, *Fisch.*																	
ANDROSACE septentrionalis, *L.*	1	1	1	1	..	A	1	1	1	C	..	..	..	..	1		
Chamæjasme, *L.* (*alp.*)	1	1	1	1	..	A	1	1	1	R	..	..	1				
triflora, *Adams.*																	
DOUGLASIA arctica, *Hk.* (*alp.*)	..	..	..	1													
NAUMBERGIA thyrsiflora, *Reich.*	1	..	..	..	..	N	1	1	1	1							
LYSIMACHIA vulgaris, *L.*	1	..	..	..	..	A	1	1	..	..	..	..	1	..	..	..	1
PRIMULA stricta, *Horn.* (*alp.*)	1	..	1	1	1	N	..	1	1	1							
Hornemanniana, *Lehm.*																	
Mistassinica, *C. & S.*																	
borealis, *Duby.*																	
nivalis, *Pall.* (*alp.*)	..	..	1	..	..	..	1	1	1								
cuneifolia, *Led.* (*alp.*)	..	..	1	..	..	..	1	1	1								
saxifragæfolia, *Lehm.*																	
farinosa, *L.*	1	..	..	..	..	A	1	1	1	L	..	1	1				
Scotica, *Hook.*																	
Sibirica, *Jacq.* (*alp.*)	1	..	..	1	S	N	1	1	..	..	..	..	..	..	H		
Finmarchica, *Willd.*																	
XLV. Plumbagineæ.																	
ARMERIA vulgaris, *Willd.*	1	1	1	1	1	A	1	1	1	C	..	1	1				
alpina, *Hoppe.*																	
elongata, *Hoffm.*																	
Labradorica, *Wallr.*																	
arctica, *Rupr.*																	
Macloviana, *Cham.*																	
XLVI. Plantagineæ.																	
PLANTAGO major, *L.*	1	..	..	1	..	A	1	1	1	×	..	..	A	..	H	..	×
media, L.	1	..	..	..	..	A	1	1	1	..	..	..	1	..	1		
lanceolata, *L.*	1	..	..	1	..	A	..	..	1	×	1	..	A	..	H	..	×
maritima, L.	1	1	..	..	1	A	1	1	1	1	..	1	1	..	H		
LITTORELLA lacustris, *L.*	1	..	..	..	..	A											
XLVII. Polygoneæ.																	
KŒNIGIA Islandica, *L.* (*alp.*)	1S	..	1	..	1	N	1	1	1	R	..	..	..	..	H		
OXYRIA reniformis, *Hk.* (*alp.*)	1S	1	1	M	1	A	1	1	1	W	..	..	1	..	H		
RUMEX Acetosa, *L.*	1	1	..	..	S	A	1	1	1	×	..	×	A	×	H		
Acetosella, *L.*	1	1	..	..	1	A	1	1	1	×	..	×	A	×	H	×	×
graminifolius, *Lamb.*	..	1	..	..	..	..	1	1									
aquaticus, *L.*	1	1	1	1	S	A	1	1	1	1	..	..	1	..	H		
Hippolapathum, *Fr.*																	
arcticus, *Trautv.*																	
domesticus, *Hartm.*																	

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DICOTYLEDONES. **Polygoniæ** (*continued*).	Europe.	Asia.	W. America.	E. America.	Greenland.	Europe to Alps, &c.	Asia to Altai, &c.	N. E. Asia and Japan.	N. W. America.	N. E. America.	Tropical America.	Extra-tropical S. America.	S. Europ., N. Afric., Asia Minor.	S. Africa.	Persia, Tibet, Himalaya, &c.	Tropical Asia.	Australia and New Zealand.
RUMEX salicifolius, *Weinm.*	..	1	1	1	..	..	..	1	1	1							
POLYGONUM Bistorta, *L.*	1	1	1	1	..	A	1	1	1	..	..	..	1	..	H		
viviparum, *L.* (*alp.*)	1S	1	1	M	1	A	1	1	1	1	..	..	1	..	H		
polymorphum, *Led.* (*alp.*)	..	..	1	..	..	A	1	1	1	..	..	..	1	..	1		
alpinum, *All.*																	
amphibium, *L.*	1	1	..	..	..	A	1	1	1	1	M	..	A	1	H		
Persicaria, *L.*	1	..	..	..	..	A	1	1	1	×	1	1	A	1	H	1	1
lapathifolium, *L.*																	
Sibiricum, *Laxm.* (*alp.*)	..	1	..	..	..	N	1	1									
aviculare, *L.*	1	..	..	..	S	A	1	1	1	1	1	1	A	1	H	..	1
Convolvulus, *L.*	1	..	..	..	..	A	1	1	1	×	..	..	A	×	H	..	×
XLVIII. **Chenopodieæ.**																	
CHENOPODIUM album, *L.*	1	..	..	1	..	A	1	1	1	×	..	..	A	..	H	..	1
maritimum, *L.*	..	..	1	1	..	A	1	1	1	1	1	1	A	1	H	1	1
MONOLEPIS Asiatica, *F. & M.*	..	1															
ATRIPLEX littoralis, *L.*	..	..	1	..	..	A	1	1	..	..	..	..	A	..	1		
patula, *L.*	1	..	1	..	..	A	1	1	1	1	..	..	A	..	H	..	×
deltoidea, *Bab.*																	
angustifolia, *Sm.*																	
Gmelini, *C. A. M.*																	
hastata, *L.*																	
CORISPERMUM hyssopifolium, *Ant. Juss.*	..	..	1	..	..	A	1	1	1	C	..	..	1	..	H		
XLIX. **Elæagneæ.**																	
ELÆAGNUS argentea, *L.*	..	..	..	1	..	..	..	..	..	C							
SHEPHERDIA Canadensis, *Nutt.*	..	..	..	1	..	..	..	..	1	1							
L. **Thymeleæ.**																	
DAPHNE Mezereum, *L.*	1	..	..	..	..	A	1	..	..	..	..	..	1				
LI. **Santalaceæ.**																	
Comandra livida, *Rich.*	..	..	1	1	..	..	..	..	1	C							
LII. **Empetreæ.**																	
EMPETRUM nigrum, *L.*	1S	1	1	1	1	A	1	1	1	1	..	1	1	..	1		
LIII. **Myriceæ.**																	
MYRICA Gale, *L.*	1	..	..	..	..	A	1	1	1	1	..	..	1				
LIV. **Urticeæ.**																	
URTICA urens, *L.*	1	..	..	..	..	A	1	..	..	×	..	1	A	..	H	..	×
dioica, *L.*	1	..	..	1	..	A	1	1	1	1	M	1	A	1	H	..	×
gracilis, *Ait.*																	
LV. **Betulaceæ.**																	
BETULA alba, *L.*	1	1	..	..	..	A	1	1	..	1	..	..	1	..	1		
glutinosa, *Wallr.*																	
intermedia, *Wahl.*																	
papyracea, *Ait.*	..	..	1	1	..	..	..	..	1	1							
nana, *L.*	1	1	1	1	1	A	1	1	1	W	..	..	1	..	1		
pumila, *L.*	..	..	1	1	..	..	..	..	1	1							
glandulosa, *Mich.*																	
fruticosa, *Pall.*	1	..	..	..	S	N	1	1									
alpestris, *Fr.*																	
humilis, *Hart.*																	
ALNUS glutinosa, *Willd.*	1	..	..	..	..	A	1	..	..	..	..	..	A				
barbata, *C. A. M.*																	

DICOTYLEDONES.	I. Arctic.					II. N. Europ. and Asiatic.			III. American.				IV.		V.		
	Europe.	Asia.	W. America.	E. America.	Greenland.	Europe to Alps, &c.	Asia to Altai, &c.	N. E. Asia and Japan.	N. W. America.	N. E. America.	Tropical America.	Extra-tropical S. America.	S. Europ., N. Afric., Asia Minor.	S. Africa.	Persia, Tibet, Himalaya, &c.	Tropical Asia.	Australia and New Zealand.
Betulaceæ (*continued*).																	
ALNUS viridis, *DC.* (*alp.*)	..	1	1	1	1	A	1	1	1	1	..	..	1				
fruticosa, *Rich.*																	
repens, *Vahl.*																	
incana, *Willd.*	1	..	1	1	..	A	1	1	1	1	..	..	1	..	1		
LVI. **Cupuliferæ.**																	
CORYLUS Avellana, *L.*	1	..	..	..	..	A	1	..	..	..	..	..	1				
LVII. **Salicineæ.**																	
SALIX pentandra, *L.*	1	1	..	..	..	A	1	1	1	1	..	..	1	..	1		
lucida, *Willd.*																	
lanata, *L.* (*alp.*)	1	1	1	1	1	N	1	1	1	C							
Richardsoni, *Hook.*																	
Barattiana, *Hook.*																	
speciosa, *H. & A.* (*alp.*)	..	..	1	1	..	..	..	..	..	R							
Lapponum, *L.* (*alp.*)	1	1	..	..	..	A	1	1	..	..	..	..	1				
Stuartiana, *Sm.*																	
Caprea, *L.*	1	..	..	..	..	A	1	1	..	..	..	..	1	..	H		
nigricans, *Fr.*	1	1	..	..	..	A	1	1	..	..	..	..	1				
punctata, *Wahl.*																	
phylicifolia, *Sm.* (*alp.*)	1	1	..	..	..	A	1	1	..	W	..	..	..	..	1		
myrtilloides, *L.*	1	1	1	1	..	N	1	1	1	1							
pedicellaris, *Pursh.*																	
hastata, *L.*	1	1	..	..	..	A	1	1	..	..	..	..	1				
cordata, *Muhl.*	..	..	..	1	..	..	..	..	..	1							
rhamnifolia, *H. & A.*	..	..	1	..	..	..	..	1	1								
ovalifolia, *Trautv.*	..	1	1	..	..	..	1	1	1								
glacialis, *And.*	..	..	1														
Arbuscula, *L.* (*alp.*)	1	..	..	..	1	A	1	..	..	W	..	..	1	..	1		
glauca, *L.* (*alp.*)	1	1	1	1	1	A	1	1	1	1	..	..	1				
desertorum, *Rich.*																	
villosa, *Don.*																	
arctica, *Br.* (*alp.*)	..	..	1	M	1	..	1	..	1	C							
alpestris, *And.*	1	1	1	1	1	A	1	1	..	W							
cordifolia, *Pursh* (partim).																	
pyrenaica, *Gouan* (partim).																	
myrsinites, *L.* (*alp.*)	1	1	1	1	S	A	1	1	..	W	..	..	1				
phlebophylla, *And.*	..	..	1	1	..	..	..	..	1								
reticulata, *L.* (*alp.*)	1S	1	1	1	1	A	1	1	1	1	..	..	1				
vestita, *Pursh.*																	
nivalis, *Hook.*																	
herbacea, *L.* (*alp.*)	1S	1	1	1	1	A	1	1	1	W	..	..	1				
polaris, *L.* (*alp.*)	1S	1	1	M	..	N	1	1	1	1	..	..	..	..	1		
POPULUS tremula, *L.*	1	..	..	..	..	A	1	1	..	..	..	..	A				
tremuloides, *Mich.*	..	..	..	1	..	..	..	..	..	1							
balsamifera, *L.*	..	..	1	1	..	..	1	1	1	1							
LVIII. **Coniferæ.**																	
PINUS sylvestris, *L.*	1	..	..	..	..	A	1	1	..	..	..	..	1	..	1		
Banksiana, *Lamb.*	..	..	..	1	..	..	..	..	1	1							
Cembra, *L.* (*alp.*)	..	1	1	..	..	A	1	1	1	..	..	..	1				
ABIES alba, *L.*	..	1	1	1	..	..	..	..	1	1							
PICEA nigra, *L.*	..	..	..	1	..	..	..	..	..	1							
excelsa, *DC.*	1	..	..	..	..	A	..	..	..	..	..	..	1				
orientalis, *L.*	1	1	..	..	..	N	1	1									
LARIX Ledebourii, *Endl.*	1	1	..	..	..	N	1	1									
Sibirica, *Led.*																	

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	Europe.	Asia.	W. America.	E. America.	Greenland.	Europe to Alps, &c.	Asia to Altai, &c.	N. E. Asia and Japan.	N. W. America.	N. E. America.	Tropical America.	Extra-tropical S. America.	S. Europ., N. Afric., Asia Minor.	S. Africa.	Persia, Tibet, Himalaya, &c.	Tropical Asia.	Australia and New Zealand.
DICOTYLEDONES.																	
Coniferæ *(continued)*.																	
LARIX Americana, *Mich.*	..	1	1	1	..	..	1	1	1	1							
microcarpa, *Lamb.*																	
pendula, *Ait.*																	
Dahurica, *F. & T.*																	
JUNIPERUS communis, *L.*	1	..	1	1	1	A	1	1	1	1	..	..	A	..	H		
nana, *Willd.*																	
Virginiana, *L.*	..	..	1	1	..	..	..	..	1	1							
prostrata, *Pers.*																	
MONOCOTYLEDONES.																	
LIX. **Alismaceæ.**																	
SAGITTARIA sagittæfolia, *L.*	1	..	..	..	..	A	1	1	1	1	..	..	1	..	H		
variabilis, *Engelm.*																	
ALISMA Plantago, *L.*	1	..	..	..	..	A	1	1	1	1	..	..	A	..	H	..	1
LX. **Fluviales.**																	
TRIGLOCHIN maritimum, *L.*	1	..	1	1	..	A	1	1	1	1	..	..	A	..	H		
palustre, *L.*	1	..	..	..	S	A	1	1	1	1	..	..	A	..	H		
SCHEUCHZERIA palustris, *L.*	1	..	..	..	..	A	1	..	..	1							
POTAMOGETON natans, *L.*	1	..	..	..	..	A	1	1	1	1	..	1	A	1	H	1	1
sparganifolius, *Læstad.*																	
perfoliatus, *L.*	1	..	..	..	..	A	1	1	..	1	..	..	A	..	H	..	1
pectinatus, *L.*	1	..	..	..	..	A	1	1	1	1	..	..	A	..	H	..	1
rufescens, *Schr.*	1	..	..	..	S	A	..	..	1	1	..	..	1	..	H		
prælongus, *Wulff.*	1	..	..	..	..	A	..	..	..	1	..	..	..	..	H	..	1
pusillus, *L.*	1	..	..	..	S	A	..	..	..	1	..	..	1	..	H		
tenuissimus, *M. K.*																	
gramineus, *L.*	1	..	..	..	S	A	..	..	..	1	..	..	1				
nigrescens, *Fr.*																	
heterophyllus, *Schreb.*																	
ZOSTERA marina, *L.*	1	..	..	..	S	A	..	1	..	1	..	..	A				
LXI. **Melanthaceæ.**																	
TOFIELDIA palustris, *L.* (*alp.*)	1	1	..	1	1	A	1	1	1	C	..	..	1				
borealis, *Wahl.*																	
coccinea, *Richards*	..	1	1	1	..	..	1	1	1	1							
ZIGADENUS chloranthus, *Rich.*	..	..	1	1	..	..	..	..	1	1							
VERATRUM album, *L.*	1	..	..	..	..	A	1	1	1	1	..	..	1	..	1		
viride, *Ait.*																	
Lobelianum, *Bernh.*																	
LXII. **Liliaceæ.**																	
FRITILLARIA Kamschatkensis, *Gawl.*	..	1	..	..	..	..	..	1	1								
LLOYDIA serotina, *L.* (*alp.*)	1	1	1	1	..	A	1	..	1	1	..	..	1	...	H		
ALLIUM Schœnoprasum, *L.*	1	1	1	1	..	A	1	1	1	1	..	..	1	..	H		
Sibiricum, *L.*																	
oleraceum, *L.*	1	..	..	..	..	A	..	..	..	..	..	..	1	..	H		
LXIII. **Smilaceæ.**																	
PARIS quadrifolia, *L.*	1	..	..	..	..	A	1	1	..	..	..	..	1	..	1		
POLYGONATUM verticillatum, *All.*	1	..	..	..	..	A	1	..	..	..	..	..	1	..	H		
SMILACINA bifolia, *Desf.*	1	..	..	1	..	A	1	1	1	1	..	..	1	..	1		
LXIV. **Orchideæ.**																	
ORCHIS maculata, *L.*	1	..	..	..	..	A	1	..	..	..	..	..	1	..	1		
cruenta, *Muell.*	1	..	..	..	..	N											
latifolia, *L.*	1	..	..	..	..	A	1	1	1	..	..	..	1	..	H		

MONOCOTYLEDONES.	I. Arctic.					II. N. Europ. and Asiatic.			III. American.				IV.		V.		
Orchideæ *(continued)*.	Europe.	Asia.	W. America.	E. America.	Greenland.	Europe to Alps, &c.	Asia to Altai, &c.	N. E. Asia and Japan.	N. W. America.	N. E. America.	Tropical America	Extra tropical S. America.	S. Europ., N. Afric., Asia Minor.	S. Africa.	Persia, Tibet, Himalaya, &c.	Tropical Asia.	Australia and New Zealand.
ORCHIS Sambucina, *L.*	1	..	..	..	..	A	..	..	..	..	..	..	1	..	1		
GYMNADENIA Conopsea, *Br.*	1	..	..	..	..	A	1	1	..	..	..	..	1	..	1		
PERISTYLUS albidus, *L.*	1	..	..	..	1	A	1	..	..	..	..	..	1				
viridis, *L.*	1	..	..	..	..	A	1	1	..	1	..	..	1				
bracteatus, *Torr.*																	
Islandicus, *Lindl.*																	
PLATANTHERA hyperborea, *Lindl.*	..	..	1	1	1	N	..	..	1	1							
dilatata, *Lindl.*																	
Kœnigii, *Lindl.*																	
obtusata, *L.*	1	..	1	1	..	..	..	..	1	1							
bifolia, *L.*	1	..	..	..	..	A	1	1	..	..	..	..	1				
EPIPACTIS latifolia, *Sw.*	1	..	..	..	..	A	1	..	..	..	..	..	A				
media, *Fr.*																	
HERMINIUM Monorchis, *Br.*	1	..	..	..	..	A	1	1	..	..	..	..	1	..	H		
alpinum, *L.* (*alp.*)	1	..	..	..	..	A	..	..	..	..	..	..	1				
MALAXIS paludosa, *L.*	1	..	..	..	..	A	1										
CALYPSO borealis, *L.*	1	..	..	1	..	N	1	1	1	1							
LISTERA cordata, *Br.*	1	..	..	..	S	A	1	1	1	1	..	..	1				
ovata, *L.*	1	..	..	..	..	A	1	..	..	..	..	..	1				
GOODYERA repens, *L.*	1	..	..	..	..	A	1	1	..	1	..	..	1	..	H		
CORALLORRHIZA innata, *L.*	1	1	1	..	1	A	1	1	1	1	..	..	1				
SPIRANTHES gracilis, *Br.*	..	..	..	1	..	..	..	..	..	1							
CYPRIPEDIUM guttatum, *Sw.*	..	..	1	1	..	N	1	1	1	1							
humile, *Salisb.*	..	..	..	1	..	..	..	..	..	1							
acaule, *Ait.*																	
Calceolus, *L.*	1	1	..	..	..	A	1	1	..	..	..	..	1	..	H		
LXV. Irideæ.																	
SISYRINCHIUM Bermudianum, *L.*	..	..	..	1	..	×	..	..	1	1	1						
anceps, *Cav.*																	
LXVI. Hydrocharideæ.																	
STRATIOTES aloides, *L.*	1	..	..	..	..	A	..	..	..	..	..	..	1				
LXVII. Aroideæ.																	
SPARGANIUM natans, *L.*	1	..	1	1	S	N	1	1	1	1	..	..	A	..	1		
hyperboreum, *Læst.*																	
simplex, *Sm.*	..	..	..	1	..	A	1	1	1	1	..	1	A	..	1	..	1
CALLA palustris, *L.*	1	..	..	..	..	N	1	1	..	1							
TYPHA latifolia, *L.*	..	..	1	1	..	A	1	1	1	1	..	..	A	..	H		
LXVIII. Junceæ.																	
NARTHECIUM ossifragum, *L.*	1	..	..	..	..	A	..	..	..	1	..	..	1				
Americanum, *Ker.*																	
LUZULA spadicea, *DC.*	1	1	1	..	1	A	1	1	1	1	..	..	1	..	1		
glabrata, *Hoppe.*																	
parviflora, *Desv.*																	
melanocarpa, *Desv.*																	
Wahlenbergii, *Rupr.*																	
campestris, *Sm.*	1	1	1	1	1	A	1	1	1	1	..	1	1	1	H	..	1
pallescens, *Wahl.*																	
multiflora, *Ehr.*																	
spicata, *Desv.* (*alp.*)	1	..	1	..	1	A	1	1	1	W	..	..	1	..	H		
arcuata, *Hook.* (*alp.*)	1S	1	1	M	1	N	..	1	1	W							
hyperborea, *Br.*																	
pilosa, *Willd.*	1	..	1	..	1	A	1	1	..	1	..	..	A	..	1		
vernalis, *DC.*																	
maxima, *L.*	1	..	..	..	..	A	..	..	..	1	..	..	1				

	I. Arctic.					II. N. Europ. and Asiatic.			III. American.				IV.		V.		
MONOCOTYLEDONES.	Europe.	Asia.	W. America.	E. America.	Greenland.	Europe to Alps, &c.	Asia to Altai, &c.	N. E. Asia and Japan.	N. W. America.	N. E. America.	Tropical America.	Extra-tropical S. America.	S. Europ., N. Afric., Asia Minor.	S. Africa.	Persia, Tibet, Himalaya, &c.	Tropical Asia.	Australia and New Zealand.
Junceæ (*continued*).																	
JUNCUS biglumis, *L.* (*alp.*)	1S	1	1	M	1	N	1	..	1	..	..	..	..	..	H		
triglumis, *L.* (*alp.*)	1	..	1	1	1	A	1	1	R	1	..	..	1	..	H		
stygius, *L.* (*alp.*)	1	1	..	..	..	A	..	..	..	1							
castaneus, *L.* (*alp.*)	1	..	1	1	1	A	1	1	1	1	..	..	..	..	H		
communis, *Ehr.*	1	..	..	..	..	A	1	1	1	1	..	1	A	..	H	..	1
conglomeratus, *L.*; effusus, *L.*																	
Balticus, *Willd.* (*alp.*)	1	1	1	..	..	A	1	1	1	1	M	1	1				
arcticus, *Willd.* (*alp.*)	1	..	1	1	1	A	1	1	1	C							
filiformis, *L.*	1	..	1	1	S	A	1	1	1	1	..	..	1				
trifidus, *L.* (*alp.*)	1	..	..	..	S	A	1	..	..	W	..	..	1	..	1		
squarrosus, *L.*	1	..	..	..	S	A	..	..	..	..	..	..	1				
bufonius, *L.*	1	..	..	1	S	A	1	1	1	1	1	1	A	1	H	1	1
polycephalus, *Mich.*	..	..	..	1	..	..	..	..	1	1							
articulatus, *L.*	1	..	..	1	S	A	1	1	..	1	1	..	A	1	H		
uliginosus, *Roth.*																	
lampocarpus, *Ehr.*																	
alpinus, *Vill.*	1	..	..	..	..	A	1	..	..	..	..	..	1				
bulbosus, *L.*	1	..	..	..	..	A	1	1	1	1	..	..	A				
compressus, *Jacq.*																	
Gerardi, *Loisel*	1	..	..	..	..	A	1	1	..	..	..	..	1	..	1		
Bothnicus, *Wahl.*																	
cœnosus, *Bichen.*																	
atro-fuscus, *Rupr.*																	
LXIX. **Cyperaceæ.**																	
CAREX dioica, *L.*	1	..	1	1	1	A	1	..	..	1	..	..	1				
parallela, *Som.*																	
gynocrates, *Wimm.*																	
rupestris, *All.* (*alp.*)	1	..	..	..	1	A	1	..	..	1	..	..	1				
nardina, *Fr.*	1	..	..	1	1	N	..	..	..	1							
Hepburnii, *Boott.*																	
capitata, *L.*	1	..	..	..	1	A	1	..	..	W							
pauciflora, *Light.*	1	..	..	..	..	A	..	..	1	1	..	..	1				
microstachya, *Ehr.*	1	..	..	..	1	A	1	..	..	..	..	..					
scirpoidea, *Mx.*	..	..	..	1	1	N	..	..	..	1							
Wormskioldiana, *Horn.*																	
tenuiflora, *Wahl.*	1	..	..	..	..	N	1	..	..	1							
canescens, *L.*	1	..	..	1	1	A	1	1	1	1	..	1	1	..	..	..	1
curta, *Good.*; vitilis, *Fr.*																	
glareosa, *Wahl.*	1	..	1	1	1	N	..	1	1	1							
ursina, *Dewey.*																	
Norvegica, *W.*	1	..	1	..	..	N	1	1	1								
elongata, *L.*	1	..	..	..	..	A	..	..	1	..	..	..	1				
Heleonastes, *Ehr.*	1S	..	1	1	1	A	..	..	..	1							
marina, *Dew.*																	
lagopina, *Wahl.* (*alp.*)	1S	..	1	..	1	A	1	1	..	1	..	..	1				
festiva, *Dew.* (*alp.*)	1	..	1	1	1	N	..	..	1	1	1	1					
leporina, *L.*	1	..	..	..	..	A	..	..	1	..	..	..	1				
stellulata, *Good.*	1	..	..	..	..	A	1	1	1	1	..	..	A	..	1	..	1
echinata, *Murr.*																	
loliacea, *L.*	1	..	..	..	..	N	1	1									
macilenta, *Fr.*																	
incurva, *Light.*	1	..	1	1	1	A	1	..	..	1	..	..	1	..	H		
fulvicoma, *Dew.*																	
stenophylla, *Light.*	1	..	..	..	S	A	1	1	..	..	..	..	1	..	1		
arctica, *Deinb.*																	
Deinbolliana, *Gay.*																	
duriuscula, *C. A. M.*																	

MONOCOTYLEDONES. Cyperaceæ (*continued*).	I. Arctic. Europe.	Asia.	W. America.	E. America.	Greenland.	II. N. Europ. and Asiatic. Europe to Alps, &c.	Asia to Altai, &c.	N. E. Asia and Japan.	III. American. N. W. America.	N. E. America.	Tropical America.	Extra-tropical S. America.	IV. S. Europ., N. Afric., Asia Minor.	S. Africa.	V. Persia, Tibet, Himalaya, &c.	Tropical Asia.	Australia and New Zealand.
CAREX chordorrhiza, *Ehr.*	1	..	..	..	..	A	..	..	1	1	..	..	1				
teretiuscula, *Good.*	1	..	..	..	..	A	..	..	..	1	..	..	1	..	H	..	1
paradoxa, *Wahl.*	1	..	..	..	..	A	..	..	..	1	..	..	1				
alpina, *Sw.* (*alp.*)	1	..	..	1	1	A	1	1	1	C	..	..	..	..	H		
Vahlii, *Schl.*																	
holostoma, *Drej.*																	
atrata, *L.* (*alp.*)	1	..	1	1	S	A	1	..	..	W	..	..	1	..	H		
Buxbaumii, *Wahl.*	1	..	..	..	..	A	1	1	1	1	..	..	..	..	H	..	1
Gmelini, *Hook.*	..	..	1	..	..	..	..	1	1	1							
fuliginosa, *St.& Hpe.* (*alp.*)	1S	..	1	M	1	N	..	..	..	1							
misandra, *Br.*																	
frigida, *All.* (*alp.*)	1	..	..	..	..	A	1	1	..	..	..	..	1				
ferruginea, *Scop.* (*alp.*)	..	1	..	..	..	A	1										
? tristis, *Bieb.*																	
rariflora, *Sm.* (*alp.*)	1	..	1	1	1	N	..	1									
stygia, *Fries.*																	
limosa, *L.*	1	..	..	..	..	A	1	1	1	1	..	..	1	..	1		
Magellanica, *Lam.*	1	..	..	1	..	A	..	..	..	1	..	1					
irrigua, *Sm.*																	
ustulata, *Wahl.* (*alp.*)	1	..	..	1	..	A	1	..	..	1	..	..	..	..	H		
podocarpa, *Br.*	..	..	..	1	..	..	..	..	..	1							
macrochæte, *C. A. M.*																	
spectabilis, *Dewey.*																	
livida, *Wahl.*	1	..	..	1	..	N	..	..	1	1							
laxa, *Wahl.*	1	..	..	..	..	N	1										
panicea, *L.*	1	..	..	1	S	A	1	1	..	1	..	..	1				
sparsiflora, *Steud.*																	
phæostachya, *Sm.*																	
vaginata, *Tausch.*																	
pallescens, *L.*	1	..	..	..	..	A	1	..	..	1	..	..	1				
supina, *Wahl.*	..	..	..	1	1	A	1	..	..	1	..	..	..	..	H		
flava, *L.*	1	..	..	..	S	A	..	..	..	1	..	..	1	..	1		
Œderi, *Retz.*																	
pedata, *Warl.* (*alp.*)	1	..	..	..	1	N	1	1									
capillaris, *L.*	1	..	..	1	1	A	1	1	..	1	..	..	1				
hordeistichos, *Vill.*	1	..	..	..	..	A	..	..	..	..	..	..	A				
salina, *Wahl.*	1	..	1	..	1	N	..	1	1	1							
subspathacea, *Wim.*																	
reducta, *Drej.*																	
cryptocarpa, *C. A. M.*																	
halophila, *Nyl.*																	
spiculosa, *Fr.*																	
maritima, *Müll.*	1	..	..	..	..	N	..	..	..	1							
vulgaris, *Fr.*	1	..	..	..	S	N	..	1	..	1	..	..	1	..	..	..	1
elytroides, *Fr.*																	
cæspitosa, *L.*	1	..	1	1	..	N	1	1	1	1	..	..	A	..	1		
acuta, *L.*	1	1	..	..	..	A	1	1	1	1	..	..	1	..	1		
stricta, *Good.*	..	..	1	..	..	A	..	..	1	1	..	..	A				
rigida, *Good* (*alp.*)	1	1	..	1	1	A	..	..	..	W							
hyperborea, *Drej.*																	
borealis, *Lang.*																	
epigejos, *Fr.*																	
discolor, *Nyl.*																	
? rufina, *Drej.*																	
aquatilis, *Wahl.*	1	..	1	M	1	N	..	1	1	1							
stans, *Drej.*																	
limula, *Fr.*																	
concolor, *Br.*																	

MONOCOTYLEDONES.	I. Arctic.					II. N. Europ. and Asiatic.			III. American.				IV.		V.		
Cyperaceæ (*continued*).	Europe.	Asia.	W. America.	E. America.	Greenland.	Europe to Alps, &c.	Asia to Altai, &c.	N. E. Asia and Japan.	N. W. America.	N. E. America.	Tropical America.	Extra-tropical S. America.	S. Europ., N. Afric., Asia Minor.	S. Africa.	Persia, Tibet, Himalaya, &c.	Tropical Asia.	Australia and New Zealand.
Carex ericetorum, *Poll.*	1	..	..	..	..	A	1	..	..	..	..	..	1				
pilulifera, *L.*	..	..	..	1	S	A	..	1	..	1	..	..	1	..	1		
Novæ-Angliæ, *Schw.*																	
filiformis, *L.*	1	..	..	..	..	A	1	1	..	1							
ornithopoda, *Willd.*	1	..	..	..	..	A	..	..	..	..	..	..	1				
concinna, *Br.*	..	1	1	..	..	..	..	1	1	R							
melanocarpa, *Cham.*																	
globularis, *L.*	1	..	..	..	..	N	1	1									
vesicaria, *L.*	1	1	1	1	1	A	1	1	1	1	..	..	A	..	H		
compacta, *Br.*																	
membranacea, *Hook.*																	
saxatilis, *L.*																	
pulla, *Good.*																	
ampullacea, *Good.*	1	..	1	1	1	A	1	1	..	1	..	..	1	..	H		
rotundata, *Wahl.*																	
oligosperma, *Mich.*	..	..	..	1	..	..	..	..	..	1							
Kobresia scirpina, *Willd.* (*alp.*)	1	..	1	1	1	A	1	1	1	1	..	..	1				
Elyna spicata, *Schrad.*																	
caricina, *Willd.* (*alp.*)	1	..	..	1	1	A	..	..	R								
Elæocharis palustris, *Br.*	1	..	..	1	S	A	1	1	1	1	1	1	A	1	H	..	
acicularis, *L.*	1	..	..	..	..	A	1	1	1	1	M	..	1	..	H	..	1
uniglumis, *Schl.*	1	..	..	..	..	A	..	..	..	..	..	..	1	..	H		
Scirpus pauciflorus, *Light.*	1	..	..	..	..	A	1	..	R	..	..	1	1	..	1		
triqueter, *L.*	..	..	..	1	..	A	..	..	1	1	1	1	1	..	..	..	1
Olneyi, *Gray.*																	
lacustris, *L.*	1	..	..	..	..	A	1	1	1	1	1	1	A	1	H	1	1
cæspitosus, *L.*	1	..	1	1	1	A	1	1	1	1	..	..	1				
Eriophorum capitatum, *Host* (*alp.*)	1S	1	1	M	1	A	1	1	1	1	..	..	1	..	H		
Chamissonis, *C. A. M.*																	
Scheuchzeri, *Hpe.*																	
russeolum, *Fr.*																	
alpinum, *L.*	1	..	..	..	..	A	1	..	..	1	..	.	1				
vaginatum, *L.*	1	1	1	1	1	A	1	1	1	1	..	..	1	..	1		
polystachyum, *L.*	1	1	1	M	1	A	1	1	1	1	..	..	1	..	1		
latifolium, *Hoppe.*																	
gracile, *Koch.*																	
angustifolium, *Rth.*																	
Rhynchospora alba, *L.*	1	..	..	..	..	A	1	1	1	1	..	..	1				
Blysmus rufus, *Huds.*	1	..	..	..	..	N	1	..	..	..	..	..	..	..	H		
LXX. Gramineæ.																	
Alopecurus alpinus, *L.* (*alp.*)	1S	1	1	M	1	N	1	1	1	C	..	1	..	..	1		
ovatus, *Horn.*																	
antarcticus, *Vahl.*																	
pratensis, *L.*	1	..	..	..	..	A	1	1	1	C	..	..	A	..	H		
ruthenicus, *Weinm.*																	
nigricans, *Horn.*																	
geniculatus, *L.*	1	..	..	1	1	A	1	1	1	1	..	..	A	..	H	..	1
aristulatus, *Mich.*																	
fulvus, *Sm.*																	
Phleum alpinum, *L.* (*alp.*)	1	1	..	..	1	A	1	1	1	WL	1	1	1	..	H		
pratense, *L.*	1	..	..	..	..	A	1	1	1	×	..	..	A	..	1		
Beckmannia eruciformis, *Host*	..	..	1	..	..	..	1	1	1	C	..	..	1	..	1		
Phalaris arundinacea, *L.*	1	..	..	1	..	A	1	1	1	1	..	1	A	1	1		
Milium effusum, *L.*	1	..	..	..	..	A	1	1	..	1	..	..	1	..	H		
Agrostis Spica-venti, *L.*	1	..	..	..	..	A	1	1	..	..	..	..	A				
rubra, *L.* (*alp.*)	1	..	..	..	1	A	1	..	1	1	..	..	1				
alpina, *Wahl.* (*non Scop.*).																	

	I. Arctic.					II. N. Europ. and Asiatic.			III. American.				IV.		V.		
MONOCOTYLEDONES. Gramineæ (*continued*).	Europe.	Asia.	W. America.	E. America.	Greenland.	Europe to Alps, &c.	Asia to Altai, &c.	N. E. Asia and Japan.	N. W. America.	N. E. America.	Tropical America.	Extra-tropical S. America.	S. Europ., N. Afric., Asia Minor.	S. Africa.	Persia, Tibet, Himalaya, &c.	Tropical Asia.	Australia and New Zealand.
AGROSTIS vulgaris, *L.*	1	..	..	..	S	A	1	1	1	1	..	1	A	..	H	..	1
alba, *L.*																	
polymorpha, *Huds.*																	
canina, *L.*	1	..	..	..	1	A	..	1	1	C	..	1	A	..	H	..	1
laxifolia, *Rich.*	..	..	..	1	..	..	..	1	1	C	M						
DEYEUXIA Canadensis, *P.B.*	..	..	1	1	..	..	..	..	1	1	M						
deschampsioides, *Tr.*	1	..	..	..	..	..	1	1	1								
Lapponica, *Vahl*	1S	1	1	1	1	N	1	1	1	1							
neglecta, *Rupr.*																	
stricta, *P.B.*																	
chalybæa, *Fr.*																	
varia, *P.B.*	..	..	1	1	1	A	1	1	R	C	..	..	1				
purpurascens, *Br.*																	
Grœnlandica, *E.M.*																	
montana, *Host.*																	
Hartmanniana, *Fr.*																	
strigosa, *Wahl.*	1	..	1	..	1	N	..	1	1								
aleutica, *Bong.*																	
Nutkaensis, *Tr.*																	
Langsdorffii, *Tr.*	1	..	1	..	..	N	1	1	1								
purpurea, *Kth.*																	
elata, *Blytt.*																	
CALAMAGROSTIS epigejos, *L.*	1	..	..	..	..	A	1	1	..	..	..	1	1	1	H		
littorea, *Schrad.*																	
lanceolata, *Roth*	1	..	..	..	1	A	1	1	..	L	..	..	1				
Halleriana, *Gaud.*																	
phragmitoides, *Hartm.*																	
PHRAGMITES communis, *L.*	1	..	..	..	..	A	1	1	1	1	1	1	A	1	H	1	1
SPARTINA cynosuroides, *W.*	..	..	..	1	..	A	..	..	1	1							
AVENA pubescens, *L.*	1	..	..	..	..	A	1	1	..	..	..	..	1				
ANTHOXANTHUM odoratum, *L.*	1	..	..	..	S	A	1	..	..	×	..	..	A	×	..	..	×
HIEROCHLOE borealis, *L.*	1	..	1	..	..	A	1	1	1	1	..	..	..	..	1		
alpina, *L.*	1	..	1	M	1	N	1	1	1	W	..	..	..	..	..	..	1
pauciflora, *Br.*	1S	1	1	M	..	..	..	1									
racemosa, *Tr.*																	
DESCHAMPSIA cæspitosa, *P. B.*	1	1	1	M	E	A	1	1	1	1	..	1	1	..	H	..	1
brevifolia, *Br.*																	
Aira arctica, *Tr.*																	
atropurpurea, *Wahl.*	1	..	1	1	S	N	..	..	1	W							
alpina, *L.* (*alp.*)	1S	..	..	..	1	N	..	..	1								
flexuosa, *L.*	1	..	..	..	S	A	1	1	1	1	..	1	1	..	1		
TRISETUM subspicatum, *P.B.* (*alp.*)	1S	..	1	M	1	A	1	1	1	1	1	1	1	..	H	..	1
agrostoideum, *Tr.*																	
flavescens, *L.*	1	..	..	..	..	A	1	1	..	..	..	..	A	..	H	..	1
Aira Ruprechtii, *Griseb.*																	
Sibiricum, *Rupr.*																	
MELICA nutans, *L.*	1	..	..	..	..	A	1	1	..	..	..	..	1				
MOLINIA cærulea, *P. B.*	1	..	..	..	..	A	1	..	..	..	..	..	A	..	1		
PHIPPSIA algida, *Br.*	1S	1	1	M	1	N	..	..	1								
monandra, *H. & A.*																	
CATABROSA aquatica, *P. B.*	1	..	1	1	S	A	1	1	1	1	..	..	A	..	H		
COLPODIUM latifolium, *Br.*	1	1	1	M	1	N	1	1	1	L							
? pauciflorum, *Hk.*																	
arundinaceum, *Hook.*																	
pendulinum, *Læstd.*	1	..	..	..	S	N	..	1	..	1							
Poa deflexa, *Rupr.*																	
remotiflora, *Rupr.*																	
similis, *Rupr.*																	

	I. Arctic.					II. N. Europ. and Asiatic.			III. American.				IV.		V.		
MONOCOTYLEDONES. Gramineæ (*continued*).	Europe.	Asia.	W. America.	E. America.	Greenland.	Europe to Alps, &c.	Asia to Altai, &c.	N. E. Asia and Japan.	N. W. America.	N. E. America.	Tropical America.	Extra-tropical S. America.	S. Europ., N. Afric., Asia Minor.	S. Africa.	Persia, Tibet, Himalaya, &c.	Tropical Asia.	Australia and New Zealand.
COLPODIUM fulvum, *Tr.*	1	1	1	..	..	N	..	1	1								
Poa scleroclada, *Rupr.*																	
latiflora, *Rupr.*																	
pœcilantha, *Rupr.*																	
DUPONTIA Fisheri, *Br.*	1S	..	1	M	1	..	..	1	1								
psilosantha, *Tr.*																	
Poa pelligera, *Rupr.*																	
GLYCERIA fluitans, *Br.*	..	..	1	1	1	A	1	1	1	1	..	1	A	..	H	..	1
arctica, *Hk.*																	
PLEUROPOGON Sabini, *Br.*	..	..	..	M													
ATROPIS distans, *Griseb.*	1	..	..	..	..	A	1	1	1	1	..	..	A	1	H		
Poa airoides, *Nutt.*																	
maritima, *L.*	1	1	1	1	1	A	1	1	1	1	..	1	A				
Poa angustata, *Br.*																	
Nutkaensis, *Presl.*																	
POA annua, *L.*	1	..	..	..	S	A	1	1	1	1	..	1	A	..	H	..	×
alpina, *L.* (*alp.*)	1S	..	1	1	1	A	1	1	1	C	..	..	1	..	H		
pratensis, *L.*	1S	1	1	1	1	A	1	1	1	1	..	1	A	..	H		
angustifolia, *L.*																	
trivialis, *L.*																	
nemoralis, *L.*	1	1	1	M	1	A	1	1	1	1	..	1	1	..	H		
cæsia, *Sm.*																	
aspera, *Gaud.*																	
Vahliana, *Liebm.*																	
serotina, *Ehr.*																	
bryophila, *Tr.*																	
flexuosa, *Wahl.* (*alp.*)	1S	1	1	M	1	A	1	1	1	W	..	..	1	..	H		
laxa, *Hœnke.*																	
Cenisea, *All.*																	
arctica, *Br.*																	
abbreviata, *Br.*																	
DACTYLIS glomerata, *L.*	1	..	..	..	..	A	..	..	..	×	..	..	A	..	H	..	×
FESTUCA elatior, *L.*	1	..	..	..	..	A	1	1	1	C	..	1	1	..	H		
Richardsoni, *Hk.*	..	..	1	1													
ovina, *L.*	IS	1	1	M	1	A	1	1	1	1	1	1	A	..	H	..	1
rubra, *L.*																	
duriuscula, *L.*																	
sabulicola, *L. Dub.*																	
arenaria, *Osb.*																	
Kœleria hirsuta, *Gaud.*																	
brevifolia, *Br.*																	
BROMUS ciliatus, *L.*	1	..	1	1	S	A	1	1	1	1	..	1	1	..	H		
inermis, *Leyss.*																	
purgans, *L.*																	
pictus, *H.f.*																	
TRITICUM repens, *L.*	1	..	1	1	1	A	1	1	1	1	M	1	A	..	H		
violaceum, *Horn.*																	
caninum, *L.*	1	..	..	..	..	A	1	1	1	1	..	1	1	..	H		
ELYMUS arenarius, *L.*	1	..	1	1	1	A	1	1	1	1	..	..	1				
mollis, *Trin.*	..	1	1	1	..	..	1	1	1	1	1						
HORDEUM jubatum, *L.*	..	..	1	1	..	A	..	1	1	1	..	1					
NARDUS stricta, *L.*	1	..	..	..	S	A	1	..	..	..	..	..	1				

ACOTYLEDONES.	I. Arctic.					II. N. Europ. and Asiatic.			III. American.				IV.		V.		
	Europe.	Asia.	W. America.	E. America.	Greenland.	Europe to Alps, &c.	Asia to Altai, &c.	N. E. Asia and Japan.	N. W. America.	N. E. America.	Tropical America.	Extra-tropical S. America.	S. Europ., N. Afric., Asia Minor.	S. Africa.	Persia, Tibet, Himalaya, &c.	Tropical Asia.	Australia and New Zealand.
LXXI. Filices.																	
Polypodium Dryopteris, *L.*	1	..	..	1	S	A	1	1	1	1	..	..	1	..	1		
Rhæticum, *L.*	1	..	..	..	S	A											
Phegopteris, *L.*	1	..	..	..	S	A	1	1	1	1	..	..	1				
vulgare, *L.*	1	..	..	..	..	A	1	1	1	1	..	..	1	..	1		
Woodsia Ilvensis, *Br.* (*alp.*)	1	1	1	1	1	A	1	1	..	1							
hyperborea, *Br.* (*alp.*)	1	..	..	..	1	A	1	..	..	C							
glabella, *Br.* (*alp.*)	..	..	..	1	..	..	1	1	..	1							
Cistopteris fragilis, *Bernh.*	1	..	1	1	1	A	1	1	..	C	..	1	A	1	1	..	1
montana, *Hænk.* (*alp.*)	1	..	..	..	..	A	..	..	..	R							
Lastrea fragrans, *Sw.*	..	1	1	1	1	..	1	1	..	1							
spinulosa, *Willd.*	1	..	1	..	..	A	1	1	1	1	..	..	1				
Filix-mas, *Sw.*	1	..	..	..	S	A	1	1	..	...	..	..	A	..	1		
Oreopteris, *Ehr.*	1	..	..	..	..	A	..	..	..	..	..	..	1	..	H		
Polystichum angulare, *Willd.*	1	..	..	..	..	A	..	..	..	..	..	..	1	..	H		
Lonchitis, *L.* (*alp.*)	1	..	..	1	1	A	1	1	..	1	..	..	1				
Pteris atropurpurea, *L.*	..	..	..	..	..	..	..	..	..	1							
aquilina, *L.*	1	..	..	..	..	A	..	1	1	1	..	..	A	1	H	1	1
Cryptogramma acrostichoides, *R.* (*alp.*)	..	..	..	1	..	..	..	..	1	C							
crispa, *Bernh.*	1	..	..	..	..	A	..	..	1	..	..	..	1				
Struthiopteris Germanica, *L.*	1	..	..	..	..	A	1	1	..	1							
Blechnum Spicant, *L.*	1	..	..	..	..	A	..	..	1	..	..	..	1				
Asplenium Filix-fœmina, *L.*	1	..	..	..	..	A	1	1	1	1	..	..	A	..	1		
Ruta-muraria, *L.*	1	..	.	..	..	..	..	..	..	1	..	..	1	..	1		
viride, *L.* (*alp.*)	1	..	..	..	A	A	..	..	..	R	..	..	1				
crenulatum, *Fr.*	1	..	..	..	..	N	1	1									
Aspidium crenatum, *Somf.*																	
Botrychium Lunaria, *L.*	1	..	..	..	1	A	1	1	..	1	..	1	1	..	H	..	1
Virginianum, *Sw.*	1	..	..	..	S	N	1	..	1	1	..	..	..	..	H	1	1
Ophioglossum vulgatum, *L.*	1	..	..	..	..	A	..	..	..	1	..	1	1	1	H	1	1
LXXII. Lycopodiaceæ.																	
Lycopodium Selago, *L.*	1S	1	1	1	1	A	1	1	1	1	..	..	1	..	1	1	1
annotinum, *L.*	1	..	1	..	1	A	1	1	1	1	..	..	1	..	1		
clavatum, *L.*	1	..	..	..	S	A	1	1	1	1	..	..	1	1	H	1	1
complanatum, *L.*	1	1	..	..	..	A	1	1	1	1	..	..	1				
selaginoides, *L.*	1	..	..	..	S	A	1	1	..	1	..	..	..	..	H		
alpinum, *L.*	1	..	..	..	S	A	1	..	..	R	..	..	1	..	H	1	
Isoetes lacustris, *L.*	1	..	..	..	S	A	..	..	..	1							
LXXIII. Equisetaceæ.																	
Equisetum palustre, *L.*	1	..	1	1	..	A	1	..	..	..	..	..	1	..	1		
variegatum, *L.*	1	..	?	?	1	A	1	1	..	1	..	..	A				
arvense, *L.*	1S	1	1	1	1	A	1	1	1	1	..	..	1				
sylvaticum, *L.*	1	..	1	..	1	A	1	1	..	1	..	..	1				
pratense, *Ehr.*	1	..	..	..	..	A	..	1	..	1	..	..	1				
limosum, *L.*	1	..	..	..	..	A	1	1	..	1	..	..	1				
hiemale, *L.*	1	..	..	..	..	A	1	1	1	1	..	..	A				
scirpoides, *Mich.*	1	1	1	1	1	N	1	1	1	1	..	..					

ADDENDUM.

Astragalus *polaris*, Bth., Arctic West America. See "*Observations on the Species*," at p. 323.

Observations on the Species.

In the preceding table I have attempted to group the arctic plants under comprehensive forms, founded on a careful study of the plants indicated by the names quoted: this I first did with as little reference as possible to the labours of others,—endeavouring, as far as was in my power, to suppress my preconceived ideas, whether original or adopted. Having thus arrived at the nearest possible approach to independent conclusions, when I compared my work with the descriptive Floras which I have elsewhere indicated as forming the basis of the Systematic Catalogue, I was surprised to find how many authors have directly or indirectly arrived at the same conclusions as myself with regard to the specific limits of the plants indicated. In some instances such revision corrected my previous views; but in by far the most numerous cases the summing up of this authoritative evidence afforded extraneous reasons for abiding by my own conclusions. The following notes are intended both to give these extraneous reasons, and to show to how much greater an extent than is generally supposed, the most able and experienced descriptive botanists vary in their estimate of the value of the "specific term" as applied to many of the commonest plants of the best-known countries. From the results of this and other most perplexing and laborious comparisons of the labours and opinions of the authors of many local and general Floras, I think I may safely affirm that the *specific term* has three different standard values, all current in descriptive botany, but each more or less confined to one class of observers, though more or less variable with all. With the general botanist it is a comprehensive term, and becomes more so with age and experience; with the monographer of large and widely diffused natural orders or genera its standard is contracted at first, but rapidly expands in successive revisions of his work; while the local botanist, or monographer of genera or orders with restricted ranges, begins with a rather broad standard, which rapidly contracts. This is no question of what is right or wrong as to the real value of the specific term. I believe each is right according to the standard he assumes as the specific; moreover, in the majority of cases all agree with regard to the absolute and undeniable distinctness of a moiety of the plants of every area *; all agree with regard to the permanent distinctiveness of many of the subspecies, varieties, &c. of the other or variable moiety; and all agree with regard to the propriety and importance of tracing the characters and ranges of varieties as carefully as of species. Still the questions remain—Should the specific term ever be arbitrary? and if so, should it be broad or narrow? I believe it must often be arbitrarily defined, and that it should be broad, because the object of botanical nomenclature is defeated by an undue multiplication of names necessary to be borne in mind by the general botanist, whose convenience ought first to be considered, and also because the multiplication of specific names will demand a corresponding increase of generic ones; moreover the daily discovery of intermediate forms, or new or closely allied forms, is introducing an incessant change in the nomenclature of narrowly defined species.

* See Introd. Essay to Tasmanian Flora, p. v, for some ideas as to the objective and subjective values of the characters of species, and the division thereby of all species into groups.

THALICTRUM. For observations on the Arctic Scandinavian forms of this genus, see Fries, Summa Veg. Scand. p. 135.

T. Kemense, Fr. When engaged on the 'Flora Indica,' Dr. Thomson and I made a very laborious investigation of this genus, referring the *T. Kemense* of Fries's 'Herb. Normale' to *T. majus*, Jacq., and further identifying it with the Himalayan *T. Maxwellii*, Royle, which also occasionally possesses stipellæ. Wahlenberg referred *T. Kemense* to *T. flavum*, β (fid. Ledebour and Ruprecht); and I have received from Dr. Andersson a specimen of *T. Kemense* that seems different from Fries's and to be identical with *T. simplex*, L., having the inflorescence of that plant, which is itself a form of *T. flavum*. Of Fries's *T. Kemense* I have fine specimens also from Alten, gathered by the late W. Christy, Esq., having rather larger leaves than those of the 'Herb. Normale.' Harvey ('Flora Capensis') has referred the only South-African *Thalictrum* to *T. minus* (*Caffrum*, E. & Z., and *gracile*, E. Meyer).

T. rariflorum, Fr. (*minus*, Fries, Herb. Norm.), appears to me almost identical in inflorescence with the *T. strictum*, Led. (*T. exaltatum*, C. A. M.), which, again, resembles few-flowered specimens of *T. flavum*, L. The 'Herb. Normale' specimen of *T. flavum*, marked "certiss." is undistinguishable from a Siberian one of Ledebour's marked "*exaltatum*, C. A. M." According to Nyman, the *T. rariflorum*, Fr., is the same as *T. Friesii*, Rupr., and *T. strictum-boreale* of Nylander. Fries does not regard the true *T. minus* of Linnæus as Lapponian.

ANEMONE *Nuttalliana*, DC. This is certainly identical with *A. patens*, L., and was so considered in Flor. Bor.-Am., in Torrey and Gray's Flora, and in the first edition of A. Gray's Manual. In the second edition of this last work, however, A. Gray keeps it distinct, saying that it more resembles *A. pulsatilla* than *patens*: this must arise from misconception, as *pulsatilla* has pinnatisect foliage, and there is no difference whatever discernible between *Nuttalliana* and *patens*, of both which I have compared large suites of specimens in all states.

A. Vahlii, Horn. (Flor. Dan. t. 2176), a Greenland plant, is referred by Lange to *A. Richardsoni*.

A. alpina, L. I have seen but one Arctic American specimen; it is much stunted. This species has not been found east of the Caucasus in the Old World, though it is not uncommon in North America on both sides of the Rocky Mountains.

RANUNCULUS *confervoides*, Fr. This slender form of the protean *R. aquatilis* is the only one found within the arctic circle; it is the *R. aquatilis* β. *pantothrix* of Ledebour, and, I think, also the *R. aquatilis* β. *heterophyllus*, Fr., of Babington's 'Iceland Plants.' My Greenland, Iceland, and Lapponian specimens seem to accord well; but Durand ('Kane's Voyage,' Appendix) calls the Greenland plant "var. *arcticus*," and states that it is the "*hederaceo-proximus*" of Gieseke, having a great affinity with *hederaceus*, Lam., non Linn.

R. Chamissonis, Schl., according to authentic specimens, appears to be the same with *R. glacialis*, L. The distribution of *glacialis* is peculiar, it having been found in East Greenland by the earliest and by all subsequent voyagers, but never on the Baffin's

Bay side (where it occurs in very high latitudes only) till Kane's Expedition, when it was brought from North Proven, lat. 72° N.

R. Flammula, L., and *reptans*, L., are both arctic plants, the latter the more so. Fries keeps these distinct, as do Torrey and Gray and others, and Koch, in his Addenda et Emendanda, because of the short-beaked achenium of *reptans*: in the body of his 'Flora' he made it var. β of *Flammula*, as do Bentham and various other authors. I find the beak of the fruit of *Flammula* to be very variable and often quite undistinguishable from that of *reptans*. There is a United States plant very like *Flammula*, but with a much more slender beak than the European plant, which is called *R. Flammula* by American authors.

R. affinis, Br. Ledebour unites this with his *R. amœnus*. I have no hesitation in referring both to *auricomus*, L.

R. frigidus, DC., and *R. Eschscholtzii*, Schl., seem to me inseparable from *nivalis*. *R. sulfureus*, Sol., is more distinct, and kept separate by Fries, but is referred to *nivalis* β by Ledebour: it is one of the most arctic plants known, and certainly passes into *nivalis*.

R. polyanthemos, L. It is so difficult to distinguish herbarium specimens of this from *R. acris*, L., that I am not sure I have got its full distribution, for which I have relied on authentic book sources. *R. nemorosus* is usually combined with it.

R. glabriusculus, Rupr. Fl. Sam., is an imperfectly described plant, referred doubtfully to *R. acris*. No allusion is made in the author's description to the peduncle, which is figured like that of *acris*; but the receptacle is described as glabrous. It was, further, found with *acris* at the Gulf of Indega, east of the mouth of the White Sea. The *acris* β. *humilis*, Wahl., is also, according to Ruprecht, common on the Samoied shores of the same sea, and in the arctic Island of Kolgujew.

R. pygmæus, Wahl. A high-arctic species, best known from *hyperboreus*, with which it is united in 'Flora Indica,' by wanting the creeping flagelliform stems. The Tyrol is the only European habitat south of Scandinavia. The *R. Sabinii*, which I have placed with it, is so named authentically, but does not differ from *pygmæus*; it is, however, one of those extremely reduced forms whose origin can only be ascertained by examining an extensive suite of specimens. Of the *R. Samojedarum*, Rupr., I have seen no specimen; it is an imperfectly described plant, found in the Island of Kolgujew at the mouth of the White Sea, and described as being very nearly related to *R. Purshii*.

R. hyperboreus, Rottb. Of this, which is a Greenland, European, and Siberian plant, I have seen no Arctic American specimen; all so called hitherto are, I think, referable to *pygmæus*. The *R. Gmelini*, referred to *hyperboreus* in Flor. Bor.-Am., is reduced to *Purshii* by Ledebour.

Caltha *palustris*, L. The prevalent opinion amongst botanists is to unite as varieties all the names I have placed under this. The true *palustris* itself inhabits the extreme north (Island of Kolgujew, Rupr.). *C. natans*, L., is a floating plant affecting high latitudes only. *C. radicans* and *C. arctica* are probably synonyms, the yellow colour of the persistent sepals being discharged after flowering. Watson regards *C. radicans* as certainly a reduced form; Nyman makes it distinct, giving Scotland as its habitat, but says of *C. palustris*, "species ut videtur collectiva"; Fries makes it a variety found in Lapland; Bentham would unite them all. The absence of any form in Greenland is a most remarkable fact, the common one being most abundant and conspicuous in Iceland.

Delphinium *Middendorffii.* Trautvetter, the author of this species, indicates its affinity with *Menziesii*, but does not appear to have compared it with that plant, which, judging from the figure of Trautvetter, may not be distinguished. Whether *D. Menziesii* itself may not be the same with some better-known species, is a question for future determination.

D. intermedium, Ait., is *elatum* β, Turc. (Fl. Baik. Dahur.).

Aquilegia *Canadensis*, L. The very close affinity and probable identity of *A. Canadensis*, L., and *A. formosa*, Fisch., is indicated in the 'Flora Indica;' and on re-examination, with more specimens of the former to compare, I find no reason for modifying that conclusion.

A. brevistylis, Hook. Originally doubtfully referred by Richardson to *A. vulgaris*, L.; the styles, however, which are somewhat variable in the European plant, are always much shorter in the American. It is a very northern species in America, and not hitherto known west of the Rocky Mountains, though I have seen specimens of a Sitka plant, in an indifferent state, which is a great deal like it. It is also allied to the Siberian *A. parviflora*, Led.

Actæa *spicata*, L. The *A. rubra*, Willd., is referred to *nigra* by Fries, both being Lapponian. Asa Gray (in litt.) combines with them *A. alba*, Big., and *arguta*, Nutt.

Papaver *nudicaule* is now almost universally regarded as specifically the same with *alpinum*, L.

Fumaria *officinalis*, L., occurs sporadically throughout Nordland, according to Fries and Andersson, but can hardly, I think, be considered an indigenous plant.

Nuphar *lutea*, L. This, together with the species enumerated under it, and *N. advena*, Ait., are, perhaps, rather forms of one collective or aggregate species than permanent undistinguishable plants; and it is further possible that the *N. sagittæfolia*, Pursh, may be another state, in which the early sagittate form of leaf is retained in the adult plant. Torrey and Gray refer *Kalmiana* to *lutea* β, and say of *advena* that it is not specifically distinct. Asa Gray latterly keeps up *advena* and *Kalmiana*, but adds to the latter *N. intermedia*, Led.? Nyman and Ledebour keep all distinct. Watson, from his notes under *pumila*, seems to regard it with doubt. Fries keeps *lutea* and *pumila* distinct, but regards *intermedia*, Led., as a variety of *lutea*, and adds as a Lapland variety to *pumila* the *Spenneriana*, Gaud. Lastly, Koch keeps *lutea*, *pumila*, and *Spenneriana*, all distinct; and Bentham unites the two first together with *intermedia* and *minima* of Engl. Bot.

Barbarea *vulgaris*, Br. This, again, is either a collective species or several species variously discriminated. Fries distinguishes *stricta*, Fr., *vulgaris*, Br. (including under it as a variety *arcuata*, Reich.), and *præcox*, Sm. Nyman excludes *præcox*, Br., from Scandinavia, and reduces *præcox*, Sm., to *arcuata*. Watson finds himself compelled to treat the distribution of *vulgaris*, Br., *stricta*, Andrz., and *arcuata* Reich., in connexion. A. Gray considers the American *stricta* and *arcuata* as varieties of *vulgaris*. Bentham says that *B. vulgaris*, *præcox*, and *stricta* pass through every gradation into one another. Another element of confusion in this group is the doubtful origin of the common pot-herb *B. præcox*. Watson treats it as an alien. Torrey and Gray, on the other hand, describe it as a native of Canada, ascending to 68° N., though perhaps *stricta* is here meant, for A. Gray latterly refers *præcox* of Fl. Bor.-Am. to *vulgaris*, var. *stricta*, and rightly as far as the specimens I have examined go to show. Fries remarks (Summa, p. 146) that Smith's original *præcox* (Flora Britannica) is a cultivated *arcuata*, the English Botany plant being different (thus accounting for Nyman's conclusions above stated). My North Indian and Himalayan Barbareas are, again, generally referable to the European forms, though scarcely characteristic of them. I long endeavoured to keep the Australian and New Zealand form distinct; but neither Bentham nor Mueller regard it as different from *vulgaris*, with which undoubted wild specimens from the Australian Alps well accord.

TURRITIS *patula*, Graham, and *retrofracta*, Hook., are, I think, identical with *T. mollis*, Hook. The *Arabis Holböllii*, Horn., is another synonym. There are certainly differences in the length and breadth of the pod in both *patula* and *retrofracta*; but these do not at all indicate the seeds being in one or two rows, which is a very variable character in both. *Arabis Holböllii* is identified with *A. retrofracta*, Grah., by Lange.

ARABIS *lyrata*, DC. This, which is the *Sisymbrium humifusum*, J. Vahl, and *Arabis sisymbrioides*, Hook., differs according to descriptions from *A. petræa*, Lamk., in the rather oblique radicle of the embryo, and biennial root (Torrey and Gray, i. 80, 81), neither of which characters appear to me to hold good in the rather numerous specimens I have examined, the radicle being in both variable as to direction, and the roots identical. In habit and every other respect, the plants entirely accord, as far as herbarium specimens allow me to judge. According to Fries, *A. petræa* is not a native of Lapland; nor does Ledebour give any European or Asiatic arctic habitat for it; it is, however, common in Finland, Scandinavia, Iceland, and N. Britain. Fries includes *A. ambigua*, DC., under it, a plant kept distinct by Ledebour and by Torrey and Gray.

CARDAMINE *bellidifolia*, L. I have sometimes been almost disposed to suspect that this may be an arctic form of *hirsuta*, to which it certainly is very closely allied, and to which it tends through *microphylla*, Willd. *C. Lenensis* is identical with *bellidifolia*, and is var. *Lenensis*, Trautv. (Florula Taimyr.).

C. hirsuta, L. This, though a common Icelandic plant, and one that crosses the circle in America, does not occur in Scandinavia north of Gothland and Finland. The *C. sylvatica*, Link, is distinguished by its six stamens, spreading pedicels, and style as long as the siliqua is broad,—all variable characters, except that of the stamens. In the southern hemisphere and elsewhere *C. hirsuta* is hexandrous. Watson finds no difficulty in distinguishing these as wild plants in England, but considers *sylvatica* a doubtful species, adding that the distinctions are less decided under cultivation. Bentham considers *sylvatica* to be a large luxuriant hexandrous form of *hirsuta*.

C. digitata, Rich. I have examined a large suite of excellent flowering specimens of this plant, in which state it differs in no respect from *pratensis*. I have not seen the fruit, however.

C. umbrosa, DC., is referred by Fries to a variety of *amara*, L.; both are Lapponian.

Eutrema *arenicola*, Hook. I have examined this plant very carefully; it is certainly not a *Eutrema*. In the few specimens known to me the radicle is slightly oblique. Turczaninoff (in Herb. Hook.) suspects that it may be his *E. piliferum* (*Draba grandiflora*, C. A. M.; *Pachyneurum grandiflorum*, Bunge; *Braya Meyeri*, Bge.; *Parrya microcarpa*, Led.); but I find no traces of the peculiar hairs of this plant in the *P. arenicola*. Richardson observes that it ranges from 107°–150° W. I have seen no specimens but his own.

Vesicaria *arctica*, Rich. Planchon, who has examined the specimens in the Hookerian Herbarium with a great deal of care, confirms the identification of the Chilian plant with the arctic. It is singular that this plant should be found as far north as 81° in Greenland, but not amongst the Polar American Islands.

Draba. Of all the arctic genera, none but *Salix* present so many difficulties as *Draba*. Whether by variation, or hybridization, or other unknown cause, the prevalent forms seem, wherever they grow, to pass into one another by insensible gradations; and no botanist has succeeded in bringing the arctic stunted varieties within such specific limits as to have gained the assent of others. No doubt many are, in their arrested condition of growth, absolutely undistinguishable in the present state of science; and whoever attempts their discrimination must expect to change his opinion somewhat at every re-examination. I am fortunate in having Mr. Ball's advice upon some of the European species, which he has studied with great care, and have followed his opinion in the naming and grouping the arctic ones; unfortunately, however, he has not completed his study of the genus, nor of all the species here enumerated; so that the geographical data are approximate only; nor does he speak with implicit confidence of their synonymy. In addition to the excellent critical notes he has published in the Bulletin of the Botanical Society of Paris (vol. vii. pp. 227 & 247), I have from him the following provisional grouping of the commoner forms:—

1. *D. androsacea*, Wahl., 1812, an Willd.?
   D. Wahlenbergii, Hartm. 1820. *D. Lapponica*, DC. Syst., an Willd.? *D. nivalis*, DC., non Lilj.

2. *D. Fladnitzensis*, Wulf., Jacq. Misc.
   D. lactea, Adams. ? *D. Carinthiaca*, Hoppe. *D. crassifolia*, Grah.

3. *D. muricella*, Wahl.
   D. nivalis, Lilj., non DC.

4. *D. rupestris*, Br.
   D. Altaica, Bge.

5. *D. hirta*, L.
   D. Dovrensis, Fr. *D. arctica*, Vahl.

6. *D. incana*, L.
   D. contorta, Ehr. *D. confusa*, Ehr. & DC. *D. Thomasii*, Koch.

Of these, Mr. Ball is disposed to unite 1 and 2, and also 4, 5, and 6, making but three species in the above group, but distinguishing six sufficiently well-marked forms.

D. muricella is in Europe confined to Scandinavia; neither *D. hirta* nor *rupestris* are found in the Alps.

Draba *alpina*, L. Regarding the numerous plants here brought together I have the following notes:—

D. algida, Ad., according to specimens from Ledebour and Bunge, differs in no respect from *D. alpina*.

D. pilosa, DC., is reduced to a synonym of *D. algida* by Ledebour. I have no authentic specimens of it.

D. aspera, Adams, is placed by Ledebour in the section *Aizoopsis*, the species of which are eminently southern and oriental; that author, however, had not seen the plant, and overlooks the fact of the distinguishing characters given by Adams being those of *D. alpina*.

D. Adamsii, Led. (*lasiocarpa*, Adams), is described as differing from *D. alpina* in the pubescent pods, stellate hairs of leaves and scape, and small flowers; but the pods of *alpina* are glabrous or pilose, and the other characters equally inconstant.

D. glacialis, Adams. Of this there are five varieties described in 'Flora Boreali-Americana.' It should be distinguished by the costa prominent in the under surface of the leaf; but amongst a vast suite of specimens thus named I find the prominence of the costa to depend on the development of the leaf, and no characters that would serve to include those so distinguished, even as a permanent variety of *alpina*, L. Durand (Kane's Voy.) keeps *glacialis* β distinct.

D. pauciflora, Br. This was proposed by Brown as a doubtful species from Melville Island; and I find, amongst starved specimens of *D. alpina* from that island, some that may be the plant that Brown alluded to.

D. micropetala, Hook. This appears to me, without doubt, to be a starved form of *alpina*. It occurs only in very high northern latitudes, amongst the polar islands. Durand (Kane's Voy.) makes of it *D. alpina*, var. *micropetala*.

D. trichella, Fr. Mr. Ball considers this to be probably a form of *alpina*.

Draba *androsacea*, Wahl. (*Lapponica*, DC. an Willd.?). This is a white-flowered species presenting as many puzzling forms as *D. alpina*, besides appearing to pass by insensible grades into *hirta*, *rupestris*, and *muricella*. Nor is it always possible to distinguish *androsacea* from *alpina* in a dried state, nor when the flowers of the former are bleached or vary to whitish, which they occasionally do both in the arctic circle and Himalaya. Of this plant *D. Wahlenbergii*, Hart., and *lactea*, Adams, are now generally acknowledged synonyms, as is *D. nivalis*, DC., non Lilj.

D. crassifolia, Grah., has been referred by Mr. Ball (in Herb. Hook.) to *lactea*, Ad. (*Fladnitzensis*, Wulf), and certainly rightly. The yellow-flowered plant figured in 'Flora Danica' is referable to *alpina*, L.

D. Martinsiana, J. Gay. Of this species I know nothing accurately.

D. oligosperma, Hook., is not different, I think, from the specimens marked *Fladnitzensis* from the Alps and Altai, and, further, is certainly a small form of *androsacea*, with pods short, elliptical, sharp at both ends, and few seeds. It is, on the other hand, very near *muricella* and *rupestris*, and to small forms of *hirta*. I have it both from the Rocky Mountains and Lapland.

D. corymbosa, Br. Durand doubtfully refers this to his var. *corymbosa* of *alpina* (= *alpina* δ, Hook.). The figure of the Greenland plant in 'Flora Danica' appears to belong to a common arctic form of *androsacea*.

Draba *muricella*, Wahl. This Mr. Ball distinguishes from *D. stellata*, Jacq., which is nowhere found in the arctic regions. *D. muricella*, Wahl., on the other hand, has not been found in Middle or Southern Europe. It is the *D. nivalis*, Lilj., non DC. Durand (Kane's Voyage) refers the *D. rupestris*, var. β, of Torrey and Gray to *nivalis*, Willd., apparently from description only.

Draba *stellata*, Jacq., non DC. Mr. Ball is my authority for including *D. Johannis*, Host.

Draba *hirta*, L. I have Mr. Ball's authority for including *Dovrensis*, Fr., and *arctica*, Vahl, under this plant. I have no confidence in its permanent distinction from *D. incana*. It is usually a much less leafy plant, with longer pedicels in comparison to the pods.

D. oblongata, Br., is apparently founded on a small specimen of *D. hirta*.

Draba *incana*, L. *D. contorta*, Ehr., and *confusa*, Ehr., are now generally considered to be forms of this; and I find them to be scarcely distinguishable as varieties.

D. Magellanica, Lamk. I have already ('Flor. Antarct.' ii. p. 233) referred this to *incana*; and a fresh series of specimens, received since that time, not only confirm this opinion, but incline me to regard *D. Falklandica*, mihi, as a mere stunted form.

D. borealis, DC. I have examined two specimens of this, communicated by Prof. Fischer; and it appears to be nothing but a rather luxuriantly leafy form of *D. incana*; the specimens have not ripe fruit, however.

Draba *rupestris*, Br. It is extremely difficult to distinguish this from small states of *lactea*, *hirta*, and *incana*, and in some cases from *D. muricella*. *D. Altaica*, Bunge, is clearly a synonym. Durand refers here the *D. hirta*, E. Bot., and *hirta*, var. 4, of Fl. Bor.-Am. Bentham refers the British *rupestris* to *hirta*.

Draba *aurea*, Vahl. This is a very puzzling plant, so like in its normal state to *D. incana*, that I do not see how these plants can be distinguished, except by the colour of the flower, which, again, apparently varies to white. I am not aware of any yellow-flowered *Draba* with the habit of *incana* being found, except in Labrador, Greenland, and the Rocky Mountains.

Cochlearia. This has always proved to me to be one of the most intractable boreal genera; and I do not believe that the common littoral forms are always defineable specifically. Habit, pods, and leaves afford the characters hitherto made use of; and all are equally fallacious, as far as affording permanent distinctions.

Ruprecht, speaking of the Samoied forms (Flor. Samojed. p. 21) says of *C. Wahlenbergii*, Rup. (*anglica*, Wahl., non L.), *C. oblongifolia*, DC., *C. arctica*, DC., *C. fenestrata*, Br., *C. Danica*, L., "Quod reliquum est, vereor, ne *Cochleariæ omnes* hic enumeratæ ad unam speciem pertineant valde variabilem; interim tamen formas distinguere necesse fuit."

In endeavouring to dispose of the arctic forms of this genus I have found myself obliged to return to the old species and definitions of Linnæus, who, as it appears to me, had a definite idea of the following four prevalent forms:—

C. officinalis, with cordate subrotund radical leaves, and oblong subsinuate cauline;

C. Danica, with hastate, angular, deltoid, petioled leaves;

C. Anglica, with all the leaves ovate lanceolate;

C. Grœnlandica, with reniform, fleshy, quite entire leaves (generally small).

Of these I find *Grœnlandica* so often passing directly into *officinalis*, both in America and Europe, that I have brought them together; the others are more distinguishable prevalent forms, though all pass into one another.

COCHLEARIA *sisymbrioides*, DC. This is much more distinct from any of the other arctic forms than the most distinct of these latter are from one another. I know of no other which at all approaches it, though the perfectly flat pod, so opposed to the prevalent generic character, may be found in states of *C. officinalis*.

COCHLEARIA *Danica*, L. This, in its typical form of a small slender spreading plant, with hastate, petioled, small leaves, is by far the most distinct of the group to which it belongs. It is found on all the northern coasts of Europe as far south as Brittany and Normandy, and suddenly reappears in its typical state in the Pyrenees. According to Fries it does not inhabit Lapland.

COCHLEARIA *Anglica*, L. Watson confesses his difficulty in always distinguishing this, which to him appears to pass on one hand into *Danica*, and on the other into *officinalis*. In Western Europe it is common as far south as the Channel, but does not extend beyond Boulogne (Gren. & Godr.). Durand appears to restrict this in Greenland to a form with elliptical pods and fenestrate septa.

C. oblongifolia, DC. Ruprecht, *l. c.*, observes that the form with elliptic silicles occurs almost everywhere on the Samoied beaches; that with globose pods only at Cape Konuschin.

C. fenestrata, Br. Nyman ('Sylloge') includes this under *Wahlenbergii*, Rupr. Durand (Kane's Voy.) distinguishes it by its smaller size. Fries makes it a var. of *Anglica*, L.

COCHLEARIA *officinalis*, L. Nyman ('Sylloge,' p. 198) refers *C. Grœnlandica*, L., and *Pyrenaica*, DC., to this. Watson ('Cybele') confines it to shore plants with globose silicles, doubtfully keeping distinct the mountain form *C. alpina*, Sweet?, *Grœnlandica*, With.?, Sm. It is a common mountain plant in Northern Europe, occurring as far south as the Pyrenees and Carpathians, but it does not extend far down the French coast. It includes Wahlenberg's *officinalis* (*Wahlenbergii*, Rupr.), also *arctica*, *Lenensis*, and *fenestrata*, Br., though the latter name has, I suspect, been rather indiscriminately applied to other *Cochleariæ* with ruptured septa. Durand defines the Greenland form by its globose silicles.

C. arctica, DC. Of this, Ruprecht remarks that the Samoied specimens have entire or fenestrate septa, but that it differs from *C. fenestrata*, Br., in larger size ($\frac{1}{2}$–1 foot) and distinctly-nerved siliquæ, from *C. Anglica* in the ellipsoid silicles (not subrotund), which are longer than their pedicel, not twice as short. Fries retains *arctica*, Schlecht., as a species not yet sufficiently established.

C. Wahlenbergii, Rupr. (*Anglica*, Wahl., Fl. Lap., non L.). Ruprecht remarks of the Samoied plant that the leaves are almost those of *C. Danica*, L., but the siliquæ elliptic, the valves sometimes nerved, and much narrower than in true *Anglica*.

HESPERIS *Pallasii*, Torr. & Gray. Durand (Kane's Voy.) includes *H. minima*, T. & G., as well as *pygmæa*, Hk. In Greenland it has been found only in the extreme north, by Kane's Expedition, on Washington Land, lat. 81° N.

SISYMBRIUM *sophioides*, Fisch. This is nothing but an abnormal form of *S. Sophia*, L., with a remarkably corymbose inflorescence. It has hitherto been found only in high northern regions.

S. brachycarpum, Rich. This, which passes by insensible transitions into *S. canescens*, Nutt., which inhabits the same regions to the south, often approaches finely-cut-leaved states of *S. Sophia*.

S. salsugineum, Pall. I have carefully compared with this the *Turritis diffusa*, Hook., and have no doubt of their absolute identity.

ERYSIMUM *hieraciifolium*, L. Ruprecht (Fl. Sam.) refers this to *E. strictum*, Fl. Wett., and notices *E. cheiranthoides*, L., as occurring very close upon the arctic circle, almost at the termination of the woody region. I am quite unable to discriminate between these northern *Erysima* and their southern congeners, nor do I find any satisfactory characters for them in books. Fries does not consider either the true *hieraciifolium*, L., or *cheiranthoides* to be Lapponian; but *E. alpinum*, Sm., is so, and is ranked by him as an insufficiently established species. Nylander ('Flora Helsingfors,' 31) mentions *E. alpinum* as a form of *cheiranthoides*, and keeps *hieraciifolium* distinct. Some idea of the difficulty (impossibility?) of distinguishing these species may be obtained by reading Fries's notes ('Summa,' p. 148) and observing the synonyms quoted by Koch under *E. strictum*.

BRAYA *alpina*, Sternb. I think there can be no doubt that *B. glabella*, Rich., and *dubia*, Br., are both synonyms of *B. alpina*, Sternb., or, at the furthest, arctic forms of that plant. I am quite unable to distinguish them by any good characters. The pods are singularly variable in length and breadth, and, as with other arctic *Cruciferæ*, are apt to be arrested by cold in early states of development, and hence to assume at later periods various forms, depending on subsequent accessions of heat and moisture.

BRAYA *rosea*, Bunge. I have retained this species, though I extremely doubt its distinctness from *B. alpina*. The Arctic European habitat is introduced on the faith of Nyman's 'Sylloge,' who quotes Bunge (Cat. Sem. Dorp., anni 1839) for its being a native of Arctic Russia (Samojed.); but I do not find any of the genus in Ruprecht's Flor. Samojed. Cisural. (1845).

BRAYA *pilosa*, Hook. I have repeatedly examined this form very carefully, and, though undoubtedly very near *B. alpina* in general appearance, I am unable to identify it with any state of that plant.

THLASPI *montanum*, L. I am quite unable to satisfy myself about the specific limits of this plant, and indeed of many other forms of the genus, whose species appear to be extravagantly multiplied. Belgium is its northern limit in Europe, whereas *T. alpestre*, to which the American plant may belong, reaches Gothland.

LEPIDIUM *ruderale*, L. This widely-spread plant advances beyond the arctic circle in North-eastern America, but apparently not in West America or Europe. It is so frequently an introduced plant, that it is difficult to assign its indigenous limits.

SUBULARIA *aquatica*, L., though apparently not a native of the Alps, is found in the Pyrenees.

VIOLA *palustris*, L. According to Fries, the typical plant of this name is rare and local in Lapland. Asa Gray identifies the White Mountain plant with it; and it is also found in Southern Greenland. It is absent in Arctic Russia.

V. epipsila, Led. Fries, in his 'Novitiæ,' makes this a variety of *palustris*; and in his 'Summa Veg. Scand.' it is regarded as a species found throughout Lapland. Koch keeps it distinct, but has never seen living specimens. Ruprecht (Flor. Samojed. Cisural.) mentions a variety *hyperborea*, in which the sepals are narrower and sharper than in the typical states, and the peduncles and petioles more slender. In the interior of the arctic Island of Kolgujew it is very rare, and has glabrous leaves.

V. blanda, Wahl. I am doubtful about the specific distinctness of this plant. It closely resembles *V. palustris*; and A. Gray keeps it distinct, but his differential characters appear very trifling. In 'Flora Bor.-Am.' the flowers of the two are said to present "the most perfect agreement." In 'Bot. Beechey's Voy.,' *V. blanda* is said to inhabit Kotzebue's Sound; and Ledebour, who has seen specimens, retains it with a query, and says that, though allied to *V. palustris* and *epipsila*, it differs in habit, smaller flowers, and approximate nodes of the root. Seemann does not include it in his Flora of Western Eskimo-land. The *blanda* is said to be fragrant. *V. uliginosa*, Schrad., is another species which is so excessively close to *palustris* as to be with difficulty distinguishable.

V. microceras, Rupr., is founded on a solitary specimen from the shores of Kolgujew Island; its author says of it, "facies tota *V. palustris*, sed folia margine et pagina superiore (non inferiore) pubescentia; sepala linearia, acuta, margine rigide ciliata, serrata."

VIOLA *canina*, L. The various forms and near allies of this plant are sources of infinite diversity of opinion amongst botanists; added to which, regarding *canina* and its allies as a group designated *Sylvestres* by Fries, they seem to inosculate in many points with another and different one, the *Pratenses*, Fries. Thus it is not difficult to unite *canina* with *Ruppii* and *stagnina*, through the forms of what is often called *lactea*. Watson has some excellent remarks on these forms; he includes *lactea*, Sm., under *flavicornis*, and keeps it doubtfully distinct from *canina*. Fries considers *montana*, L., a distinct variety only of *canina*, and gives all Lapland as the habitat for both, whereas *arenaria* and *sylvatica*, though also Lapponian, are more local: in his 'Novitiæ' he makes *sylvestris*, Lam., a variety of *canina*, as does De Gingins in DeCandolle's 'Prodromus.' Koch makes both

Ruppii and *montana* varieties of *canina*. Babington, in Henfrey's 'Bot. Gazette,' 1850, p. 141, roughly discriminates three British forms:—*sylvatica*, Fr., 'Herb. Norm.' (*canina* β, Fries, Novit. 272; *sylvestris*, Koch, non Lam.); *canina*, Linn. (*sylvestris*, Lam.), with a var. β including *lactea*, Sm.; and *stagnina*, Kit. (*persicæfolia*, Fr.; *lactea*, Reich.), which I do not find quoted in any Arctic Flora, and so have not entered in my list of names.

V. arenaria, DC., is very closely allied to *canina*; and though distinct in appearance, it is difficult to find any good characters. Bentham quotes both *lactea* and *sylvatica* as varieties under *canina*.

V. Muhlenbergii, Torrey (*Muhlenbergiana*, Ging.). Torrey and Gray remark how very near this is to *canina*; and in the 'Flora Boreali-Americana' the difficulty of pointing out diagnostic characters is admitted; it is, however, kept up by all authors, and is no doubt a permanently but slightly altered form. It is found in Greenland.

V. bicolor, Pursh, is regarded by the American botanists as a variety of *arvensis*, DC., itself a form of *V. tricolor*; to me it appears to be a permanently distinct plant, though having but feeble diagnostic characters. Both *tricolor* and *arvensis* are Arctic European and Siberian; but *bicolor* alone is American, and found only to the eastward of the Rocky Mountains.

Dianthus *repens*, Willd. This, which is not Scandinavian, appears to me nothing but an arctic form of *alpina*, L. Both are arctic.

D. dentosus, Fisch., appears the same with *D. Seguieri*, Vill., or so nearly allied that it is difficult to distinguish them. Neither are natives of Scandinavia.

Silene *inflata*, L., and *S. maritima*, L. I have kept these forms apart, though they are united by many authors (Bentham included). In the arctic regions they are distinguishable. *S. maritima* has not been found on the Pacific coasts, though *S. inflata* occurs in N. E. Asia? Watson observes that, on the coast of Britain, some forms of *maritima* become so very like those of *inflata* as to be hardly distinguishable.

S. paucifolia, Ledeb., from the shores of the Arctic Ocean, is unknown to me; it is a plant of Pallas, and evidently very near, if not identical with *S. inflata*.

Lychnis *apetala*, L. I have no hesitation in saying that no satisfactory limits can be assigned to the six forms ranged under this name. In the Himalaya, where it is abundant at great elevations (*macrorhiza* and *cuneifolia*, Royle), I have observed it to be singularly variable in most or all of those characters which have been employed to separate its forms in other countries. Durand (Kane's Voyage, Appendix) finds the characters of *pauciflora* Fisch., and *uniflora*, Led., to be present in Greenland specimens. Fries keeps *apetala* and *affinis* distinct, the former being found throughout Lapland, the latter rare; he distinguishes *affinis* by its flowers, erect at period of expansion, and obovate angular (not reniform) seeds.

L. sylvestris, Schkr., is *doica* α of Linnæus, and *diurna*, Sibth. *L. pratensis*, Spr., is *dioica* β, L., and *vespertina*, Sibth. Bentham keeps them distinct.

Sagina *cæspitosa*, J. Vahl, is *Arenaria cæspitosa*, Fl. Dan. 2289, according to Lange.

S. intermedia, Fenzl in Rupr. Flor. Samojed., is the same with *nivalis*, Fr.

S. saxatilis, Wimm., is the same with *Linnæi*, Presl, and approaches very closely both to *S. nivalis* and *procumbens*. Bentham unites with it *S. subulata*, Wimm. (*procumbens* β, L.).

ARENARIA *nardifolia*, Led. This and *A. formosa* are considered varieties of one by Fenzl (Led. Fl. Ross.). Torrey and Gray remark that the Arctic American plant figured in 'Flor. Bor.-Am.' does not accord well with Ledebour's. To me they appear both to resemble very closely *A. lychnidea*, M. Bieb, a Caucasian species; but very large suites of all these and their cognate species are required to arrive at any conclusion as to their limits. All the North Asiatic and American *Alsineæ* are in a most unsatisfactory state.

A. Lapponica, Spr., is reduced to *A. uliginosa*, by Fenzl in 'Flor. Ross.,' and both to *Alsine stricta*, Wahl.

A. Rossii, Br. This, which I find often confounded with *rubella* in Arctic Herbaria, may prove to be a polar state of *A. uliginosa*, Schl.; it has been found in very high latitudes only.

A. stricta, Mich., is *A.* (*Alsine*) *Michauxii*, Fenzl, according to A. Gray (Bot. N. U. States).

A. verna, L. Under this name I have grouped four others, which represent as many arctic forms of this protean plant, and have all been reduced to it by Fenzl and other writers. Thus *hirta* and *propinqua* both come under *lusus* 1. of Fenzl's var. β. *hirta*; *rubella* and *quadrivalvis* under var. θ. *glacialis*. Fries, however, distinguishes *rubella* specifically from *verna* by its habit, and rugulose, not granulate seeds. *A. Giesekii*, Horn. (Flor. Dan. 1518), is *rubella* γ of Lange.

A. Pumilio, Br., is reduced to *arctica*, Stev., β, by Torrey and Gray; but if correctly, I do not see how *arctica* is to be kept distinct from *biflora*, Wahl. Ledebour's *arctica* is indeed referred to *biflora* by Fenzl. According to Fenzl's descriptions (which do not however contrast), *arctica* is distinguished by the broader petals (sometimes narrower by deformity), and seeds "lævissimis fuscis," in opposition to "levissime rugulosis." But I find the seeds of the Lapland plant to be undistinguishable under any magnifying power from those of the American; and the petals are, as Fenzl's description states, excessively variable in both.

A. Norvegica, Gunn. Fries, who includes this under *A. ciliata* as a variety, or, perhaps, distinct species, assigns it a rather different range, *ciliata* being found in Lapland and N. Finland only; *Norvegica* in N. Norway and S. Lapland. *A. ciliata* alone is found in Arctic Russia, according to Ledebour's 'Flora;' but neither appear in Ruprecht's 'Samoied Flora.' Watson considers their distinctness to be questionable; and Bentham unites them.

A. Grœnlandica, Spr. This has been found in Arctic Greenland by Kane's Expedition only, which brought it from Upernavik, lat. 73° N.

HONKENEJA *peploides*, Ehr. A doubtful native of Lapland according to Fries, who indicates a subspecies (*oblongifolia*, Torr. & Gray) as inhabiting that country.

STELLARIA *crispa*, Cham. Fenzl says of this, "A *S. boreali* vix distincta, facile tamen distinguenda." I am at a loss to distinguish it, either by specimens or book characters. According to Fries, *borealis* is rare in Lapland, but its var. *calycantha* is common throughout that country. Planchon, who has studied the genus very carefully, points out (Herb.

Hook.) that the *borealis* γ of 'Fl. Bor.-Am.' is the same with *gracilis*, Rich., *l. c.*, and a plant of Drummond's, called *Larbrea aquatica*, and further that all are referable to *S. umbellata*, Turc.

S. longipes, Goldie. Of the plants brought under this name, *S. læta*, Rich., and *Edwardsii*, Br., are all but universally considered to be identical or states. Of Bunge's *S. peduncularis* being the same, there can I think be little question. Of *S. hebecalyx*, Fenzl, and *ciliatosepala*, Trautv., I have seen no authentic specimens; but, judging from the drawings and descriptions, and from specimens in the Herbarium from Labrador, displaying similar characters, I have no doubt of these also being mere varieties. Fenzl says that *hebecalyx* is intermediate between a variety of *longipes* and *Dahurica* β. Planchon (in Herb. Hook.) refers *Dahurica* to *longipes* doubtfully; and Turczaninoff (fid. Rupr. Fl. Sam.) regards *Dahurica* β 2 of Fenzl as the same with *glauca*, L. The smooth testa of the seed, however, distinguishes all the forms of *longipes*. Durand (Kane's Voy.) refers *S. stricta*, Rich., to *longipes* β. *minor* and δ. *læta*. Planchon (Herb. Hook.) further refers *S. imbricata*, Bunge, *alpestris*, Turc., and *Fischeriana*, Ser., to *longipes*, and, I think, rightly. The *S. glauca* of Greenland (Lyall's plants, nob. in Linn. Journ. vol. i. p. 116) is a state of this plant.

S. longifolia, Fries. A very confusing plant, whether as regards its synonymy or limits. I am quite unable to distinguish the European from the American form; both have a smooth testa, and seeds otherwise identical. Fries distinguishes them; and Koch ('Synops.' 131) says that *longifolia*, Muhl., is most certainly distinct, but gives no characters.

S. alpestris is regarded by Fries as a variety, and perhaps a distinct species; it approaches states of *uliginosa* in many characters; but the seeds are always smooth.

Lepigonum *salinum*, Fr. This should perhaps be regarded as a member of an aggregate species including *L. marinum*, Wahl., of which Babington considers it a variety, and *rubrum*, Wahl., plants which in their extreme forms differ widely, but seem united by innumerable variations; Bentham unites them.

Cerastium *Fischerianum*, Ser. Ruprecht includes a plant of this name, in 'Herb. Chamisso,' under *vulgatum*, and further doubts the possibility of distinguishing it from arctic forms of *C. arvense*. Fenzl (in 'Led. Fl. Ross.') reduces both this and *Beeringianum* to *vulgatum*. Torrey and Gray, and, following these, Durand, refer *Fischerianum* to *alpinum*, and keep *Beeringianum* distinct, but next to it in order.

C. arvense, L. Ruprecht gives the only arctic habitat for this, viz. the extreme forest-limit in Samoiedland, but he gives its var. β (*arvense*, *incanum*, Led.) as abundant in sandy places on the arctic Island of Kolgujew.

Polygala *vulgaris*, L. I hesitated long whether to amalgamate the distribution of this with the Siberian *P. comosa*, but have refrained.

Astragalus polaris, Benth.; glaber v. parce pubescens, caule breviter diffuso, stipulis posticæ concretis, foliolis 11–15 ovatis oblongisve retusis v. emarginato-bifidis, pedunculis folio subæqualibus apice 1–4-floris, calycis dentibus tubo paullo brevioribus, corolla calyce subtriplo longiore, carina alis vexilloque breviore, legumine subsessili inflato membranaceo nigro-piloso calyce 3–4-plo longiore, sutura carinali haud intrusa.—G. B.

Hab. Eschscholtz Bay, in Kotzebue's Sound, *Seemann.*

In many respects similar, especially in habit, stipules, and form, to *A. alpinus*, L., but always more glabrous, with more deeply emarginate or almost bilobed leaflets, fewer flowers, longer calyx, narrower petals, shorter keel, almost sessile ovary, and widely different pod, which is broadly linear oblong, not pendent, inflated, fully an inch long, and rounded at the ends.

The introduction of a perfectly new and distinct arctic plant into the supplementary observations appended to this paper requires some notice here. I am indebted for it to to Dr. Seemann, who pointed it out to me, on his return from the Fiji Islands (after the first part of this paper was printed), as a plant omitted in his Botany of the 'Voyage of the Herald,' and as that alluded to by him as *Oxytropis polaris* in the narrative of that voyage. It is so like *Astragalus alpinus*, that it had been mixed with specimens of that plant, which is abundant throughout Eskimo-land. I have sought in vain, through a very large suite of specimens of *A. alpinus* and *oroboides* (which it also in many respects resembles), for another specimen of *polaris*; it must therefore at present be considered as an addition (eighth) to the small list of peculiarly arctic plants mentioned at p. 258, and the sixth to the species peculiar to Arctic N. W. America enumerated at p. 267.

Oxytropis *campestris*, DC. Many names are included under this, which represent species, varieties, and synonyms in the opinions of different authors. Of these, *O. borealis*, DC., is referred (with *O. sordida*) to *campestris* by Ledebour. Of *O. Middendorffii*, Trautv., I have seen no authentic specimens; but Trautvetter's plate appears to identify it with a not uncommon form of the same plant.

O. sordida, Pers. The plant of Fries, 'Herb. Normale,' is undoubtedly referable to *campestris*; Ruprecht (Flor. Samojed.) goes at length into its characters, describes it as very near *O. campestris ε. verrucosa*, Led., from the Gulf of St. Lawrence. This latter, Ruprecht refers to *borealis*, DC., which differs from *campestris* "in the glandular verrucose parts, and calyx covered densely with black hairs,"—all very inconstant characters in arctic specimens. Nyman and Fries put *O. sordida* under *campestris*. Koch and Ledebour both regard it as a variety, *β. sordida*.

O. polaris, Seem., alluded to (but not described) in Seemann's 'Narrative of the Voyage of the Herald,' is founded in error. See Astragalus *polaris*, suprà.

O. arctica, Br. Ruprecht appears to refer the Arctic Siberian and Kotzebue Sound plant of this name to *O. sordida*. Ledebour refers Brown's *arctica* of Arctic America to a form of *Uralensis*. Torrey and Gray follow 'Flora Boreali-Americana,' in keeping it distinct, with the observation that it probably does not differ from *Uralensis*.

O. nigrescens, Fisch. This is certainly a very distinct and remarkable form; but I much doubt its permanent distinctness from *O. Uralensis*. In the 'Flora Boreali-Americana' it is regarded as probably very nearly allied to *arctica* (*Uralensis*).

Spiræa *chamædrifolia*, L. The only apparently Arctic European habitat which I find recorded for this plant is the River Kolva in Samoiedland; but, the precise spot not being indicated by Ruprecht, it may not cross the arctic circle. Though a high northern species, it is not Scandinavian.

DRYAS *integrifolia*, Vahl, was originally considered a variety by Chamisso and Schlechtendal, but is kept distinct in 'Flora Boreali-Americana,' by Torrey and Gray, and Asa Gray. I have, however, vainly endeavoured to find any satisfactory characters for it; the only one of any consequence, derived from the outline, &c. of the leaf, is not only most inconstant, but presents every transition to *D. octopetala*. As, however, the most narrow- and entire-leaved forms have been found only in the extreme north, no doubt due to excessive cold, the occurrence of *integrifotia* on the White Mountains would, if confirmed, be a curious proof of the permanence in a local variety of the most variable of all characters—the development of the leaf. Peck is (according to Pursh) the authority for the United States locality, which wants confirmation.

GEUM *strictum*, Ait. This, though kept as a distinct species by Torrey and Gray and all authors, appears to differ from *G. urbanum* only in its stout form, and petals longer than the calyx; it is described by American authors as an extremely variable plant. There are other species that might equally well be included; but the whole genus wants working up.

SIEVERSIA *humilis*, Br. This is scarcely worthy of ranking as a variety of *S. Rossii*, to which it is reduced by Ledebour and Torrey and Gray.

RUBUS *propinquus*, Richardson, is *R. arcticus* γ of Torrey and Gray, distinguished by having flagelliform stems.

R. acaulis, Mich., is *R. arcticus* β, Torrey and Gray, and *R. pistillatus*, Smith.

R. castoreus, Læst. Fries keeps this distinct from *arcticus*, both being Lapponian. See many excellent remarks on all these species in his 'Summa Veg. Scand.' p. 169 Wahlberg makes this a bastard between *arcticus* and *saxatilis*, occurring under two forms.

R. triflorus, Hook. This Fries regards as a hybrid between *saxatilis* and *castoreus*, if I understand aright his system of symbols and nomenclature. Torrey and Gray regard it as a distinct species, as does Asa Gray. Michaux and Seringe both ranked it as a variety of *saxatilis*. As *castoreus* and the European form of *saxatilis* are not found together on the American continent, Fries's view of *triflorus* being a hybrid seems untenable.

POTENTILLA *Pennsylvanica*, L. Spain is the only European habitat for this plant. *P. rubricaulis*, Lehm., does not seem to differ at all from *sericea*, L. Torrey and Gray indicate numerous varieties of *sericea*, but keep *Pennsylvanica* a distinct species. When studying the Himalayan forms of *Potentilla*, I found it impossible to draw any line between the following varieties of *sericea*, viz. *Soongarica*, Bge., *conferta*, Bge., *multicaulis*, Bge., *holosericea*, Nutt., *multifida*, L., *Pennsylvanica* β. *strigosa*, and γ. *bipinnatifida*, T. and G.; and it further appeared to me that *P. sericea* was connected with *nivea* by numerous inosculating forms.

P. nivea, L. I have (under *sericea*) stated the difficulty of discriminating between this and *sericea*. The names included under it represent varieties, subspecies, or species, according to the different views of botanists. Thus *P. Vahliana*, L., is the *nivea* var. γ of Torrey and Gray, and includes *Jamesoniana*, Grev. *P. pulchella*, Br., is a very arctic form, and according to Brown is Greville's *sericea*, L., between which plant and *nivea* it appears quite intermediate; all depends upon what arbitrary character is assumed to be the diagnostic one.

P. Keilhauii, Sommf. Of this I know nothing; Nyman doubtfully refers the Spitzbergen plant of this name to Brown's *pulchella*. *P. frigida*? Grev., is referred here by Brown, and by Torrey and Gray under *Vahliana*, L., β, which is also the *P. Grœnlandica*, Br., of the same authors.

P. frigida, Vill. I am quite puzzled with this. Arctic American and Greenland specimens seem to connect *P. minima*, Hall. (*Brauniana*, Hoppe), *glacialis*, Hall., and *nana*, Lehm. The United States plant, found only on the White Mountains (*P. Robbinsiana*, Oakes), is referred to *minima* β by Torrey and Gray, and afterwards to *frigida*, Vill., by Gray, who observes that the European *minima* is probably a variety. The Danish authorities refer the Greenland and Labrador plant to *P. emarginata*, Pursh (*nana*, Lehm.), whilst both Asa Gray and Durand refer it to *frigida*, Vill. I cannot help suspecting that *P. elegans*, C. & S., of Eastern Siberia, is the same thing, and that all will be found to inosculate with the varieties or forms of *P. verna*. I have confirmed Torrey and Gray's conjecture regarding *nana*, Lehm., being the same with *emarginata*, Pursh.

P. verna, L. Under this, as one collective species or group of subspecies and varieties, I have introduced five North European arctic and alpine plants, whose forms inosculate perplexingly. The typical *P. verna* is not Lapponian, according to Fries; and none of its included forms occur anywhere in N.E. America, except Labrador and Greenland (assuming that *biflora* is distinct as a species). *P. aurea*, L., is distinguished by Koch by its leaves silvery beneath; the *aurea* of Smith he refers to *alpestris*, Hall. I find this character to be very variable. *P. crocea*, Schl., is referred by Koch to a variety of *alpestris*; he has, however, a var. *crocea* of *verna*. *P. maculata*, Lehm., is, together with *aurea* and *crocea*, referred to *Salisburgensis* by Torrey and Gray.—*P. Salisburgensis*, Hænke, is regarded by Koch as a synonym of *alpestris*. Ruprecht, who observes that *Salisburgensis* is found throughout the arctic Island of Kolgujew, says that it is the same with *verna*, L., "genuina." *P. alpestris*, Hall.: this, which is a much larger-flowered plant than the ordinary *verna*, and otherwise different in habit, is kept distinct by Fries. Koch also distinguishes it from *verna* by its habit and ovate stipules, and from *aurea* by the leaves not silvery beneath. Bentham regards both *aurea* and *alpestris* as luxuriant forms of *verna*. Watson suggests that the distribution of *verna*, *alpestris*, and *Salisburgensis* should be treated in Great Britain as that of one plant.

Fragaria *vesca*, L. I have adopted the conclusions of J. Gay (Ann. Sc. Nat. ser. 4. vol. viii. p. 196) for the distribution of this plant, but very much suspect that it would have been more consistent to have (for distributional purposes) included that of *collina*, Ehr., *canadensis*, Mich., and *Chilensis*, Ehr., under it.

Sanguisorba *officinalis*, L. The four species brought under this vary very much; and I doubt if the majority will ever rank above local or permanent varieties. *S. officinalis* itself is

European, Caucasian, and Siberian. *S. media*, L., which is reduced by Torrey and Gray to a var. of *Canadensis*, L., is N.W. American. *S. Canadensis*, L., is not found anywhere in Canada, though a native of both N.E. and N.W. America; it differs from *officinalis* in the long stamens and narrower spikes. *S. tenuifolia*, Fisch., is N.E. Asian, and considered by Asa Gray (Bot. of Japan, p. 387) as hardly more than a variety of *Canadensis*. So much for the local distribution of the common forms; the only other is *S. polygama*, Nylander, a species retained by Fries, with East Lapland as its only Scandinavian habitat.

Rosa *majalis*, Herm. This is *R. cinnamomea* β, Torrey & Gray, which Ledebour and Koch do not even rank as a variety.

R. blanda, Ait. This is also *R. Woodsii*, Borr., of 'Flor. Bor.-Am.' according to Torrey and Gray. Fries does not include it in his Lapland column. *R. acicularis*, Lindl. (non DC.), is referred by Ledebour to *alpina*, L., and appears to be the same with *R. Gmelini*, a common Siberian plant. I do not see how it is to be distinguished from *blanda*. *R. Carelica*, F.: Ruprecht (Flor. Sam. p. 33) reduces this to a var. of *R. acicularis*, as do Meyen (see Nylander, Dist. Plant. Fenn. p. 86) and Trautvetter (Flor. Boganid.). *R. fraxinifola*, Lindl. (and Seringe), is referred to *blanda* in 'Flora Boreali-Americana' and by Torrey and Gray.

R. villosa, L., *tomentosa*, Sm. Bentham adds to this *R. mollis*, E. Bot.

R. canina, L., is, according to Ledebour, found in Arctic Lapland; but I find no Scandinavian authority for it, and have not included it.

Pyrus *Aucuparia*, L. This, and the two plants brought under it, are species, subspecies, or local forms, according to the value assigned to those terms. It is remarkable that the Greenland one is nearer the American form than the European. *P. Americana* was *Aucuparia* β of Michaux. The true *P. Aucuparia* is, however, a native of both continents, having been found at Lake Winnipeg by Bourgeau, and in Siberia, lat. 64° (Trautv. Flora Jenissei).

Punus *Padus*, L. I almost think that I should consistently have added *P. serotina*, DC., of North of America, to this.

Amelanchier *alnifolia*, Nutt. Torrey and Gray reduce all the American *Amelanchiers* to *Canadensis*, of which this is their var. δ; it is found on both sides of the Rocky Mountains.

Epilobium *alsinifolium*, Vill. Watson regards this as possibly a luxuriant form of *alpinum*, adding that intermediate forms may be assigned to either; he also cautions us that mountain forms of *E. tetragonum* occasionally pass for it. Bentham keeps it distinct; Koch, Torrey and Gray, and Asa Gray make it the same with *origanifolium*.

E. Hornemanni, Reich. This is *alpinum* β of 'Flora Bor.-Am.,' and γ of Torrey and Gray. Ledebour keeps it distinct.

E. origanifolium, Lam. This is *E. alpinum* γ of Torrey and Gray and Asa Gray; Ledebour keeps it distinct, as does Fries, who gives Lapland as habitat for both. Andersson distinguishes these and *lineare* by the seeds, which, not being perfected in the majority of specimens from arctic habitats, are to me unavailable characters; Koch also keeps them distinct, and characterizes them by their leaves.

E. lineare, Muhl. Fries keeps this distinct from *palustre*, L., both being found in Lapland. It is referred to *palustre*, var. β, in the 'Flora Bor.-Am.,' in Torrey and Gray's Flora, and in Asa Gray's Manual.

Callitriche *verna*, L. I have treated this as one collective species, including *autumnalis*, following Bentham's idea. Fries keeps this and *autumnalis*, L., distinct, giving Lapland as a habitat for both. Bentham unites them. A. Gray and most authors keep them distinct.

Myriophyllum *spicatum*, L., is not Lapponian according to Fries, though Lapland and Asiatic Russia are given as habitats by Ledebour.

Hippuris *montana*, Led. I have not seen this plant, which, judging from Ledebour's description, would appear undoubtedly to be only a starved state of *H. vulgaris*. *H. maritima*, Hellen, is reduced by Wahlenberg, Fries, and Koch to a variety of *vulgaris*; on the other hand, it is retained as a species by Brown, Ruprecht, 'Flor. Bor.-Am.,' and Torrey and Gray. Both this and *vulgaris* are arctic.

Ceratophyllum. Owing chiefly to imperfect materials, I am obliged to treat *Ceratophyllum* as consisting of one collective species. The specimens I have examined do not present such definite characters in the fruit as the descriptions of authors would seem to imply. Bentham regards *submersum* and *demersum* as forms of one; Torrey and Gray suggest that there is but one American species; Fries, Koch, and Watson keep these two distinct. Neither of them are Arctic European or Asiatic, though found in Arctic America.

Claytonia *lanceolata*, Pursh, *arctica*, Adams, and *sarmentosa*, C. A. M., are undoubtedly trifling varieties of one plant, neither constant *inter se* nor as to locality.

Montia *fontana*, L. The absence of this cosmopolitan plant in all parts of Temperate America east of the Rocky Mountains, except Labrador, is one of the most remarkable facts in botanical geography. Newfoundland is given as a habitat by Le Pylaie; but this, like that of *Calluna vulgaris*, wants confirmation. *M. rivularis*, Gmel., is reduced to a variety by Fries and Torrey and Gray.

Sedum *elongatum*, Led. I do not know this plant by authentic specimens. Ledebour gives it as a doubtful species, confounded with *S. Rhodiola* by Chamisso, Hooker and Arnott, and Torrey and Gray.

S. euphorbioides, Schl. Of this I know nothing; according to Ledebour it is probably a variety of the Siberian *S. algidum*, Led., itself very near to *quadrifidum*, Pall.

Ribes *propinquum*, Richardson. This does not differ from *R. rubrum*, L., to which it is reduced as var. β by Trautvetter and Meyer in 'Flora Ochotsk.'

Chrysosplenium *tetrandrum*, Lund, is noticed by Fries as a variety of *alternifolium*, also occurring in Lapland. I have not seen authentic specimens.

Parnassia *obtusiflora*, Rupr., appears nothing but a small specimen of *palustris*, L., in which the petals are often as short and of the same shape as in Ruprecht's plant, and the cauline leaf wanting. I doubt much if *P. Kotzebuei* is really distinct.

SAXIFRAGA *Aizoon*, Jacq. Koch, Fries, and most authors keep this distinct from *S. Cotyledon*; but I must own that I cannot satisfactorily discriminate their forms or make them tally with their assigned habitats, and am thus obliged to treat them as one plant. Both, according to Fries, grow in Lapland and Western Europe generally. *Cotyledon* alone is stated to be Icelandic; *Aizoon*, which alone is Greenlandic, Labrador, and N. American, is nowhere stated to occur in the Russian dominions.

S. cæspitosa, L. It is not my purpose to enter into the disputed question of the limits of the members of this aggregate collective species. I have repeatedly examined all, and found innumerable grades connecting the most dissimilar, such as *exarata* and *sileniflora*. Almost all are high arctic. *S. uniflora* is the same as *venosa*, and is referred by Torrey and Gray to *cæspitosa*, to which *S. Grœnlandica* is reduced by almost all authors. *S. exarata*, Vill., is kept distinct in 'Flor. Bor.-Am.' (with an appended observation regarding the difficulty of distinguishing it), as also by Torrey and Gray, Ledebour, and most authors. *S. muscoides*, Wulff., is the common Middle and S. European form.

S. sileniflora is confined to Arctic America; and *Magellanica*, in a form identical with *exarata*, does not extend in S. America north of Peru.

S. controversa, Sternb., which, according to most authors, is a synonym of *adscendens*, has been found on the Rocky Mountains by Bourgeau and Hector during Palliser's Expedition, but nowhere else in Continental America.

S. exilis, DC. This, as suggested in 'Flor. Bor.-Am.,' is, so far as may be judged by specimens tallying with the description, certainly only a weedy state of *cernua*.

S. bulbifera, L. Koch distinguishes this from *granulata* by its leafy cyme and other characters that appear to be clearly connected with its being a bulbilliferous condition of *S. granulata*, between which and *bulbifera* I find intermediate grades. Ledebour and Fries also keep it distinct. It is not Arctic Lapponian, but Russian.

S. hyperborea, Br., is referred to *rivularis* β in 'Flor. Bor.-Am.' and by Torrey and Gray; it is often a starved high-arctic form, but not a permanent or well-marked one; it is confined to Arctic America, and Greenland.

S. coriacea, Adams. This appears to me, from the description, not to be distinct from *nivalis*. I have seen no authentically named specimens.

S. reflexa, Hook. This is certainly only *Virginiensis*, of which several specimens from the Rocky Mountains precisely accord with the arctic.

S. hieraciifolia, W. & K., though Arctic Russian, fid. Ledebour, is not Lapponian, according to Fries..

S. foliolosa, Br. This is a monster, as pointed out by Fries (*comosa*), rather than a variety proper, the foliaceous cyme and bulbilli being produced at the expense of the inflorescence proper. Ledebour reduces it, and Ruprecht notices its transition to *stellaris*, L.

S. propinqua, Br., is identified with *Hirculus*, L., in 'Flor. Bor.-Am.' and by most succeeding authors.

S. æstivalis, Fisch., is reduced to *punctata* by Ledebour.

Conioselinum *Tataricum*, Fisch., and *Selinum Gmelini*, De Bray, are both synonyms of *C. Fischeri*, Wimm.

Archangelica *littoralis*, Fries. Wahlenberg originally regarded this as a variety, and, I think, rightly, its characters being slight and of relative value only. Ledebour doubts its claims. Fries, who keeps it distinct, discusses the species (Summa, p. 181).

A. Norvegica, Tabern., is not contained in Fries's 'Summa.' Ruprecht (Flor. Samojed.) gives it as the *Angelica Archangelica* β of Linnæus, and adds that it is most highly esteemed as an article of food.

A. atropurpurea, Hoffm. This is the "Common Archangelica" of American authors, which, according to the specimen I have seen and descriptions I have compared, differs very slightly from *Angelica Archangelica*, L. The *Physolophium saxatile*, Turcz. (*Cœlopleurum* [*Pleurospermum*, Bong.] *Gmelini*, Led. fid. Flor. Ochotsk.), is, as far as I can make out from descriptions, either a form of *Archangelica officinalis*, or some very closely allied plant which I cannot distinguish from its forms.

Athamanta *arctica*, Nym., is *Libanotis arctica*, Rupr., a plant of which but one specimen is known, differing, according to its author, from *condensata*, L., in the colour of the flower only. DeCandolle reduces *condensata* to a var. of *A. Libanotis*, L.; and *A. Sibirica* is only another form of the same species.

Heracleum *arcticum*, Rupr. I have not seen this plant, which, from a careful comparison of its description with *H. Sibiricum*, I take to be an arctic state of that plant.

Pachypleurum *alpinum*, Led., is the same with *Gaya* (*Neogaya*) *simplex*, Gaud.

Sium *latifolium*, L., is stated by Gunner to be an inhabitant of Tromsœ (Wahlenberg); but I do not find so northern a habitat confirmed by Fries or Andersson, and so have not included the species.

Viburnum *Opulus*, L., scarcely reaches the arctic circle in Lapland. *V. Oxycoccus*, Pursh, is finally identified with it by A. Gray.

Galium *uliginosum*, L. Watson remarks that states of this are frequently confounded with *palustre* and *pusillum*, which may well be the case with arctic specimens.

G. trifidum. L. Ruprecht calls the European plant β. *Europæum*, and indicates some differences, which I do not think hold in the extensive suite of specimens I have examined. *G. Claytoni* was thought to be distinct in 'Flor. Bor.-Am.,' but is reduced by Torrey and Gray, and by Ledebour.

G. infestum, W. K. Fries considers this to be a variety of *Aparine*; and it alone is Lapponian.

G. saxatile, L., does not advance north of Southern Norway, nor west of Uralian Siberia; hence its being arctic in Greenland is remarkable. It is also Icelandic.

Nardosmia *frigida*, Hk., *corymbosa*, Hk., and *sagittata*, Hk., are clearly all forms of one rather variable plant, connected by intermediates.

N. straminea, Cass. United with *N. lævigata*, DC., by Ledebour; but Ruprecht considers it different.

PTARMICA *alpina*, L. The numerous plants here brought together do not differ more *inter se* than do the forms of *P. vulgaris* (with which this is intimately connected), and they are further all united by intermediate forms. *P. alpina* itself is found in Arctic Siberia and the Altai; *P. oxyloba* is only known in Arctic Siberia. *P. speciosa*, DC.: Ledebour rightly remarks that this is rather a form of *vulgaris* than a species. *P. multiflora*, Hk., was originally referred to a var. of *vulgaris*, from which it differs in its deeply cut leaves, and broad-, short-ligulate flowers. *P. Sibirica*, Led., is confined to East Siberia and Escholtz Bay. Of the *borealis*, Bong., of Sitcha, I have seen no authentic specimens.

CHRYSANTHEMUM *Sibiricum*, Turc., is retained by DC., Ledebour, &c., but apparently on very slender grounds.

C. integrifolium, Rich., is an eminently northern form, not found west or north of the Tchuktchi country, and scarcely south of the polar circle; it may prove to be connected with *leucanthemum* by intermediate forms.

C. leucanthemum, L., is not Lapponian, but Arctic Russian. *C. Segetum* is occasionally found in Nordland, but apparently rather as an alien than a genuine arctic plant.

PYRETHRUM *pulchellum*, Turc., is certainly identical with the small arctic form of *inodorum*; and Fries adds as a variety the *P. ambiguum*, Ledeb., correctly. Ruprecht considered the woolly hairs on the peduncle of *P. pulchellum* sufficient to distinguish it; but this is not the case.

ARTEMISIA *Tilesii*, Led. Fries ranks this as a var. of *vulgaris*, L., both being found in Lapland. Seemann remarks that they occur together throughout Western Eskimo-land.

A. Chamissoniana, Bess., is reduced to *arctica*, Less., in 'Flor. Bor.-Am.,' and by most succeeding authors. *A. Norvegica*, Fr.: in the 'Flor. Bor.-Am.' it is stated that this is identical with *A. Chamissoniana*; on comparison I find it has rather larger capitula, but is not otherwise different; it is a very rare alpine plant in Norway, not entering the arctic circle.

A. globularia, Cham. I think this is quite the same with *glomerata*; both are confined to the country around Behring's Straits.

A. androsacea, Seem. This is a remarkable and very local plant, which I cannot identify with any more southern species, though, judging from analogy, I suspect that it may eventually prove only an arctic tufted variety of some better-known plant.

A. cæspitosa, Bess. I have seen no specimen of this; but, judging both by plate and description, I do not doubt that Torrey and Gray's surmise is correct as to its being the same with *Richardsoniana*.

A. Canadensis, Mich. This, according to Richardson, advances to the arctic circle east of the Rocky Mountains. After a careful re-examination I cannot doubt its identity with *A. desertorum*, Spr., as also certainly with *commutata* β. *Gebleriana*, Bess. in Herb. Hook. *Canadensis* is the earliest name.

BIDENS *tripartita*, L., is not found in Arctic Lapland, though it enters the arctic circle in Russia. I am quite unable to distinguish the American *B. connata*, Muhl.

ANTENNARIA *hyperborea*, Don, is considered by Fries to be a corymbose form of *dioica*, Br.

GNAPHALIUM *Norvegicum*, Gunn. Fries and Koch consider this a distinct species from *sylvaticum*, both being Lapponian. Watson finds the British *Norvegicum* so linked to *sylvaticum*, that he is obliged to treat them as one. Bentham considers *Norvegicum* a high-arctic and alpine form of *sylvaticum*.

G. pilulare, Wahl., is reduced to a var. of *uliginosum* by Fries.

ARNICA *montana*, L., certainly includes the three which I have included under it, and which hardly deserve to be ranked as constant varieties. Fries keeps *alpina* distinct, and assigns it a more northern habitat than *montana*. Torrey and Gray unite *angustifolia*, Vahl, with *alpina*, Læst., and make of it *montana* β. *alpina*. The *angustifolia*, H. & A., is by the same authors considered the same as *alpina*, and called *angustifolia* β. *Lessingii*; they observe, at the same time, that the arctic forms, though so very closely approaching, appear quite distinct in more southern habitats. Durand (Kane's Voy.) unites *alpina*, Wahl., *plantaginea* and *fulgens*, Pursh, with *montana*, var. *alpina*, L.

SENECIO *resedæfolius*, Less., is Arctic Russian, but not Lapponian.

S. arcticus, Rupr., is *Cineraria congesta*, Br., "*sensu latiore*?" of Fries; and *C. congesta*, Br., is reduced by him to a northern var. of *S. palustris*. The absence of both this and *campestris* in Greenland is very remarkable.

S. campestris, L. I have very carefully compared many specimens of the plants placed under this, and am quite unable to discriminate between their forms. According to Koch and Fries, *Cineraria alpina* includes *C. campestris*, Retz. *C aurantiaca*, Hoppe, is kept distinct by Koch, but united by Fries as a var. of *C. alpina*.

S. octoglossus, Ledeb., is referred by Fries to *nemorensis*, which in Scandinavia is not found south of Lapland.

LIGULARIA *Sibirica*, L., is found only in East Lapland and Arctic Russia, Finland, &c., not in Nordland.

SOLIDAGO *multiradiata*, Aiton, is the *Virga-aurea* γ of Torrey and Gray, and ε. *arctica* of Ledebour.

ASTER *Richardsoni*, Spr., and *montanus*, Richardson, are referred to *Sibiricus* by Fries, and, I think, rightly; also doubtfully by Ruprecht. Trautvetter (Flora Boganid.) refers *Richardsoni* to *Sibiricus* β. *subintegerrima*.

A. pygmæus, T. &. G. I have vainly sought to distinguish this from *salsuginosus*.

A. alpinus, L. (with which *A. flaccidus*, Bunge, of Siberia and Dahuria appears to be identical), is not reputed to be Scandinavian, but a native of the Alps and Carpathians.

A. falcatus, Lindl., is certainly nothing but *multiflorus*, Ait.

ERIGERON *trifidus*, Hook., is identical with *compositus*, Psh., as is now well known.

E. elongatus, Led. Fries, who keeps this distinct, says (in Herb. Norm.) that it should rather be considered a form of *acris*, of which it appears to me to be a mere variety, and a very slight one.

E. politus, Fr. This also Fries keeps distinct; he considers it most allied to *alpinus*, and includes under it *glabratus*, Hook. For my own part, I find it impossible to separate the forms of *acris* from those of *alpinus*, and am rather disposed to refer this to the former.

E. uniflorus, L. This is *E. alpinus* β of Ledebour, and *alpinus* γ of De Candolle, and is united with *alpinus* by Bentham also. According to Fries, who unites *pulchellus*, DC., with it as a variety, it is a good species. I cannot regard it otherwise than as an arctic and alpine state of *alpinus*, with a more woolly involucre, fewer capitula, and better-developed inner-ray florets. I find all intermediate forms.

E. purpureus, Ait., is included under *Philadelphicus* by Torrey and Gray, &c.

Taraxacum *Dens-leonis*, Desf. Fries adopts the name *officinale*, Weber, and includes *palustre* as a variety, both being Lapponian, in which Watson, Koch, and most botanists coincide. *T. ceratophorum* is rather a form with an over-developed condition of the involucral scales, than a variety properly so called.

T. Scorzonera, Reich., from Arctic Siberia (Flor. Taimyr.), is not included in Ledebour's 'Flora Rossica.'

T. phymatocarpum, J. Vahl, Flor. Dan. 2298, found in Arctic Greeland only, is a small form with the habit and involucre of *T. palustre*, Sm., and shorter achenia than is usual in the genus.

Sonchus *maritimus*, L., is kept distinct by Koch, but included by Fries as a variety of *arvensis*.

Leontodon *autumnalis*, L. I am obliged to regard *Keretinus*, Nyl., as the same with *autumnalis*, because Ball (Ann. Nat. Hist. 1850, p. 2) observes that the character of erect and drooping capitulum (on which this species appears founded) is not to be relied on in other species of the genus. I have never seen copious specimens of this *L. Keretinus*, which Ball omits in his otherwise very full account of the genus (*l. c.*). Fries regards it as a not yet fully developed species. Ledebour puts it in another section of the genus. Koch makes *L. Taraxaci*, L. (*Apargia*, Smith), a variety of *autumnalis*; and Watson says that the British *Taraxaci* graduates insensibly into *autumnalis*. Ball makes it a synonym. Fries introduces under *autumnalis* a variety *nigro-lanatum*; he describes both as being common throughout Lapland.

Hieracium. I have grouped the various arctic forms discriminated by Fries, into a few aggregate species, such as are recognized by Arnott, Bentham, Watson, &c.

Saussurea *alpina*, L. I have treated this as an aggregate species, because *S. nuda*, *monticola*, and *angustifolia* all seem to graduate into it, and several of them into one another I should not be surprised if *S. subsinuata*, which is hitherto known from one locality only, proved still another form of the same variable plant.

Carduus *crispus*, L. This attains a higher latitude than *C. acanthoides*, L., of which Bentham and others consider it a variety. The two certainly pass into one another.

Campanula *linifolia*, Hænke, and *Scheuzeri*, Vill., are certainly referable to *C. rotundifolia*, as held by Linnæus and most modern authors, though *Scheuzeri* is regarded by Fries as distinct.

VACCINIUM *pubescens*, Wormsk. (Flor. Dan. 1516), a Greenland plant, is referred to *uliginosum* variety by Lange.

VACCINIUM (OXYCOCCUS) *microcarpum*, Rupr., is included under *O. palustris* by Nyman, and is clearly nothing but a small-fruited state of that plant.

CALLUNA *vulgaris*, L., is mentioned in DeCandolle's 'Prodromus,' on the authority of a specimen gathered by La Pylaie, as a native of Newfoundland; but I find no confirmation of this habitat, nor is it found in any part of the American continent. In the Old World it wanders no further east than the Ural district.

LEDUM *palustre*, L. Asa Gray and DeCandolle distinguish two species, by the stamens 5 and 10, leaves broad and narrow, and capsules; but these do not affect different geographical ranges, and Andersson, a most careful observer, says (Conspect. Veg. Lapp. 18, in note), "inter hanc varietatem (*latifolium*) et normalem tam multi animadvertuntur transitus, ut nullo modo distingui possint. Nostra planta foliis etiam latioribus, quam specimina Grœnlandica, nonnunquam lecta." Of the three included species, *L. dilatatum* is ranked by Fries with *palustre*, to which also *Grœnlandicum* is referable—L. *latifolium*, Ait., is merged into *palustre* by Michaux and in 'Flor. Bor.-Am.'

PYROLA *rotundifolia*, L. This I consider includes *chlorantha*, Sw., which, though not found in Arctic Europe, is said by Durand (Kane's Voyage) to be found in Greenland. As, however, Durand does not include *grandiflora*, Rad., and Lange makes no mention of *chlorantha*, it is possible that the same species is intended by both authors.

P. Grœnlandica is referred to *rotundifolia* in Flor. Bor.-Am., and by DeCandolle; it is kept distinct by Lange, who refers it to *grandiflora*, Rad.

P. elliptica, Nut., is certainly only a variety of *rotundifolia*, and is in most respects intermediate between *rotundifolia* and *chlorantha*.

P. media, L. Bentham is inclined to doubt if this be permanently distinct from *P. minor*.

Ruprecht (Flor. Samojed.) mentions *P. uniflora*, L., as a doubtful native of Kolgujew Island, off the White Sea.

GENTIANA *lingulata*, Ag. Fries treats this as a distinct variety of *Amarella*, which alone is Lapponian. After a very careful examination of *G. acuta*, Mich., I am disposed to regard it as the Lapponian form of *Amarella*; I cannot fix characters that will distinguish them. Grisebach says of it, "*Amarellæ* simillima sed bene distincta species."

G. involucrata, Rottb. This very rare plant is also Icelandic.

G. æstiva, R. & S., is *verna* γ of Grisebach; it is not found in Lapland, any more than *Pleurogyne rotata*; both, however, are Arctic Russian.

POLEMONIUM *cæruleum*, L. I have treated all the arctic forms of this variable plant as constituting an aggregate species. All are regarded as varieties in 'Flora Boreali-Americana.' Ledebour makes *pulchellum* different, and includes *capitatum* and *humile* under it; these, however, graduate quite insensibly into *cæruleum*. Ruprecht finds both in the arctic island of Kolgujew. It is very remarkable that this plant inhabits no part of Greenland but the east coast only, and at a very high latitude.

PHLOX *Richardsonii*, Hook. This appears to me only an arctic tufted form of *P. Sibirica*, to which, I think, may also be referred *P. Douglassii*; all have more or less, and often strongly, recurved margins to the leaves; and the other differences are comparative and trifling.

MYOSOTIS *alpestris*, Sw. (*suaveolens*, M. & K.). Fries and Koch merge this into a variety of *sylvatica*, which alone inhabits Lapland. Bentham takes the same view. Watson retains it, finding that it keeps its characters well under cultivation.

M. cæspitosa, Schltz. This Bentham unites with *palustris*, and probably correctly.

M. arvensis, L. (*intermedia*, Link.). Watson finds this occasionally approximating to *cæspitosa*; and I find it difficult to separate northern forms of one from the other.

ERETRICHIUM *villosum*, Bunge. *E. aretioides*, A. DC., is nothing but a dwarf arctic state of this. Ledebour unites *E. latifolium*, Rupr. (non Kar. & Kir.), with the same, as var. β; and so does Trautvetter (Flor. Taimyr.).

MERTENSIA *pilosa*, DC., which includes *Lith. corymbosum*, Lehm., and *paniculatum*, Don, is clearly referable to *denticulata*, Don, the hairy calyx being a very inconstant character. These should possibly all be united under *Sibirica*.

M. Drummondii, Don. I find no plicæ in the tube of the corolla of this plant, whence it must be removed from the section in which DeCandolle places it to that with *Virginiensis*, of which it appears to be a northern form, as suspected in 'Flora Bor.-Am.' It has not, however, been gathered anywhere between the Arctic Sea-coast and the United States.

MENTHA *Lapponica*, Wahl., is referred by Fries to a northern variety of *arvensis*. Both grow in Lapland.

GALEOPSIS *Tetrahit*, L. Fries and Koch keep this distinct, as does Watson, who gives as presumptive evidence in its favour the statement that the seeds of *versicolor* yield plants of their own kind only. Bentham says that they graduate one into the other.

STACHYS *palustris*, L. According to the synonyms quoted by Asa Gray, this N. American plant includes many very divergent forms, including some that might almost be referred to *S. sylvatica*. Under the latter plant I have not introduced the Chilian *S. chonotica*, which approaches it closely.

LIMOSELLA *aquatica*, L. I include under this *L. tenuifolia*, which is the more common southern form, and certainly is nothing but a variety with reduced foliage. *L. borealis*, Lessing, is another form, found in Lapland only, according to Fries.

GYMNANDRA *borealis*, Pall. I am quite unable to distinguish *Stelleri* and *Pallasii*, which were included originally by Pallas under *borealis*. Choisy says, in DC. Prodr. xii. 24, that it is difficult to dissent from Pallas's view, who regarded the genus as *monotypic*, Willdenow makes eight species, which Chamisso and Schlechtendal reduce to three.

CASTILLEJA *septentrionalis*, Lindl. I have no hesitation in uniting this with *pallida*, as suggested 'in Flor. Bor.-Am.' It advances south to Canada.

VERONICA *borealis*, Læst., is included by Fries as a variety of *serpyllifolia*, both being Lapponian.

V. fruticulosa, L. Koch retains this as different from *saxatilis*, but Bentham considers it the same.

MELAMPYRUM *Americanum*, Mich. Asa Gray keeps this up as a species, but Bentham reduces it to a var. of *pratense*. The smaller, more slender corolla is the only character I can find.

RHINANTHUS *minor*, Ehr. This form of the genus is, according to Fries, the only one found in Lapland; it is the *Crista-galli*, var. *α*, of Linnæus according to Koch. Bentham does not consider it a sufficiently constant form to rank as a race even.

EUPHRASIA *officinalis*, L. The varieties *montana*, Fr., and *alpestris*, Koch, are found throughout Lapland according to Fries.

PEDICULARIS *amœna*, Ad. Retained as distinct from *verticillata* by Ledebour and by Bentham, who, however, on examining more specimens with me, agrees that it is only a slight variety connected by intermediates; both are arctic plants.

P. borealis, Stev., is, according to Fries, a Lapland and Finland variety of *palustris*, L.

P. lanata, Willd., is reduced to *hirsuta* by Bentham, and, I think, rightly.

P. arctica, Br., is reduced to *Langsdorffii* by Bentham, with *purpurascens*, for an old synonym.

P. Langsdorffii. This I find to pass by insensible gradations into *Sudetica*.

P. Kanei. I have never seen authentic specimens of this, but the description agrees with forms of undoubted *Sudetica* gathered in Greenland.

UTRICULARIA *vulgaris*, L. This is unquestionably a native of Arctic Europe; but though common in Temperate N. America, both east and west, I am not so sure of its entering the arctic circle there. I presume, however, it is one of the two alluded to by Richardson ('Boat Journey through Rupert's Land').

U. intermedia, Ehr. Fries and Koch keep this distinct from *U. minor*. Watson also retains them, but observes that much confusion exists about them. Bentham and Oliver (who has lately worked a great deal at this genus) think that *intermedia* is only a form of *minor*. Of the two, *U. intermedia* is both Arctic European and American; *minor* is Arctic European, but is also found in Tibet.

DODECATHEON *integrifolium*, Mich., and *frigidum*, C. & S., are certainly only varieties of *Meadia*. Torrey indeed (Bot. Whipple's Exped., p. 62) recognizes but one species of the genus, which is found from the arctic circle to New Mexico.

TRIENTALIS *latifolia*, Hook., is considered a variety of *Europæa* by Torrey (Bot. Whipple's Exped.); it extends along the Rocky Mountains to California.

T. arctica, Fisch., is scarcely distinguishable from *Europæa* as a variety, to which Ledebour refers it. I have seen no arctic specimens, though it extends to Sitcha and Kamschatka. The *T. Americana*, the best-marked American species, extends from the U. States to Labrador. It differs in appearance from *Europæa*, and is certainly far more distinct from it than either *arctica* or *latifolia*. Torrey at first considered it a variety; but both he and Asa Gray have since regarded it as a species.

ANDROSACE *triflora*, Adams. This, which is unknown to Ledebour, Duby, and myself, appears, from the description, not to differ from *Chamæjasme*. *A. Chamæjasme*, though more properly a West Arctic American plant, extends eastward to Victoria Land.

Ledebour (Flor. Ross. iii.18) gives Kotzebue Sound as a habitat for *villosa*, quoting, erroneously, Beechey's 'Voyage.' I do not think it is anywhere an arctic plant.

PRIMULA *stricta*, Horn. I find it difficult to distinguish some arctic forms of this from others of *farinosa*, but think I have given its distribution correctly. *P. Hornemanniana* is now generally admitted to be a synonym. *P. Mistassinica*, C. & S. (non Mich.), is referred by Ledebour to *P. stricta*; and *P. Mistassinica*, Mich., was united with the same plant in the 'Flora Boreali-Americana,' with probably good reason according to Duby.

P. borealis, Duby. Ledebour says of this, "planta mire varians." Ruprecht suggests that it is only a var. of *stricta*, and rightly, I have no doubt.

P. nivalis, Pall. The distribution of this plant is peculiar. It is found nowhere in Europe, except the Caucasian provinces be considered such; it is, however, a native of all Siberia and N. W. America.

P. saxifragæfolia, Lehm. Ledebour reduces this to *cuneifolia*, and no doubt correctly.

P. Scotica, Hook. This is a form distinct enough in many places, but graduates into *P. farinosa*, with which Bentham joins it. Fries keeps it distinct, as does Watson, who remarks that its characters depend chiefly on its larger purple corolla. *P. farinosa* itself, though a native of Finland, scarcely extends into Lapland.

P. Finmarchica, Willd. Fries says the flowers are purple, and distinguishes it from *Sibirica*, observing that it is arctic, and not alpine. Ruprecht, Ledebour, and Duby make of it *Sibirica* β.

ARMERIA *vulgaris*, L. I do not see how the distribution of the plants named under this can be treated apart. Of these *A. alpina* is an inland form found in the Alps of various parts of Europe, though not Scandinavian according to Fries; it is the *Armeria* γ *alpina* of DeCandolle. *A. elongata*, Hoffm., is the only one entered as Lapponian by Fries; it is referred to *Armeria* α by Ledebour. *A. Labradorica*, Wallr., is *vulgaris* ε of Meyen's Labrador plants. *A. arctica*, Rupr., is *A. vulgaris* of Nyman, and *vulgaris* β. *arctica* of Ledebour. *A. Macloviana*, Cham., is the same with *Andina*, which Torrey (who has a var. *Californica*) refers to *vulgaris*, observing that many of the species broken off from *vulgaris* had better be referred back (Bot. Whipple's Exped. p. 62).

RUMEX *Hippolapathum*, Fr., is reduced to *aquaticus* by Meisner in DC. Prod., and in part by Ledebour.

R. arcticus, Trautv. I am unacquainted with this plant, which would seem not to differ from *R. aquaticus* in any important character, or in distribution. Trautvetter (Plant. Taimyr.) observes that it is perhaps Chamisso's variety of *domesticus* with a simple whorled raceme.

R. domesticus, Hartmn., is *aquaticus* β of Wahlenberg. Fries reduces *aquaticus*, L., to a var. of *domesticus*. Both are Lapponian. Koch separates them, but by characters hardly tangible; Ledebour, who keeps them distinct, thinks it would be better to unite them. Meisner refers *domesticus* to *longifolius*, DC., and makes of the Arctic American plant the var. *nanus*.

R. salicifolius, Weinm. I am doubtful as to the merits of this species, and cannot come to any conclusion about it.

POLYGONUM *polymorphum*, Led., is not Scandinavian; but several of its varieties are Arctic Siberian and American, as β. *setigerum*, γ. *lapathifolium*, and *frigidum* (*P. alpinum*, All.).

P. lapathifolium, L. Kept distinct from *Persicaria* by Fries, Watson, Koch, and Bentham; but I find it impossible to distinguish North Indian specimens of one from the other, these being united by every intermediate form. *P. Persicaria* is, according to Fries, very rare in Lapland, and sporadic only.

Ledebour includes *P. Hydropiper* as Arctic Lapland on the authority of Felmann; but I find no confirmation in the works of Fries and Andersson.

CHENOPODIUM *maritimum*, L., is doubtfully mentioned as a native of the arctic sea-coast of America by Richardson. I have examined the specimens; they are very young, but identical with *maritimum*, which is a common subarctic plant.

MONOLEPIS *Asiatica*, Moq. I know nothing of this plant. The only recorded habitats I find are both Arctic Siberian, viz. Nishni Kolymsk and the Boganida River.

ATRIPLEX *patula*, L., It is impossible to unravel the synonymy and distribution of this plant and *A. hastata*, if, indeed, they really be distinct, which Moquin doubts. Fries keeps one *hastata* distinct, assigning it a place in the section with rugose seeds. Koch distinguishes it by the cordate-triangular (not hastato-rhomboid) sinuate-toothed perigonia. Moquin unites *angustifolia* with it. Bentham unites both these with *deltoides*, *littoralis*, and *erecta*. See, for further remarks in reference to the British species, Woods (Proc. Linn. for April 17, 1849), who observes that in several species the seeds are of two forms in the same individual,—one form slightly depressed, smooth, black and shining; the other (in larger lower perigonia) three times as large, more depressed, chesnut and wrinkled: he admits *angustifolia*, *patula*, *deltoidea*, and perhaps *erecta*. On the south-east coasts of England, I recognize three very distinct forms, often growing intermixed, viz. *A. littoralis*, L., *A. patula*, L. (*erecta*, Huds.), and *angustifolia*, Smith (all fairly well represented in English Botany). Of these the first and last are Arctic European and Arctic W. American; and *littoralis* Arctic W. American only, though common in temperate America.

A. deltoidea, Bab. Moquin refers this to *hastata*; Fries makes a variety of this (*prostrata*) a native of Lapland; Watson includes its distribution under that of *patula* (see remarks, 'Cybele,' ii. 324).

A. angustifolia, Sm. Moquin makes of this a synonym of *patula*; Watson keeps it distinct, but says nothing in its favour; Koch brings it to *patula*, and both to *latifolia*, Wahl.

A. Gmelini, C. A. M. A little-known plant, referable, according to Ledebour, to *patula*, but rather, I think, to *littoralis*, L., or perhaps to *angustifolia*, Sm.

URTICA *gracilis*, Ait. This is reduced to *dioica*, var. ε, by Weddell.

BETULA. I am quite unable to disentangle the species, forms, and varieties of this genus, or to harmonize the views of Fries, Spach, Regel, and other botanists. The Northern species are clearly most difficult of discrimination, as a reference to Fries's notes (Summa, pp. 211 and 556) will show. Regel's recent 'Monograph' seems carefully and judiciously executed.

B. glutinosa, Wallr., is now by Fries and others considered one with *alba*. Koch refers it to *pubescens*, Ehr., β. *Carpatica*; Regel (Monog. Betulac. p. 21) to *alba* δ. *glutinosa*.

B. intermedia, Wahl., is *alba* β of Ledebour, an Arctic Russian plant; it is the *humilis* of Hartm. and Rupr. (non Schrank). Ledebour observes that it approaches to *nana* very closely.

B. papyracea, Ait., is reduced to a var. of *alba* by Spach and Regel, and possibly rightly; but the American botanists, who know both, keep them distinct.

B. nana, L., is, according to Asa Gray, distinguished by a narrowly winged fruit; but the wing of Scotch specimens is very broad, and Ledebour remarks that this is a variable character; Regel says it is narrow or almost absent.

B. glandulosa, Mich. This, according to Asa Gray, is the *pumila*, L., distinguished by its cylindric catkins and broad-winged fruit. I have seen no Greenland specimens of it. It is the *nana* γ. *intermedia* of Regel, who keeps *pumila*, L., as a distinct species; he apparently has not consulted Asa Gray's 'Botany of the N. U. States.'

B. alpestris, Fr., is the *humilis*, Hartm., fid. Fries, and is so like British specimens of *nana* as to be scarcely distinguishable. I think it may well be included under *fruticosa*, Pall.; Ruprecht, however, refers *humilis*, Hartm. (non Schrank), to *intermedia* (*alba*, var. *intermedia*, Wahl.). Regel makes of it *nana* δ. *alpestris*, and possibly rightly.

ALNUS *barbata*, C. A. M. Fries keeps this distinct, and gives as a habitat Lapland, where *glutinosa* does not grow. It is the *glutinosa* γ. *barbata* of Ledebour, and β. *pubescens* of Regel.

A. viridis, DC. Ledebour distinguishes the plant of Chamisso, from Arctic America, from DeCandolle's; but to me they seem identical.

A. fruticosa, Rich. This, in the list, p. 301, is a misprint for *glutinosa*, Richardson (non Willd., &c.), which has been referred to *viridis* in 'Flor. Bor.-Am.,' and rightly.

A. repens, Vahl. The specimens I have examined of this appear identical with Richardson's *glutinosa*, and with *A. viridis*, DC. It is omitted in Regel's Monograph.

SALIX. I am indebted to Dr. Andersson of Stockholm for the Arctic List of this genus, who has further kindly supplied the following observations.

Salix pentandra. In Lapponia et Siberia certissime occurrit, in Lapponia ad locum Enare (maxime septentrionem versus!), in terra Samojedorum, in Kamschatka infra circulum polarem. In America sub forma *lucida* ad Fort Franklin et Mackenzie River. Ibi itaque non ad floram arcticam pertinet.

S. lanata, L. In omnibus regionibus arcticis vulgaris.

S. Richardsoni, H., est *S. lanatæ* forma Americana: cf. And. *l. c.* p. 13.

S. speciosa, H. et A. Species elegantissima, Americæ decus!

S. Lapponum, L. In Lapponia et Norvegia vulgaris. Terra Samojed. Siberia arctica ad Obdosck, etiam ibi rara. Ex America valde dubia: cf. And. *l. c.* p. 17.

S. Stuartiana, Sm. *S. Lapponum* est forma.

S. caprea. In Scandinavia ad promontorium boreale usque. In Rossia arctica (Kiola, terra Samojed.); in Siberia regiones tantum meridionales amat. In America non adest (ibi *S. capreoides*, And.).

S. nigricans. In Scandinavia omni etiam maxime boreali vulgaris. In Rossia Asiatica non circulum polarem ascendit, terra Samojedorum excepta, ubi a Ruprecht observata. In Kamschatka adest. In America nondum inventa.

S. punctata, Ldbg. Est modificatio lævis *S. nigricantis*, in Lapponia tantum observata.

S. phylicifolia, L. In Scandinavia omni boreali vulgaris. In Rossia arctica quidem occurrit, sed rarior. In America *S. discolor*, Muhl., *S. phylicoides*, And., et *S. macrocarpa* in regionibus extra-arcticis eam repræsentant: cf. And. *l. c.* pp. 18, 19.

S. myrtilloides, L. (*S pedicellaris* auct. Amer.).

S. hastata, L. In Lapponia vulgaris, Rossiæ arcticæ etiam incola. In America *S. cordata* hujus est forma analoga.

S. rhamnifolia. Ad sinus St. Laurentii et in Unalaschka.

S. ovalifolia, Trautv. Ibidem.

S. Arbuscula. Vera Linnæi species Lapponiæ arcticæ est incola. Ex Rossia Asiatica ut etiam ex America dubia; in formis autem nostræ analogis ibi occurrit, regiones autem magis meridionales amat.

S. glauca, L. In regionibus arcticis omnibus vulgaris.

S. desertorum, Rich. *S. glaucæ* forma vel subspecies: cf. And. *l. c.* p. 23.

S. villosa, Don. *Salicis glaucæ* est forma vegeta: cf. Andersson, 'Salices boreali-Americanæ,' p. 22.

? *S. arctica*, Br. Maxima vel polymorpha species regionibus omnibus arcticis peculiaris. Vereor ne sub nominibus variis (*S. myrsinites*, *S. retusa*, *S. ovalifolia*, *S. polaris*, &c.) formæ variæ hujus speciei ab auctoribus sæpe descriptæ sint. And. *l. c.* p. 23.

S. cordifolia, Psh. Partim ad *S. alpestrem*, And., partim ad *S. subcordatam*, And., pertinet: cf. And. *l. c.* p. 24.

S. Pyrenaica, G. In Lapponia et America (*S. cordifolia*, Pal. pro parte): cf. *S. alpestrem*, And., *l. c.* p. 27. Verisimiliter etiam in Siberia arctica occurrit sub speciebus plurimis diu cognitis latens obscura.

S. myrsinites, L. Sub plurimis formis in regione arctica ubique.

S. reticulata, L. In regionibus arcticis omnibus vulgaris.

S. vestita. *S. reticulatæ* est forma fruticosa et vegeta: cf. And. *l. c.* p. 29.

S. nivalis. *S. reticulatæ* est forma nana: cf. And. *l. c.* p. 29.

S. herbacea, } In regionibus omnibus arcticis vulgaris.
S. polaris. }

The following species, though enumerated as arctic by sundry authors, are not included by Dr. Andersson, who has the following remarks on them:—

S. laurina. Vere silvestris in Suecia non occurrit. In Europa centrali et australi magis vulgaris, regiones boreales non petit: proles forsan hybrida.

S. Smithiana. Ab ill. Ruprecht ad ostium fl. Mesen in terra Samojedorum lecta dicitur. Specimina nulla ex eo loco vidi, eamque ibi silvestrem esse dubito, potius *S. viminalis* forma latifolia. *S. viminalis* et *Smithiana* in Songaria endemicæ!

S. mollissima, Sm. = *S. Smithiana.* Vix in regionibus arcticis lecta.

S. acuminata, Sm. Auctoritate Ruprechti terræ Samojed. a Ledebourio adscripta. Mihi forma *S. capreæ videtur*! Species a *S. caprea* et *S. Smithiana* hybrida, raro occurrit.

S. aurita. In Scandinavia infra circulum polarem desinit. Rossiæ Asiaticæ a Fellman adscripta, sine dubio *immerito.* In terra Samojed. a Schrank lecta dicitur, attamen maxime dubito! E flora arctica certe excludenda. (In America *S. brachystachys*, Benth.)

S. depressa, L. Nomen in *S. vagans* mutandum: cf. And. *l. c.* p. 15, q. v.

S. reptans (Rich.? Ruprecht, Flora Samojed. p. 54). Specimina authentica non vidi; vereor ne forma sit *S. arcticæ*? vix autem, ut opinatur Ledebour, *S. glaucæ.*

S. Finmarchica, Fr. Species a *S. myrtilloidi* et *S. aurita* sine dubio hybrida, non supra circulum borealem detecta!

S. Uva-ursi, Psh. Nomen excludendum ut e *S. rhamnifolia*, *ovalifolia* et sequente compositum.

S. Cutleri, Tuck. In civ. New York: cf. And. *l. c.* pp. 26, 28.

S. canescens, Fr. Species a *S. Lapponum* cum *S. caprea*, *cinerea* et *aurita* hybrida, passim in Lapponia inferiore obvia. Ex ceteris regionibus incerta.

S. Taymyrensis, } *S. Boganidensis.* } Species hasce valde dubias judico. Potius *S. phylicæfoliæ* v. *S. Arbusculæ* formæ pygmææ trunco subterraneo. Quidquam certi de iis nondum enuntiare non audeo.

S. repens, L. Intra fines Lapponiæ non occurrit. Nec Asiam nec Americam borealem inhabitat. Itaque omnino excludenda!

S. versifolia, Wahlb., est species a *S. myrtilloidi* et *Lapponum* certissime hybrida, in Lapponia sporadica inventa. E Siberia arctica, prope Obdosck, signo (?) eam affert Ledebour. In regionibus extra Scandinavias, Livonia excepta, a me nunquam visa.

S. glabra, Scop. Nunquam extra alpes Europæ meridionalis observata!

S. grandifolia vera extra alpes Helvetiæ et Austriæ nondum observata!

S. amygdalina. Ad fluv. Tomea (infra circul. polarem) occurrit in Scandinavia. Nec in Rossia regiones subarcticas adpropinquat.

S. cinerea. In Lapponia subarctica non occurrit, etiam Asiam arcticam v. subarcticam fugit. In America vix adest.

S. retusa, L. In Lapponia non inventa. Species Rossicæ vix certæ, in *S. cuneatam* abeuntes. In America fit *S. phlebophylla*: And. *l. c.* p. 27.

LARIX *Sibirica*, Led. This, which is synonymous with *Ledebourii*, Endl., is neither American nor Western European. Its western limit is Archangel.

L. microcarpa, Lamb., is reduced by Asa Gray to a form of *Americana*, and, no doubt, rightly. *L. pendula*, Ait., is the same plant; and I can find nothing to warrant the separation of *L. Dahurica*, F. & Turc., from these.

JUNIPERUS *nana*, Willd. Fries makes of this a variety of *communis*, L. (as do Watson, Koch, and Ledebour), which is distinguished by the broader, incurved leaves. Every intermediate grade of leaf may be found uniting them.

J. prostrata, Pers. The Arctic American plant is certainly nothing but a stunted form of *Virginiana*, and is with difficulty distinguished from *J. Sabina*, L.

MONOCOTYLEDONES.

SAGITTARIA *variabilis*, Engelm. This is extremely closely allied to and the representative of *S. sagittæfolia*; it is chiefly distinguished by the absence of purple on the claw of the petals. The latter plant is Arctic Russian, but not Lapponian.

POTAMOGETON *sparganifolius*, Læst. Fries and Ledebour both retain this as a distinct species, the former noticing its very close affinity with *natans*.

P. tenuissimus, M. K. Fries makes of this a Lapponian variety of *pusillus*; Ledebour follows him.

P. nigrescens, Fr. Under this Fries doubtfully includes *lanceolatus*, E. Bot. He observes its very close affinity with *gramineus*, and that *P. coloratus*, Hoffm., is wholly intermediate.

P. heterophyllus, Schreb. Fries, Koch, and Ledebour all agree in considering this a form of *gramineus*, L.

TOFIELDIA *borealis*, Wahl., is the same with *T. palustris*, L.

VERATRUM *viride*, Ait. Asa Gray says of this, "too near the European *V. album*." The chief character lies in the breadth of the segments of the perianth, which, however, varies considerably in both.

V. Lobelianum, Bernh., is *album* β, floribus viridibus, of Chamisso and Ledebour, a very arctic form.

ALLIUM *Sibiricum*, L. Ledebour unites this with *Schœnoprasum*; Fries keeps them distinct, regarding the latter as a cultivated plant only.

ORCHIS *sambucina*, L. The distribution of this is peculiarly wide in some respects for an Orchideous plant, extending diagonally through Europe from Lapland to the confines of N.E. Persia in Karabagh.

PERISTYLUS *bracteatus*, Torr. This and *P. Islandicus*, Lindl., are so very closely allied to *viridis*, that they can hardly rank as anything but forms of that plant. This would appear to be the opinion of Lindley and of the 'Flora Boreali-Americana.'

PLATANTHERA *hyperborea*, Lindl. Iceland is the only European locality for this plant. From Lindley's observations and those in 'Flora Boreali-Americana,' there is no doubt that *dilatata*, Lindl., and *Kœnigii*, Lindl., are states of the same. Asa Gray further adds that *Huronensis* is a synonym of *hyperborea*, and that *dilatata* is too near the same.

EPIPACTIS *media*, Fr. This its author makes a distinct species, and does not include the true *latifolia* in his Lapland list. Koch refers it to *rubiginosa*, Gaud., distinguished from *latifolia* by the crispate callosities on the labellum. Watson includes the English *media* under *latifolia,* but doubts its being the same as Fries's plant. Bentham unites the English one, which I have seen under cultivation in Dr. Lindley's garden, where it was considered by that learned author to be a slight variety of *latifolia,* and essentially the same as Fries's *media,* though differing somewhat.

CYPRIPEDIUM *acaule,* Ait., is a synonym of *humile,* according to A. Gray.

C. Calceolus, L., is introduced into the Arctic European column on Ledebour's authority; it is not in Fries's List as an Arctic Lapland plant.

SISYRINCHIUM *Bermudianum,* L. The distribution of this plant is very extensive, reaching from the arctic circle to the Bahamas; and I strongly suspect that an Andean and Chilian species is identifiable with it.

S. anceps, Cav., is referred by A. Gray and others to a variety of *Bermudianum,* L.

SPARGANIUM *hyperboreum,* Læst., is *S. natans* β. *submuticum,* Hartmann; it is not in Fries's 'Summa,' where *S. natans* appears as an Arctic Lapland species.

NARTHECIUM *Americanum,* Ker. This, though kept up in all the American Floras, appears to me to be absolutely identical with the European *N. ossifragum.*

LUZULA *spadicea,* DC. All the species, &c., enumerated under this are considered varieties or synonyms, by Ernest Meyer in Ledebour's 'Flora Rossica.' *L. glabrata,* Hoppe, is distinct according to Fries, and is the *spadicea* γ of DeCandolle, and η *Kunthii* of E. Meyer; it is distinguished by the usually single-flowered pedicels. *L. parviflora,* Desv., also kept distinct by Fries, and found throughout Lapland, is *spadicea* ε of E. Meyer. *L. melanocarpa,* Desv., is considered a var. of *parviflora* by Asa Gray. *L. Wahlenbergii,* Rupr., is the same with *spadicea* η *Kunthii,* E. Meyer. For remarks on its distinctness from *glabrata* and *parviflora* see Ruprecht's 'Flor. Samojed.' Trautvetter (Plant. Taim.) observes that some of Ruprecht's *Wahlenbergii* probably belong to a var. of *hyperborea.*

L. pallescens, Wahl. Fries regards this as a species not yet fully established. Koch makes of it *multiflora,* var. ε. E. Meyer and Bentham unite it, *congesta,* and *multiflora* with *campestris.*

L. multiflora, Ehr., is *campestris* β of DC. and E. Meyer. Fries and Koch keep it distinct and include *congesta* under it.

L. hyperborea, Br. E. Meyer and most authors unite this with *arcuata,* Hook. Fries distinguishes it specifically by its plane leaves and capitate spikes.

L. vernalis, DC., is referred to *pilosa,* by Koch, E. Meyer, and most authors.

JUNCUS *biglumis,* L., and *triglumis,* L., are united by Bentham, and are possibly states of one plant, though always so distinguishable that most other authors keep them apart.

J. conglomeratus, L., and *effusus,* L., the two principal forms of *J. communis,* Ehr., are both arctic.

J. Balticus, Willd. Bentham observes that this is probably a luxuriant form of *arcticus.*

J. uliginosus, Roth. Fries and Koch keep this (the *supinus,* Mœnch.) distinct from *articulatus.* E. Meyer regards them as synonyms.

J. lampocarpus, Ehr., is *articulatus* α and β of Linnæus, fide Koch. E. Meyer unites it. According to Fries, it is not Scandinavian.

J. alpinus, Vill. I have followed E. Meyer, Fries, and Koch, in keeping this distinct, though Kunth unites it with *articulatus*, and in the 'Flora Boreali-Americana' it is put as a synonym of *uliginosus*.

J. compressus, Jacq., is the same with *bulbosus*, L.

J. Bothnicus, Wahl., is a synonym of *Gerardi*, according to Koch and E. Meyer, as is *cœnosus*, Bich. fid. Fries and E. Meyer: the latter observes that *J. Gerardi* always grows in salt marshes, and *compressus* never.

J. atrofuscus, Rupr., is reduced to a synonym of *Gerardi* by E. Meyer in Ledebour, Fl. Ross.

Carex. I am indebted to Dr. Boott for revising the list of Carices, which, as it stands, embodies his views as to the specific limits of the Arctic forms and their distribution.

Scirpus *Olneyi*, A. Gray. This appears to me nothing but a very slight variety of *S. triqueter*.

Eriophorum *Chamissonis*, C.A.M., is regarded by Fries as identical with *capitatum*.

E. Scheuchzeri, Hoppe (*capitatum*, Host.), is distinguished from *capitatum* by the leaves scabrous at the margin, subglobose spike, and stoloniferous roots; it is not Scandinavian, but found in Arctic Greenland.

E. russeolum, Fr. Kept distinct by Fries, from its opake mucronate scales and yellow-brown setæ. It is found only in Lapland and West Finland.

E. latifolium, L. I find it quite impossible to distinguish *gracile*, *angustifolium*, and *polystachyum* by any definite or constant characters, and revert to the Linnæan opinion that all are forms of one, in which Bentham concurs.

Gramineæ.—This list has been twice most carefully revised by Col. Munro, who regards all the names brought under others as undoubted varieties or synonyms. I have in the following notes invariably put foremost the views of Grisebach (Flor. Ross.) and Andersson, as those of the two best and most accurate authors on Northern Grasses with whom I am acquainted. Andersson's in particular is an excellent work in all respects; he keeps up many critical species, but indicates in all cases accurately their intermediate positions, and recognizes the trivial nature of their characters.

Alopecurus *ovatus*, Horn., is *alpinus* β. *borealis* of Trinius and Grisebach, in Ledebour (Fl. Ross.), according to whom the α. *Scoticus* does not occur in Russia. *A. alpinus*, L., does not occur in Andersson's 'Gramineæ Scandinaviæ.'

A. Ruthenicus, Wein. This, a synonym of *nigricans*, Hornemann, is kept distinct by Fries, Andersson, and Grisebach. Fries says of a variety *pusillus*, "fere *A. alpinus*, Sm.;" again, of *nigricans*, "*A. pratensi* valde affinis."

A. aristulatus, Mich. Kept distinct by Asa Gray; it is the *geniculatus*, var. β, of Torrey's Flora.

A. fulvus, Sm., is kept up by Grisebach and Fries. It is considered the same as *aristulatus* in 'Flor. Bor.-Am.' Andersson says of it, "*A. geniculato* valde affinis ejusque varietati *fluitanti* nimium similis."

BECKMANNIA *erucæformis*, Host. The distribution of this plant is most extraordinary: in Europe it is absent in the whole north, west, and central area, but extends from N. Italy to Middle Russia through Greece. In Asia it is found in Mesopotamia, Persia, Caucasus, Siberia, N.E. Asia, and Japan. In America it inhabits the whole west coast from Oregon to California, the Rocky Mountains, the Saskatchewan, and passes down the Mackenzie to beyond the arctic circle. It is absent in the North and Central United States, but was found at St. Louis by Drummond. It is omitted in 'Flora Boreali-Americana.'

AGROSTIS *alpina*, Wahl. The *alpina* of Scopoli is kept distinct by Grisebach. Fries includes a Lapland plant of Villars's of that name under *rupestris*, All., as Lapponian. Andersson reduces *alpina*, Wahl., to *rubra*, and observes that it is a very northern plant, hardly known out of Scandinavia. I follow Munro in bringing *alpina* under *rubra*, L., though I must confess I do not see why in that case *A. rupestris*, All., should not follow. The true *A. alpina* of Scopoli, said to have been once found on the Loffoden Islands, is excluded by Andersson. The true *A. rupestris*, All., according to Blytt and Andersson, is not Scandinavian.

A. alba, L. I follow Munro in uniting this (*polymorpha*, Huds.,) with *vulgaris*. Grisebach keeps it distinct.

DEYEUXIA and CALAMAGROSTIS. I have implicitly followed Munro in these genera, being quite unable to arrive at any satisfactory conclusion regarding them.

D. Canadensis, P. B. Durand is the only authority for this being a South Greenland plant; but as he does not mention *varia*, *strigosa*, or *lanceolata* (all reputed Greenland plants), I hesitate to admit it.

D. neglecta, Rupr. and Ehr., is a synonym of *stricta*, according to Grisebach, Fries, and Andersson. It is kept distinct from *Lapponica* by all.

D. chalybæa, Fries, is kept distinct by its author and Andersson, who observes of it, "*C. Lapponicæ* simillima, sed non parum diversa." It is the *Lapponica* β. *chalybæa* of Læstad.

D. purpurascens, Br. Asa Gray refers this doubtfully to *sylvatica*, DC. (Manual Bot. N. U. S.); Torrey more confidently (see 'Flor. Bor.-Am.').

D. Grœnlandica, E. M. This is one of Kunth's unknown species (Agrost. 239) referred here by Col. Munro. It is not referred to in Lange's Greenland list. It is also a Labrador plant, according to E. Meyer.

D. montana, Host., is the *Arundo varia* of Wahlenberg. Fries gives the Baltic Islands as its only Scandinavian habitat.

D. Hartmanniana, Fr., is kept distinct by Andersson and Grisebach; but Fries considers it insufficiently established. Andersson says of it, "pulcherrima species, inter *Hallerianam* et *sylvaticam* fere media;" he places it next *strigosa*. I follow Munro in bringing it under *varia*.

D. aleutica, Bong. Kept up by Grisebach; but Col. Munro considers it identical with *strigosa*.

D. Langsdorffii, Tr. Kept up by Grisebach, but considered by Munro the same with *purpurea*.

D. elata, Blytt, is the form β. *major* of *phragmitoides*, according to Andersson, which approaches *lanceolata*.

CALAMAGROSTIS *litorea*, DC., is a synonym of *laxa*, Host., according to Grisebach. According to Fries, it is an insufficiently defined species. Andersson observes its extremely close affinity with *Epigejos*.

C. Halleriana, Gaud. A distinct species, according to Grisebach, Fries, and Andersson, who, however, says (under *lanceolata*, var. *cinerascens*), "*C. Hallerianæ* proxima," and, again, "inter *C. lanceolatam* et *phragmitoidem* omnino media videtur."

C. phragmitoides, Hartm. Also kept up by Grisebach, Fries, and by Andersson, who observes of one variety, "*C. Hallerianæ* analoga;" of another, "ad *C. lanceolatam* quodammodo vergens;" and of a third, "a *C. lanceolata* difficile dignoscitur."

HIEROCHLOE *racemosa*, Tr., is a synonym of *pauciflora*, according to Grisebach.

DESCHAMPSIA *brevifolia*, Br. This, the *Aira arctica*, Tr., who elsewhere regards it as a var. of *cæspitosa*, is kept up by Grisebach. Fries reduces it. Andersson remarks of *brevifolia*, Hn., that it is very remarkable from resembling a hybrid between *cæspitosa* and *flexuosa*.

TRISETUM *agrostideum*, Tr., is kept distinct from *subspicatum* by Andersson, Grisebach, and Fries. Andersson remarks that it is so entirely intermediate between *flavescens* and *subspicatum*, that it is extremely difficult to say to which it is best referred.

T. Sibiricum, Rupr. (*Aira Ruprechtii*, Griseb.), is distinguished by Grisebach by its much larger scabrous-bearded florets. Andersson observes how very near it is to *agrostideum*.

PHIPPSIA *monandra*, H. & A., is a synonym of *algida*, according to Grisebach. It is *algida* β of Kunth. It is kept distinct in 'Flor. Bor.-Am.'

CATABROSA *aquatica*, Br. Durand gives this as a native of Greenland, lat. 65° N.

COLPODIUM *pauciflorum*, Hook. Only one habitat is known for this; it may be a reduced or starved state of *latifolium*; but much better specimens are required to determine the point.

C. arundinaceum, Hook., is *latifolium* β, Trinius and Grisebach, and is reduced to a synonym by Andersson.

C. fulvum, Tr. Andersson doubts whether this and *pendulinum* are really distinct species; and judging from the fine specimen in Herb. Hook., I am disposed to think, with reason.

Poa deflexa, Rupr., *remotiflora*, Rupr., and *similis*, Rupr., all of Samoyedland, are all reduced by Grisebach to *Colp. pendulinum*—the last as a variety, the two first as synonyms.

P. scleroclada, Rupr., *latiflora*, Rupr., and *pœcilantha*, Rupr., all of Samoyedland, are reduced by Grisebach to synonyms of *Colp. fulvum*.

DUPONTIA *Fisheri*, Br., was named after Mr. Fisher, one of Parry's officers, and should not be written *Fischeri*.

D. psilosantha, Tr., of which *Poa pelligera*, Rupr., is a synonym, according to Grisebach, is kept by that author as a distinct species.

GLYCERIA *arctica*, Hk., is certainly only a starved state of *fluitans*. Durand gives this as a native of Greenland, lat. 68° N.

POA *airoides*, Nutt., is identical with *Atropis distans*, Griseb.

P. angustata, Br. (*Atropis*, Griseb.), is kept distinct by Grisebach with *P. Nutkaensis* as a synonym; it is a very arctic form.

P. angustifolia, L., is *pratensis* γ of Grisebach; it is rare in the arctic regions. Andersson refers it, with a query, to *serotina*.

P. trivialis, L., is kept distinct by Grisebach, Fries, Andersson, and almost all authors; it is also arctic. Fries doubts the identity of the Linnæan plant.

P. nemoralis, L. I have followed Munro in bringing together the following names, which, whether species or no, are not to be discriminated by arctic stunted specimens; he considers them all forms of one:—

P. cæsia, Smith, is kept up by Grisebach and Andersson, with *aspera*, Gaud., as a synonym; Fries also keeps it distinct; Andersson indicates its extremely close affinity with *nemoralis*.

P. Grœnlandica, Steud., is nothing but *serotina*, Ehr., which is kept up by Grisebach, Fries, Asa Gray, and Andersson.

P. bryophila, Tr. Called arctic by Grisebach, who has never seen the plant; but I do not find the locality (Fret. Senjawin) in any map. Munro reduces it to *nemoralis*.

P. Vahliana, Liebm., Flor. Dan. 2401, is but a slight variety of *nemoralis*.

P. laxa, Hænke. Grisebach, Andersson, and Fries all keep this distinct from *flexuosa*. In 'Flor. Bor.-Am.' they are treated as synonyms. For remarks on its affinities, see Andersson (Gram. Scand.).

P. Cenisia, All. Grisebach keeps this distinct, but refers *Cenisia* of Fries's Herb. Norm. to *arctica*, Br. (*flexuosa*, Wahl.). Fries refers *flexuosa*, Wahl., to *Cenisia*. Andersson considers *Cenisia* hardly distinct from *arctica*, Br.

P. arctica, Br. Kept distinct by Grisebach, who makes *flexuosa*, Wahl., a synonym of it. It is *flexuosa* β of Trinius, and *laxa*, Br. in Ross's Voyage.

P. abbreviata, Br. Unknown to Grisebach, and reduced by Munro. Fries and Andersson reduce *abbreviata*, Blytt, to *Cenisia*, var. *depauperata*.

FESTUCA *Richardsoni*, Hook. Durand, on Torrey's authority, gives what Torrey doubtfully considers a variety of this plant as a native of Greenland. I know of no species to which *Richardsoni* is closely allied, except the Rocky Mountain var. *F. scabrella*, of which it may be a hirsute form.

F. *ovina*, L. I follow Munro and Bentham in reducing *rubra* and *duriuscula*, and the former authority in bringing *Kœleria hirsuta* and *F. brevifolia* here. The latter is a marked small form, but passes gradually into *rubra*. Andersson keeps up *ovina*, *duriuscula*, and *rubra*, bringing *arenaria* under the last, and *sabulosa* under the first. Grisebach keeps up *ovina*, L., with *duriuscula* as var. δ; also *rubra*, L., with *arenaria* as var. β, and *Kœleria hirsuta* (of which I know nothing) as distinct from both; but Munro reduces all to *ovina*, L. Fries unites *arenaria* and *rubra*, keeping *duriuscula* and *ovina* distinct.

F. brevifolia, Br. Brown says of this (Flora of Melville Island), "forsan nimis affinis *F. ovinæ*."

BROMUS *inermis*, Leys., and *purgans*, L., are both kept distinct from *ciliatus*, L., by Grisebach. I am indebted to Munro for their identification, together with that of *pictus*, mihi, which is undoubtedly *ciliatus*, L. Asa Gray refers *purgans* to *ciliatus*. Durand mentions this plant as a native of Greenland, lat. 65°, under the name of *B. Kalmii*? according to Dr. Torrey.

TRITICUM *violaceum*, Horn. Fries keeps this distinct; but Blytt suspects it to be a variety of *T. caninum*. Andersson observes that it is an alpine and arctic plant, not uncommon in Greenland, altogether intermediate between *caninum* and *repens*, and concludes "nonne attamen modificatio alpina?"

Since the printing of the foregoing paper, I have received, through the kindness of Dr. Asa Gray, particulars of the discovery of *Calluna vulgaris* near Tewksbury, Massachusetts, by Mr. Jackson Dawson, occurring rather abundantly over about half an acre of boggy ground, amongst various strictly American plants. This tends to confirm the statement of De la Pylaie, that *Calluna* is an inhabitant of Newfoundland.

J. D. HOOKER.

Kew, Oct. 11, 1861.

ERRATUM.

At p. 317, line 8, *after* "regions" *add* "of Europe and Asia."

XVIII. *Further Observations on* Entozoa, *with Experiments.* *By* T. Spencer Cobbold, *M.D., F.L.S.**

Read December 20th, 1860.

Although, since my last communication, I have had fewer opportunities of examining Entozoa, I think it will be admitted that the new or otherwise important forms which have come under my notice, are of sufficient interest to be placed on record, in continuation of the series of papers previously submitted to the Society.

In the present instance, the number of different animals specially examined with reference to the presence or absence of internal parasites, amounts in all to forty-three, including seven fish, two reptiles, seventeen birds and nineteen mammals. Of these only three fish, one reptile, seven birds and the same number of mammals, were found infested. In so far as these numbers refer to species formerly living in the Zoological Society's menagerie, the proportion is small, and tends to confirm both the statement and explanation which I have before hazarded in respect of the comparative freedom from internal trematode parasites, found to obtain in foreign animals subjected to a condition of captivity.

1. Distoma conjunctum (mihi).

Distoma conjunctum, Cobbold, Linn. Soc. Proceed. vol. v., Zool. Div. p. 8.

Remarks.—As already briefly indicated in my synopsis of the Distomidæ, published in the Society's Proceedings (*loc. cit.*), this species of fluke infests the liver of the American Red Fox (*Canis fulvus*). The animal in question died at the Zoological Society's Gardens, Regent's Park, in December, 1858, and was dissected on the 24th of that month, the carcase being still quite fresh. The biliary ducts were found thickened and enlarged in several places, forming here and there small cysts of variable size. In these cavities—partly occupied by purulent matter—the distomes were lodged; and when placed in water they showed signs of life. Their extreme transparency at once displayed, under the microscope, the relative position and degree of development of the various organs, as shown by the accompanying figure (fig. 1, Plate XXXIII.), in which I may particularly remark the great breadth of the digestive cæca, the well-defined excretory canals passing transversely inwards from the botryoidal albumen-forming glands (Dotterstock), and also the large yelk-forming organ or ovary (Eikeimstock), placed in the centre of the body, immediately below the uterine folds. A still more noticeable feature, however, is seen in the unusual length and breadth of the contractile vesicle belonging to the excretory system. It occupies fully one-third of the longitudinal diameter of the body, and bifurcates at the summit, the course of each division being traceable almost as far forward as the bulb of the œsophagus; below, it is suddenly constricted, and terminates, as usual, by a small central aperture. The sac itself

* An abstract of this paper has been published in the Society's Proceedings, Zool. Div. vol. v. p. 255.

is comparatively narrow and tortuous at the upper half, where it passes between, and apparently contributes to separate, the two well-developed and irregularly oval-shaped testes. The inferior half is much broader, and is occupied by numerous glittering corpuscles, which are especially numerous at the lower end. The character of these particles has already been accurately described by Wedl, Wagner, and others; but I did not observe any of them connected together in the form of cellular masses, such as Claparède has described as occurring in the excretory ducts of *Holostomata*. In connexion with the reproductive system, I may notice the circumstance of a pair of these flukes being found sexually united, as represented in fig. 2; an observation so rare, that it has, I believe, led some to infer that the hermaphroditic flukes were capable of self-impregnation. Even Bilharz's discovery of a trematode specially furnished with a gynæcophoric canal, afforded no direct proof of a true sexual function in the androgynous *Distomata*, because in his aberrant form—as obtains also in a few others—the sexes are separate. Many thousands of flukes must have now passed under my examination, and yet this is the first instance in which I have observed a true sexual union; moreover, I am not acquainted with any similar observation on record, in so far as it affects the truly hermaphroditic species. In the instance now mentioned, the opposed suckers were so firmly adherent that it was found impossible to detach the animals without breaking them up piecemeal. Lastly, I may notice that the ova (f', fig. 1) contained in the uterine folds have a longitudinal diameter of only $\frac{1}{750}$ of an inch.

2. Pentastoma denticulatum, Rudolphi.

Pentastoma denticulatum, Rudolphi, Bremser, Wiegmann, Dujardin, Diesing and others.

P. tænioides, in the young state, according to Gurlt, Küchenmeister, and especially Leuckart. See Mem. in Henle and Pfeiffer's Zeitsch. f. rat. Medecin, Bd. iv. p. 78, 1858.

Remarks.—Although it is clear from the investigations of Schubert and Van Beneden respecting the condition and development of the embryo of *Pentastoma*, that this genus is closely allied to the Acaridæ, its habits are so intimately associated with those of Entozoa proper, that there can be no impropriety in offering a short notice in this place.

On the 10th of February, 1859, I obtained numerous examples from the viscera of a Bubale (*Antilope Bubalis*, Pallas), which had died the day previous at the Zoological Society's Gardens. The greater part of these worms occupied the surface of the lungs and intestines; a considerable number, however, being enclosed in cysts beneath the pulmonary pleura. Fifteen or more having been taken away for the purposes of microscopic examination and experiment, I had ample opportunity of watching the movements of the cephalic claws whilst the animals were still living. I may here remark, that these claws do not in any way resemble those of the Tape-worm family, but, in strict accordance with other external features, show that the Pentastomes belong to an entirely different type. Placed under the half-inch objective, with the ventral surface uppermost, the transparency of the body permits a full view of the apparatus of hooks, as displayed in the accompanying drawing (fig. 3). It will be here noticed that the points of the claws are directed towards the observer, and not towards the longitudinal axis of the body as Küchenmeister's figure ('Parasiten,' tab. viii. fig. 11) would lead one to suppose; moreover, the claws are placed obliquely in reference to the central line, the angle of divergence being about 25°. During the eversion and retractation of the claws, the vacant spaces directly above them dilate and contract, so as greatly to facilitate the prehensile action of the hooks. These depressions are obviously inversions of the ventral integument, forming socket-like pouches for the implantation of the hook-capsules. If one of the claws be isolated and viewed laterally, it will be seen to consist of two parts—namely, a strongly curved *hook* (*a*, fig. 4), and a *capsule* (*b*). The upper part of the latter forms a hood (*d*), for the lodgement, support, and protection of the hook; the lower tubular portion serving to fix the apparatus in the body, and at the same time to regulate the movements of the claw through the intervention of a muscular pulley (*g*), which enters the tube at the lower end. Acting antagonistically to this, we find an extensor muscle (*f*) inserted into the anterior border of the base of the hook itself. The summit or projecting point of the hood is flattened out, so as to form a three-cornered process (*e*), which covers and protects the sharp extremity of the hook when the latter is retracted.

In regard to other external appearances, my observations for the most part correspond with those already on record; but with reference to the rows of minute integumentary spines, it will be seen from my figure (3), that the uppermost row is placed somewhat more apart from the second—at least, at the sides; the whole forming a complete and graceful tracing, as it passes downwards on either side between the inferior and superior pair of cephalic claws. Further, I do not find the spines themselves to be simply conical, as hitherto represented, because their uniformity of outline is interrupted at the lower third, as shown at the left margin of figure 5; this appearance, indeed, can only be seen by a lateral view. The so-called stigmata (Athemlöcher of Nordmann) display a double outline, but no vessels could be traced in connexion with them.

With respect to the internal structure of this parasite, very little can be made out—a circumstance materially favouring the notion that we have to deal with an imperfectly developed animal. Throughout the body there exists a central clear space, and this is well defined by dark lateral masses, which narrow out on either side of the head, in the form of a horse-shoe-shaped band enclosing the mouth and the four chitinous claw-masses. These dark patches at first sight look like albumenogene organs, but a closer examination shows that they are entirely made up of large parenchymatous cellules, unconnected by any special fibres or tubes. In an isolated and highly magnified group of them, the granular contents and central nuclei at once became visible, as represented in fig. 6, where some have become flattened at the sides from accidental pressure *.

Before finally quitting the consideration of this parasite, I may advert to the recently advanced opinion of Gurlt, Küchenmeister and others, respecting its assumed larval condition. After the perusal of Leuckart's original memoir †, kindly placed in my hands by Mr. Busk, I naturally felt desirous of repeating that distinguished zoologist's experiments. Accordingly (as I have already stated in the Quart. Journ. Micr. Sc.), on the 11th of February, I proceeded to infest two dogs. Into the nostrils of the first hound, stated to be

* Leuckart, in his recent work, 'Bau und Entwickelungsgeschichte der Pentastomen,' says they are glandular, and finds ducts in connexion with them.

† Henle and Pfeiffer's Zeitsch. *loc. cit.*—See also my translation in the 'Micr. Journal,' vol. vii. p. 182.

only ten months old, I introduced nine living Pentastomes, and in the second—an old dog—five examples. All the worms quickly disappeared, and I therefore fully expected a satisfactory result. I was doomed to disappointment. On the 4th of March the young animal was destroyed, and I made a most careful dissection of the head, without, however, finding a single Pentastome in any of the nasal, frontal or facial cavities. I regret to add, that the old dog was subsequently killed and thrown away during my absence, and I have not since had an opportunity of repeating the experiment. Prof. Leuckart, having seen the memorandum above-mentioned, suggests that the parasites may have been dislodged by the dog's sneezing.

3. Trichocephalus affinis, Rudolphi.

T. affinis, Rudolphi; Miram; Lamarck; Gurlt; Mayer; Dujardin; Diesing, Helminth. vol. ii. p. 296; Küchenmeister, Parasiten, p. 275.

T. Cameli, Rudolphi.

T. ovis, Abildgaard.

T. Giraffæ, Clot-Bey (non descript.), in Bulletin Scient. de l'Acad. Imp. de St. Pétersb. 1839, tom. vi. p. 94; also in Isis, 1839, p. 663; Diesing, Syst. Helminth. vol. ii. p. 294 (species inquirendæ).

T. gracilis, Cobbold, Proceed. Zool. Soc. for 1860, p. 103 (non descript.).

Remarks.—In a paper, entitled "Contributions to the Anatomy of the Giraffe," which I had the honour of communicating to the Zoological Society on the 14th of February last, the circumstance of my having detected *Trichocephali* in the cæcum and colon of that ruminant is already mentioned. At the time referred to, I purposely abstained from giving any particular account of the worm, but, believing it to be a distinct form, I recognized it provisionally under the title of *T. gracilis*. Subsequently, finding the latter title to be applicable to a *Trichocephalus* discovered by Olfers and Natterer in two species of *Agouti*, I abandoned it; and I have, moreover, since satisfied myself by a very careful investigation, that the species in question is identical with the *T. affinis* of Rudolphi. Under the synonym of *Trichocephalus Giraffæ*, Diesing has grouped this worm among his doubtful forms, its presence having been previously noticed by Clot-Bey in the small intestines of a giraffe dissected at Cairo in the year 1839.

Viewed with the naked eye (fig. 7), one can scarcely detect any difference between this form and the well-known *T. dispar* of the human subject—an observation which applies to some other species of the same genus. In my examples the females measure from $1\frac{3}{4}$–2 inches in length, over all; the males reaching from 2–$2\frac{1}{4}$ inches. With the pocket lens, the surface of the worm appears smooth throughout, but when highly magnified, peculiar markings are seen on the anterior thin portion, which probably also extend over the body proper. The so-called neck presents a tolerably uniform thickness along its entire course; it is so narrow as to measure only from $\frac{1}{125}$–$\frac{1}{120}$th of an inch transversely, whilst the finely-pointed head itself, immediately below the mouth, has a diameter less than $\frac{1}{1000}$th of an inch. In the fresh state the head appeared to be lobed, or rather, I may say, furnished with two alæform lobed appendages, as represented in fig. 8; but in preserved specimens these appearances either partially or entirely disappear, leaving one in doubt as to their true nature. Küchenmeister has noticed the evanescence of apparently similar structures surrounding the mouth of *T. dispar*, and therefore supposes that the lobes in question are due to the presence of a peculiar organ, capable of eversion and inversion, and not merely the result of accidental sarcode globules. Be that as it may, I have been surprised to notice how completely other well-marked external and internal characters alter or disappear from shrinking, &c., caused by immersion in spirit. This observation especially applies to a very peculiar longitudinal band, which commences a little below the head, and can be traced on one side of the neck the whole way down to the beginning of the so-called body; it is remarkably distinct in fresh specimens, but barely discernible in those preserved. This band was first discovered by Dujardin, who states it to consist of prominent and pointed papillæ. Wedl has also described it as consisting of little warts and spines; whilst Küchenmeister goes so far as to compare these little prominences to the hooklets present on the male copulatory organs. According, however, to my own examinations, this band is made up of projecting, bluntly pointed, polygonal, epidermal cells, which in certain adjustments of the focus refract transmitted light so strongly, that the band of them looks as if it consisted of a regularly arranged series of pigment spots (fig. 9 *a*); at other times the centre of each cell becomes clear (a'), and the irregularly polygonal character of each individual cell is rendered more apparent. On one side of the longitudinal band, Dujardin also figures and describes a series of minute superficial papillæ, which he associates with a festooned border of the band. I have not observed these prominences; and the festooned markings are clearly due to the subjacent convolutions of the œsophagus (*b*), which are singularly uniform in size and disposition. In the fresh state, the dermal rings (*c c*) are beautifully distinct; they are said to extend all round the filamentary neck, but I found the transverse lines, indicating their limits, to cease at a little distance apart from either side of the longitudinal band. Midway between the latter and the serrated border of the neck there exists internally a double row of oval corpuscles (*d d*); but, as no vessels or fibres were observed in connexion with them, and their contents were not visible, I will hazard no opinion respecting their nature.

Turning now to the reproductive organs, the first thing that strikes one has reference to the unusual length of the penis and its membranous sheath—a character believed to be peculiar to this species. In this respect, at least, it departs very materially from what is observable in *T. dispar*, where the sheath forms externally a funnel-shaped tube, which may possibly be a distinct organ. At all events, if specific differences have any existence —and unfortunately for zoological science, recent hypotheses tend to limit, if not virtually to deny, their value altogether—no one can any longer reasonably entertain the notion that *T. affinis* and *T. dispar* are one and the same species. The organ to which I have just referred as present in *T. affinis*, is itself included in a sheath-like muscular mass, which I suppose to be concerned in the evolution of the penis. The free end of this intromittent muscle is shown in fig. 11 *a*. I never saw this muscular mass everted, but the anal opening (*b*, fig. 11) is sufficiently capacious to give it free passage, if necessary. The everted part of the sheath of the penis (fig. 10, and *c*, fig. 11) measures about the $\frac{1}{19}$th of an inch in length; it is perfectly transparent, not always uniform in breadth, but covered throughout its entire extent with minute, conical, sharply pointed spines, whose apices are directed backwards towards the body of the animal. The occasional absence of uniformity in the diameter of the sheath seems to me to be a point of some importance; for, had not my examinations extended over a considerable number of examples, I might have been led to the belief that I had to deal with several distinct forms of *Trichocephalus*. At first, indeed, this conclusion seemed inevitable, but finding intermediate conditions between perfect uniformity and the presence of a large flask-shaped distension near the free extremity, I can only suppose the variations to be due to the degree of protrusion at which the organ has arrived. In the accompanying woodcuts I have outlined a few of these appearances (figs. 1, 2, 3), which are intended for comparison with the simple condition of the sheath shown in fig. 10, Plate XXXIII. The penis itself is about three times longer than the everted sheath, the exposed portion measuring the $\frac{1}{14}$th of an inch; it is cylindrical, curved towards the tip, and coiled within the spirally twisted tail at its superior two-thirds; the free extremity is scimitar-shaped, and rather sharply pointed (fig. 12). I did not observe any markings on its surface, but internally there were lines indicating the presence of a groove or internal tube, such as has been described as occurring in *T. dispar*.

In regard to the organs of generation in the female, Küchenmeister states that there are no external appendages in *Trichocephalus* comparable to those known to exist in the allied *Trichosomata*. So far, however, from this being the case, there is, in the present species at least, a remarkably prominent, and more or less hour-glass-shaped sheath; this projecting vulva, if it may be so termed, being obliquely truncated at the free end, where it is also hollowed out, or rather inverted to give origin to the centrally enclosed vagina, whose orifice is somewhat constricted (fig. 13). The surface of this appendage is supplied with small spines, precisely similar to those described in connexion with the sheath of the male intromittent organ, the spines being likewise retroverted. This observation is confirmed by the statements of Mayer, who has described their occurrence at the vaginal orifice of *T. dispar*. Dr. Joseph Eberth, of Würzburg*, however, in a recent number of Siebold and Kölliker's 'Zeitschrift,' rather incautiously denies the assertions of Mayer†. Dr. Eberth, having discovered a series of long conical processes within the vagina of *T. dispar*, totally unlike those described by Mayer and myself, has inferred that the structures in question are the same as those seen by us. I translate and quote his own words:—"According to Mayer, these are similar in form and size to the spines on the appendix of the penis. By means of these backwardly-directed points, the spicule when introduced into the vagina is said to be retained during the copulatory act. These statements," he adds, "are not correct: the villi of the vagina are larger than the spines of the male, and their points are, on the contrary, directed forwards." The latter part of this observation is, doubtless, quite true; for it is evident that our little spines are entirely different from the curious villi discovered by Dr. Eberth.

The ova, previous to impregnation, as in other Nematodes, are, at a certain stage, flat and irregularly triangular in outline; the thin limiting membrane by which they are surrounded enclosing finely granular contents (fig. 14). In the perfectly developed egg,

* "Die Generationsorgane von *Trichocephalus dispar*," Zeitschrift for April 1860, p. 384.

† Zeitschrift für wissen. Zool., Band 9, s. 367.

the external chitinous capsule presents the same characters as in *T. dispar*; at either pole of the egg, where the shell terminates abruptly, an inner transparent membrane projects, in the form of a mammillary process (fig. 15). None of the eggs I examined appeared to contain fully developed embryos, but the interior yolk-mass exhibited evidences of segmentation, many of them displaying two nuclei. These ova have a longitudinal diameter of $\frac{1}{340}$th to $\frac{1}{320}$th of an inch.

Fig. 1.

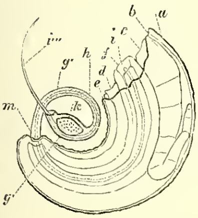


Fig. 2.

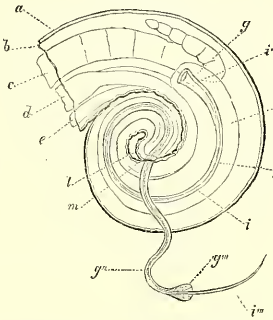
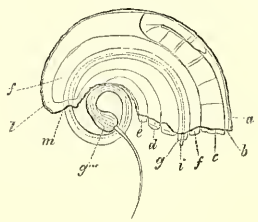


Fig. 3.



Figs. 1, 2, 3. *a*, Epidermis; *b*, cutis; *c*, cut cæcal end of the testis; *d*, seminal duct; *e*, intestine; *f*, intromittent muscle surrounding *g*, the sheath of the penis; *g'*, infundibuliform portion; *g''*, exserted portion, armed with minute retroverted spines; *g'''*, flask or cup-shaped expansion of the free extremity of the sheath; *h*, rings formed by contraction of a portion of the sheath; *i*, penis; *i''*, infundibuliform upper extremity of the penis or spicule; *i'''*, free pointed end of the same; *k*, an oval granular mass in one of the flask-shaped expansions, apparently consisting of spermatic particles; *l*, cloacal cavity; *m*, anus. Drawn, with the aid of a camera, from specimens mounted and preserved in glycerine.

In regard to the solution of Küchenmeister's hypothesis, which assumes the encysted *Trichinæ* to be only immature forms of the more highly developed *Trichocephalus*, my experiments have again been attended with merely negative results; but this has possibly arisen more from the unsuitableness of the particular hosts selected and operated on, than from any other cause. From economical considerations, I confess to have refrained from experimenting on sheep and pigs. On the 8th of December, 1859, I fed a rabbit with portions of raw potato, on which were placed three fresh female *Trichocephali*, all of them being readily devoured. On the 13th January following the rabbit was destroyed, and carefully examined, when neither *Trichinæ* nor eggs of *Trichocephalus* could be detected. On the day above mentioned I also fed a chicken with three other fresh *Trichocephali*; these worms having all been previously obtained from the giraffe. The bird perished from exposure to severe cold on the sixth night succeeding the experiment. When, however, I dissected it several days afterwards, although the muscles showed no *Trichinæ*, I was to a certain extent gratified to find several egg-shells of the *Trichocephali* still lodged in the intestinal cæca. Most of the egg-capsules were empty; but a few of them exhibited thinly scattered and disintegrated contents*.

* Since the above was written, I observe that Leuckart's recent investigations disprove the notion that *Trichinæ* are the young of *Trichocephalus*. See his treatise entitled 'Untersuchungen über *Trichina spiralis*, zugleich in Beitrag zur Kenntuiss der Würmkrankheiten.' 4to. Leipzig u. Heidelberg, 1860. See also 'Ann. des Sci. Nat.,' 4me sér. tom. xiii. p. 318.

The interest of this last-mentioned dissection did not altogether terminate here, as I was partly rewarded for my trouble by finding in the duodenum of the chicken a multitude of loose tape-worm joints, or proglottides in a somewhat unusual condition. There were also present a few imperfect Strobilas, whose joints had undergone no apparent alteration in form. Of course the loose joints had no genetic relation to the Entozoa which formed the subject of experiment; but, viewed independently, they appeared of sufficient interest to demand separate investigation. Accordingly I requested Prof. Huxley to examine them, and he kindly assisted me in arriving at a true explanation of their character. These proglottides were more or less oval, rounded, compressed, semi-opake, whitish bodies; to the naked eye discernible only by contrast with the coloured intestinal contents. They varied in size, the larger averaging $\frac{1}{25}$th of an inch in breadth; these latter containing fully developed 6-hooked embryos. Each individual of the brood (fig. 16) was enclosed in an outer and inner envelope; the middle pair of hooks, or boring apparatus, being simple and straight, and those of the lateral pairs lobed. The mature embryo measured $\frac{1}{400}$th of an inch in diameter over all. The point of interest in regard to these joints lies in the circumstance of their probable early separation from the head of the parent Strobila while living; this being rendered likely from the fact that Prof. Huxley found among the proglottides a tape-worm head with only one joint attached. Although some days had elapsed since the chicken's death, the frozen condition of the bird had prevented any structural disintegration of the tissues of the worm-segments; and I did not observe any free six-hooked embryos in the intestinal mucus. On the whole, therefore, it is fair to conclude that immature joints had become detached from the Strobila, and had attained their sexual maturity independently; a view, which, if confirmed by subsequent observation, will render the individuality of each proglottis remarkably significant.

Appendix.—In this place, as on a former occasion, I have thought it useful to note down, more or less briefly, such other interesting forms of Entozoa as have incidentally come under my observation; at least, I have here particularized a selection of them. Some of these parasites will elsewhere demand a more extended notice. From the Perch I have obtained two forms of *Echinorhynchus*, accompanied by a solitary example of the well-known viviparous Nematode, *Cucullanus elegans*. Being an adult female, it contained germs, eggs, and young in every possible stage of development. From a Pike I procured three very juvenile examples of *Tricuspidaria nodulosa*. In this parasite, and in immediate connexion with the sub-epidermal calcareous corpuscles, I have discovered peculiar vessels with flask-shaped ends, the latter surrounding the corpuscles. I have already described these structures in the 'Quart. Journ. Micr. Sc.*'; but I may here be permitted to add that, as they appear to be quite independent of the ordinary excretory system of vessels, I have since, on further consideration, arrived at the conclusion that they are rather to be regarded as special organs for the secretion and formation of the corpuscles than as a vicarious development of the excretory vascular system.

From the intestines of a large snapping Turtle (*Chelydra serpentina*) I have procured

* Vol. vii. in Memoranda, p. 115 and p. 202.

some unusually slender forms of *Echinorhynchi*, which were accompanied by several unimportant-looking Nematodes.

Amongst birds I may mention the occurrence of numerous tape-worm proglottides infesting a black-throated species of *Amadina*; and in the intestinal cæca of the Cheer Pheasant (*Phasianus Wallichii*), as also in those of the Black-backed Kaleege (*Euplocomus melanotis*), multitudes of the oft-recurring *Ascaris vesicularis*. The last-named bird was bred in the Zoological Society's Gardens. Here also may be noticed the existence of many examples of no less than three entirely different species of *Strongylus* infesting respectively the proventriculus, intestines, and cæca of an Ashy-headed Goose (*Bernicla poliocephala*). One of these parasitic forms appears to be new; but, of the others, the second is clearly referable to *Strongylus tubifex*, and the third is probably *S. nodularis*. The intestines of a Tinamou (*Tinamus* ——?) likewise yielded several specimens of a new *Strongylus*.

From a Starling (*Sturnus vulgaris*) shot by me on the 10th of January last, I obtained a solitary example of the *Tænia farciminalis*, the lowermost joints of which, though still firmly adherent to the strobila, were amply furnished with mature eggs containing six-hooked embryos, having a diameter of about $\frac{1}{350}$th of an inch. I have figured one of these in the shell (fig. 17), to contrast with those found in the cestode infesting the chicken. The last-named parasite I suppose to have been *Tænia infundibuliformis*.

Turning to Mammalia, I have to notice the occurrence of multitudes of Pentastomes in the abdominal cavity and viscera of a Cape Guevi (*Cephalophus pygmæus*), these being in all respects similar to those I have described from the Bubale Antelope. In a Spring-bok (*Gazella Euchore*) I also encountered two characteristic specimens of the so-called *Cysticercus tenuicollis*; and in one of the bronchial tubes of the American Red Fox (*Vulpes fulvus*), from which the new Distome, *D. conjunctum* (mihi), was procured, there were found two specimens of *Trichosoma ærophilum*. The eggs of the last-named worm are scarcely distinguishable in outline from those of *Trichocephalus affinis*, their longitudinal diameter being only a trifle less—that is to say, about the $\frac{1}{350}$th of an inch (fig. 18). From the common Rat I have secured an example of *Tænia pusilla*, measuring upwards of 20 inches in length; and lastly, I may mention some remarkably large *Cysticerci* infesting the abdominal cavity of the Æthiopian Wart Hog (*Phacochœrus æthiopicus*), and of the Red River Hog (*Potamochœrus penicillatus*). These gigantic Scolices are apparently referable to two distinct forms of tape-worm; but, as their separate description and comparison will involve many other points of interest, I do not offer any further particulars respecting them in the present communication*.

* In the recently published 'Proceedings of the Zoological Society' for 1861, Part I., I have since given a minute description of these Cysticerci (p. 93, plate xvii.); and in a separate paper published in the same Part of the 'Proceedings' the new forms of Entozoa above mentioned are described under the following titles:—*Echinorhynchus inflexus* from the Turtle; *Cestoideum Amadinæ* from the Amadina; *Strongylus acuticaudatus* from the Ashy-headed Goose; and *Strongylus spiculatus* from the Tinamou. Three of these species are likewise figured in plate xx.

EXPLANATION OF PLATE XXXIII.

Fig. 1. *Distoma conjunctum* (mihi). × 25 diameters: *a*, oral sucker; *b*, ventral sucker; *e*, œsophageal bulb; *d, d*, digestive cæca; *e*, reproductive papilla; *f*, uterine folds; *f'*, egg × 220 diameters; *g*, ovary; *h, h*, excretory ducts of (*i, i*) the albumenogene glands; *k, k*, testes; *l*, contractile vesicle.

Fig. 2. A pair of the above-named Distomes, sexually connected. Slightly enlarged.

Fig. 3. Upper fourth of *Pentastoma denticulatum*. × 60 diameters, with the ventral surface exposed. It exhibits the mouth with its chitinous ring, the four cephalic claws with the hooks retracted, the alternating rows of integumentary spines and stigmata, a central clear space and dark lateral masses of cellular parenchyma.

Fig. 4. One of the cephalic claws isolated and magnified 100 diameters: *a*, the moveable hook; *b*, tubular portion of the chitinous capsule with its longitudinal groove (*c*) near the anterior border; *d*, the hood; *e*, the three-cornered point-cover; *f*, extensor, and *g*, retractor muscles of the hook.

Fig. 5. Diagram of a portion of integument, × 250 diameters: *a*, spines; *b*, stigmata. The spaces between the rows of spines are vertically shortened one-third.

Fig. 6. Group of parenchymatous cellules from the lateral dark masses, showing central nuclei and granular contents. × 220 diameters.

Fig. 7. Two examples of *Trichocephalus affinis*, male and female. Slightly enlarged in breadth.

Fig. 8. Head of one of the above, showing the small oral aperture and lateral alaform appendages. × 220 diameters.

Fig. 9. Portion of the so-called neck displaying—*a*, longitudinal band of epidermal cellules; *a'*, four of the cellules under an altered focus; *b*, œsophageal folds; *c, c*, dermal rings; *d, d*, oval corpuscles. × 230 diameters.

Fig. 10. Spirally twisted portion of the body of a male *Trichocephalus*, magnified 20 diameters, showing the entire extent of the penis and its sheath, without any flask-shaped expansion.

Fig. 11. Caudal extremity of the same: *a*, lower end of the sheath-like intromittent muscle; *b*, anal opening; *c*, sheath of the penis, or *appendix copulatorius*, with conical retroverted spines. × 110 diameters.

Fig. 12. Pointed free end of the penis. × 220 diameters.

Fig. 13. Membranous vulva of the female *Trichocephalus* furnished with retroverted spines, and enclosing the commencement of the vagina. × 140 diameters.

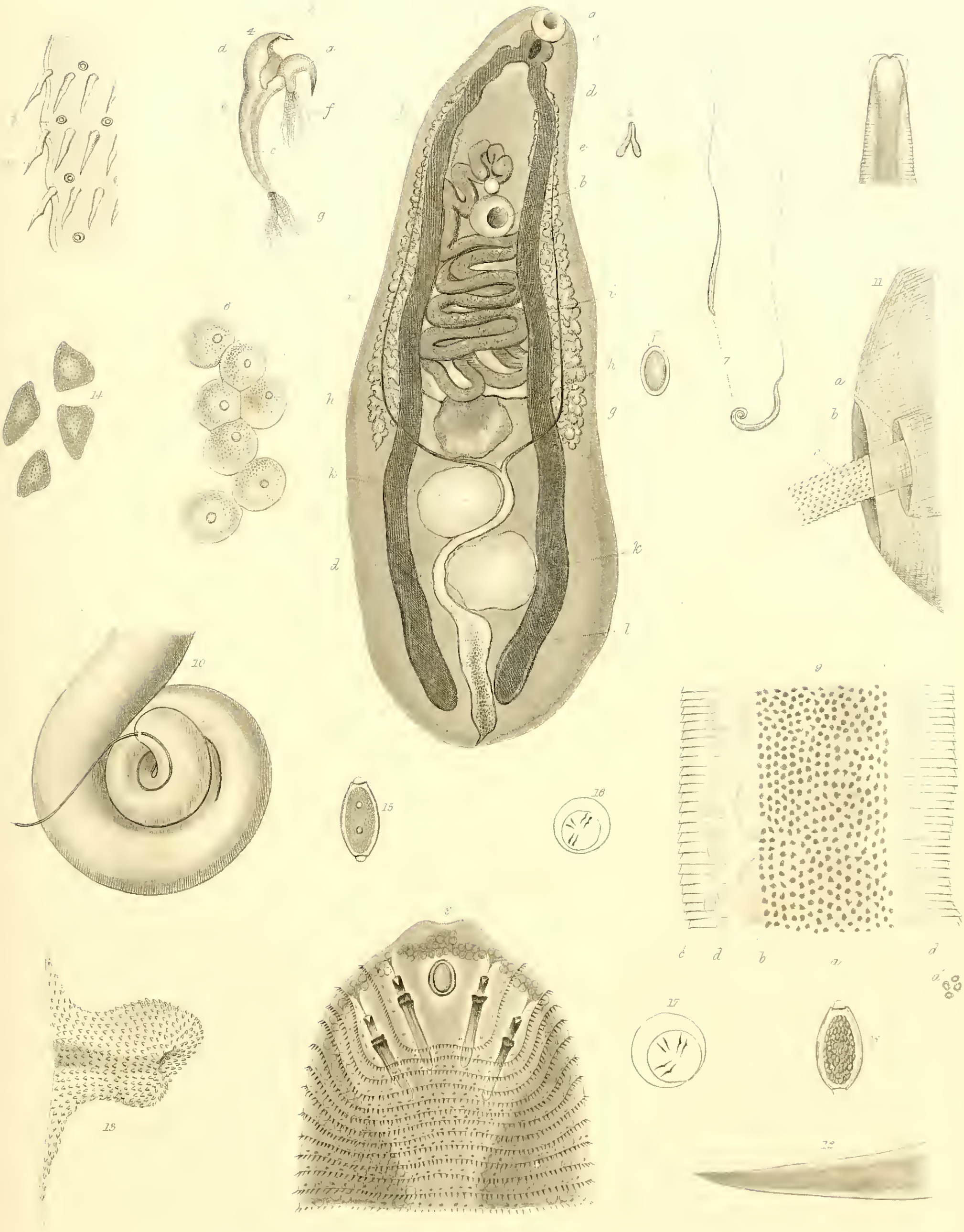
Fig. 14. Four unimpregnated ova. × 220 diameters.

Fig. 15. Fully developed egg. × 180 diameters.

Fig. 16. Egg containing a six-hooked embryo or proscolex, removed from a free and mature proglottis, occupying the intestine of a common fowl. × 180 diameters.

Fig. 17. Egg with enclosed embryo from *Tænia farciminalis*. × 220 diameters.

Fig. 18. Egg of *Trichosoma ærophilum*. × 230 diameters.



T. S. Cobbold, M.D. del.

XIX. *On Prolification in Flowers, and especially on that Form termed Median Prolification.*

By MAXWELL T. MASTERS, *Esq., F.L.S., Lecturer on Botany at St. George's Hospital.*

Read January 17th, 1861.

THE following paper contains some general remarks on the nature and varieties of that kind of malformation of the flower which Linnæus and other botanists have termed Prolification, the plants peculiarly liable to it, their conformation and the inferences to be derived from them as to the nature of the deviation in question, the coincident changes in the various floral whorls, and other points of interest connected with the subject. The facts upon which the ensuing remarks are based have been derived from the standard treatises of Moquin-Tandon and Engelmann on Vegetable Teratology, and from a large number of descriptive notices scattered through such of the French and English scientific periodicals since 1841, the date of publication of the 'Eléments de Tératologie' of Moquin-Tandon, as I have been enabled to consult. In addition I owe to the kindness of friends many similar extracts from the German periodicals; and lastly, I have had the opportunity of personally examining a large number of cases of this malformation which have been supplied either by the kindness of my friends or by my own research.

Unless some special reason should demand them, I shall not stay to give exact references to the very numerous papers and memoirs I have had occasion to consult; many of them are duly cited in the two standard works already mentioned, while others will be referred to as circumstances may require.

A special interest is attached to the subject in an historical point of view, inasmuch as both Linnæus and Goethe availed themselves of it in the construction of their theories of morphology *.

For the most part I shall avail myself of the classification of M. Moquin-Tandon, who speaks of prolification as *median* when an adventitious bud springs from the centre of the flower as a direct continuation of its growing point, as *axillary* when it springs from the axil of one of the parts of the flower, as *lateral* when the addition is rather to the inflorescence than to the flower itself. He speaks also of prolification of the fruit as well as of the flower; but I think no advantage arises from separating this kind of prolification from that which occurs in the centre of the flower, for reasons that will hereafter be given. Furthermore the adventitious growth may either be a flower-bud, a leaf-bud, or a compound bud †.

Engelmann applies the term *diaphysis* to central prolification, and *ecblastesis* to the axillary form: these terms have the advantage of priority; but botanists seem to have adopted the less pedantic nomenclature of the French author, and with good reason ‡.

* Linn. 'Prolepsis Plant.' §§ vi. et vii. Goethe, 'Versuch über die Metamorph.' cap. xv. & xvi. §§ 103–106.

† Moquin-Tandon, 'Eléments de Tératologie,' 8vo. Paris, 1841, pp. 362–387.

‡ Engelmann, 'De Antholysi Prodromus,' 8vo. Frankfurt, 1832, §§ 52–61.

I propose on this occasion to treat of Median Prolification alone, reserving the axillary and lateral varieties for another opportunity. In Median Prolification the adventitious bud springs from the centre of the flower; the usual arrest of growth which occurs at this spot no longer holds good, but a new growth takes place, manifesting itself generally in the formation of a new flower-bud, of a new leaf-bud, of a branch, or even in the production of an inflorescence. The new growth may occur whether the carpels be present or not; if present, then it may emerge from among or between them, or it may originate within the cavity of the carpels.

Certain of the European families of plants (to which, with few exceptions, these remarks alone apply) present this deviation from their ordinary structure with greater frequency than others: thus the following orders seem to be the most frequently affected by it—*Ranunculaceæ*, *Caryophyllaceæ*, *Rosaceæ*; while it is commonly met with in *Scrophulariaceæ*, *Primulaceæ*, and *Umbelliferæ*. Of genera which seem peculiarly liable to it, I may mention the following—*Anemone*, *Ranunculus*, *Cheiranthus*, *Dianthus*, *Dictamnus*, *Daucus*, *Rosa*, *Geum*, *Pyrus*, *Trifolium*, *Antirrhinum*, *Digitalis*, *Primula*. Appended to this paper is a list showing the orders and genera in which prolification is recorded to have occurred, and specifying whether the new growth take the form of a flower-bud or of a leaf-bud; the latter condition is, as Linnæus long since remarked, much less common than the former. The list must not be considered as complete; but from the abundance of material at my disposal it may, I hope, be esteemed sufficiently so to illustrate and give colour to the remarks and opinions that I now venture to bring before the Society.

A reference to the list of genera affected by this malformation, and the knowledge of its comparatively greater frequency in some than in others of them, will show that it is more often met with in plants having an indefinite form of inflorescence than in those having a definite one. It would seem probable that there may be some real relation between the conditions; but I am not prepared at present to affirm the existence of anything more than an apparent relation.

The change may affect some only, or the whole of the flowers constituting an inflorescence; and though it is by no means a constant occurrence, it very frequently happens that the central or terminal flower in a definite inflorescence is alone affected, the others remaining in their ordinary condition, as in Pinks; and in the indefinite forms of inflorescence, it is equally common that the uppermost flower or flowers are the most liable to be thus affected.

In those plants which present this deviation from the ordinary condition with the greatest frequency, it often happens that the axis is normally more or less prolonged, either between the various whorls of the flower, as in the case of the gynophore, etc., or into the cavity of the carpels, as in the instances of free central placentation. To bear out this assertion, I will cite the following instances taken from those genera having definite inflorescence, and which are very commonly affected with prolification: thus, in *Anemone* and *Ranunculus* the thalamus is prolonged to bear the numerous carpels; in *Dianthus* there is a marked internode separating the carpels from the other parts of the flower; in *Primulaceæ* central prolification is very common, and this is one of the orders where the placenta seems, from the researches of Duchartre and others, to be truly a production of the axis within the carpels *; in *Thesium* also, another genus with free central placenta, this malformation has been found.

So also among plants with indefinite inflorescence, prolification seems very frequently to affect those wherein the axis is normally prolonged; thus it is common in *Dictamnus*, which plant has an internode supporting the pistil; it is common among *Umbelliferæ*, where the carpophore may be truly considered an axile production; it is common among *Rosaceæ* and *Ranunculaceæ*, in many of which the axis or thalamus is well-marked, and it is by no means infrequent in the flowers of the Orange, where the floral internodes are also slightly elongated; on the other hand, I have never observed the change, or heard of it, in *Geraniaceæ*, *Magnoliaceæ*, and some other orders where the floral part of the axis is at some point or other elongated; still there can be but little doubt that there is a real relation between prolification and the normal extension of the floral internodes.

Under these circumstances, those instances wherein the parts of the flower become separated one from the other by the elongation of the internodes, would constitute a lesser degree of the same change, which operates most completely in the formation of a new bud at the extremity of the prolonged axis. Some specimens of *Geum rivale* (a plant very liable to become prolified) in my possession show this very clearly. In the wild plant the thalamus is elevated on a short stalk; in the abnormal ones the thalamus is simply upon a longer stalk than usual, or in a more advanced stage of the deviation the lengthened thalamus takes the form of a branch provided with leaves and terminated by a flower; it is noticeable, also, in these specimens, that the sepals of the lower flower have assumed entirely the dimensions and appearance of leaves (sketch 1).

Inasmuch as the pistil of the lower flower is frequently absent, and its place supplied by the new flower-bud, it was suggested that the pistils were converted into the new bud; but, as Moquin well remarks, there is little ground for such an opinion, as the carpels are frequently present, either quite unchanged or variously modified.

A singular instance of prolification in the central flower of one of the verticillasters of *Phlomis fruticosa* fell under my own notice; it was a case wherein the calyx was torn on one side and one of its lobes had become petaloid. Between the calyx and the corolla were three or four spathulate, hairy, bract-like organs; the corolla and stamens were unchanged; but in place of the usual four-lobed ovary there was a single carpel with a basilar style, terminated by a forked stigma. Occupying the place of the other lobes of the pistil was an oblong woolly flower-bud consisting of calyx, corolla, and stamens, but with no trace of pistil. I have been unable to find recorded any instance of malformation among Labiates or Borages at all similar to this. It differed from most other examples of prolification in that the axis was not prolonged, the adventitious bud occupying precisely the position of the three lobes of the ovary that were absent. The sole remaining carpel had a style and a stigma as perfect in appearance as though the pistil had been perfect (sketch 2).

Prolification has occasionally been recorded in flowers that have, in their ordinary condition, but one carpel, as in *Leguminosæ* and in *Santalaceæ*. In *Leguminosæ* it would

* Duchartre, Ann. des Sc. Nat. 3me série, vol. ii. 1844, p. 293.

seem as if the adventitious bud were strictly a lateral and axillary production, and moreover that the legume itself is not strictly terminal but lateral in position; so that I shall defer making any remarks upon prolification as occurring in this natural family till the subject of axillary prolification is treated of. In the only recorded instance that I am aware of, of this malformation affecting the genus *Thesium*, the pistil was altogether absent, and occupying its place was the new bud or branch.

As might be expected, it very rarely happens that median prolification occurs without some other deviation, in one or more parts of the flower, being simultaneously manifested.

Some of these changes are commonly met with, as, for instance, the multiplication or doubling, as it is termed, of the petals; others, though less frequent, are of more interest. In speaking of some of these coincident changes, I do not wish to draw any inferences as to the causes of these mutations, nor to say whether the prolification has induced the changes in question, or the reverse. Obviously there is generally some such relation, the accurate determination of which would demand a line of research which I do not feel competent to undertake.

Fusion of two or more flowers. This is especially common in cultivated specimens of *Digitalis purpurea*; the uppermost flowers of the raceme become fused together so as to form one large, regular, erect, cup-shaped corolla, to the tube of which the stamens are attached, in greater number than ordinary, and all of equal length; the bracts and sepals are confusedly arranged on the exterior of the flower; while in the centre, in the place usually occupied by the pistil, there rises a conical prolongation of the axis bearing at its outer or lower portion a number of open carpels, provided, it may be, with styles and ovules; these enclose an inner series of scale-like bracts, from whose axils proceed more or less perfect florets; so that in the most highly developed stage a perfect raceme of flowers may be seen to spring from the centre of a cup-shaped regular flower, whose lobes show its compound character. All intermediate stages of this malformation may be found from cases where there is a simple fusion of two flowers with a second verticil of carpels within the outer, up to such cases as those which have been just mentioned. Drawings of some of these accompany this paper (sketch 3), and for illustrations of the most advanced stage of this monstrosity I refer to some illustrations of Professor Vrolik in the 'Flora' for 1846, p. 97, tab. i. & ii., and for 1844, tab. i. It is worthy of special remark, that in all these cases the flowers at the uppermost part of the raceme are alone affected, and that, in addition to the prolification, there is fusion of two or more flowers, and regularity in the form of the compound corolla and stamens.

The calyx of a prolified flower is either unchanged, or it is modified in harmony with the changes in the central part of the flower. If the ovary be normally superior or free from the calyx, then the latter is comparatively rarely changed; for instance, in proliferous Pinks I have never met with any change in the calyx, except indeed in those instances where the floral axis is prolonged and produces from its side a successive series of sepals, as in what is called the Wheatear Carnation; but though these instances may be, as I believe, an imperfect degree of prolification, they do not affect the general truth of the above opinion, that the calyx is but rarely changed in a prolified flower if it be free from the ovary; but that this is not a universal rule is shown by proliferous flowers of *Geum* *rivale*, where the sepals are usually large and leaf-like, as they likewise are frequently in proliferous Roses and Pears.

Proliferous Roses have a special interest, inasmuch as they show very conclusively that the so-called calyx tube of these plants is merely a concave and inverted thalamus which, in prolified specimens, becomes elongated after the fashion of *Geum rivale**, etc. I have in my possession a Rose, wherein from the middle of the outer surface of the urn-shaped thalamus proceeds a perfect leaf, which could hardly be produced from the united sepals or calyx-tube; a similar occurrence in a Pear is figured in one of the plates of Keith's 'Physiological Botany', sketch 4.

An important change in the calyx necessarily occurs when flowers with an habitually adherent ovary become prolified, as the calyx is then disjoined from the ovary; its constituent sepals are then frequently separated one from the other, and not rarely assume more or less of the appearance of leaves, as in proliferous flowers of *Umbelliferæ*, *Campanulaceæ*, *Compositæ*, etc.

As to the corolla, it was long since noticed that prolification was especially liable to occur in double flowers; indeed Dr. Hill, who published a treatise on this subject, setting forth the method of artificially producing prolified flowers, deemed the doubling as an almost necessary precursor of prolification †; but, though frequently so, it is not invariably the case that the flower so affected is double—*e. g. Geum*. If double, the doubling may arise from actual multiplication of the petals, or from the substitution of petals for stamens and pistils, according to the kind of flower affected. Occasionally in prolified flowers, the parts of the corolla, like those of the calyx, become foliaceous, and in the case of proliferous Pears fleshy and succulent. There is in cultivation a kind of *Cheiranthus*? in which there is a constant repetition of the calyx and corolla, conjoined with an entire absence of the stamens and pistils; a short internode separates each flower from the one above it, and thus frequently ten or a dozen of these imperfect flowers may be seen on the end of a flower-stalk, giving an appearance as if they were strung like beads, at regular intervals, on a common stalk. I have seen a similar instance in a less degree in a species of *Helianthemum*.

The stamens are subject to various changes in prolified flowers; they assume, for instance, a leaf-like or petal-like condition, or take on them more or less of a carpellary form, or they may be entirely absent; but none of these changes seem to be at all necessarily connected with the proliferous state of the flower. Of more interest is the change in the position of these organs which sometimes necessarily accrues from the elongation of the axis and the disjunction of the calyx: thus in proliferous Roses the stamens become strictly hypogynous, instead of remaining perigynous. In *Umbelliferæ* the epigynous condition is changed for the perigynous, etc.

The condition of the pistillary organs in a prolified flower is always worthy of notice. The frequent complete absence of the carpels gave rise to the opinion that the pistil or the pistils were converted into a stem bearing leaves or flowers. Setting aside the morpho-

* Bell Salter, Ann. Nat. Hist. 1847, vol. xix. p. 471, etc.

† "The Origin and Production of Proliferous Flowers, with the Culture at large for raising Double Flowers from Single, and Proliferous from the Double." By J. Hill, M.D. London, 1759.

logical difficulties in the way of accepting such an opinion, an examination of any number of cases is always sufficient to refute it; for, as Moquin well remarks, the carpels may frequently be found either in an unaltered condition or more or less modified.

In the more perfect specimens of prolification, such as those raised by art, the carpels are very frequently absent, as in those figured by Dr. Hill in the work before quoted. I may here remark that the cultivation of these prolified flowers was at one time much more attended to than it is at present. In one of the old stained-glass windows (Dutch) of the Bodleian Picture Gallery at Oxford is a representation of a proliferous *Ranunculus*.

If the pistil be normally syncarpous, its constituent carpels, if present in the prolified flower, become disjoined one from the other to allow of the passage from between them of the prolonged axis: thus was it in the specimens of *Digitalis* before referred to, as well as in some monstrous specimens of the wild Carrot, laid before the Society by the writer of this paper in March 1859. Not only are the carpels thus frequently separated one from the other by the prolonged axis, but they undergo commonly a still further change in becoming more or less completely foliaceous, as in the *Daucus* just mentioned, where the carpels were prolonged into two lance-shaped leaves, whose margins in some cases were slightly incurved at the apex, forcibly calling to mind the long "beaks" that some Umbelliferous genera have terminating their fruits—for instance, *Scandix*. Dr. Norman, in the fourth series of the 'Annales des Sciences,' vol. ix., has described a prolification of the flower of *Anchusa ochroleuca*, in which the pistil consisted of two leaves, situated anteroposteriorly on a long internode, with a small terminal flower-bud between them; and numerous similar instances might be cited. In this place may be noticed those instances wherein the placenta elongates so much that the pericarp becomes ruptured to allow of the protrusion of the placenta, although this prolongation is not attended by the formation of new buds. Cases of this kind occurring in *Melastoma* and *Solanum* have been put on record by M. Alph. de Candolle *. This is a change analogous with that which occurs in some species of *Leontice* or *Caulophyllum*, as commented on by Robert Brown.

If the pistil be apocarpous and the carpels arranged spirally on an elevated thalamus, it then frequently happens that the carpels, especially the upper ones, become carried up with the prolonged axis, more widely separated one from the other than below, and particularly liable to undergo various petalloid or foliaceous changes as in proliferous *Roses*, *Potentilla*, &c.; but if the carpels be few in number and placed in a verticillate manner, the axis then generally passes upwards without any change in the form or position of the carpels being apparent, as in the proliferous *Columbine*, a sketch of which accompanies this paper (sketch 5).

The monocarpellary flowers that have come under my notice in a prolified condition are very few. Some *Leguminosæ*, an *Amygdalus*, and a *Thesium* complete the list. In the two former, there is good reason to think that the solitary carpel is only terminal from the abortion of a second carpel, and therefore, as well as for other reasons that will hereafter be given, prolification in these flowers belongs rather to the axillary than to the median form. The *Thesium* has been before referred to in the course of this paper; the pistil is here normally monocarpellary and adherent to the calyx; in the abnormal

* Neue Denkschriften der allgemeine Schweizerischen Gesellschaft. Band 5, 1841, plate 2.

flower the pistil is altogether absent, and a flower-bud occupies its place at the summit of a prolonged axis, quite detached from the calyx *.

When a flower with the ovary naturally inferior or adherent to the calyx becomes prolified, a change in the relative position of the calyx and ovary almost necessarily takes place, the latter becoming superior or detached from the calyx; this has been already alluded to in *Umbelliferæ*. I have recently found an instance in a species of *Campanula*, where the calyx was free, the corolla double, the stamens with petaloid filaments, and in the place of the pistil there was a bud consisting of several series of green bracts, arranged in threes and enclosing quite in the centre three carpellary leaves detached from one another and the other parts of the flower, and open along their margins, where the ovules were placed (sketch 6) †. A similar relative change in the position of the calyx and the ovary takes place when the *Compositæ* are affected with central prolification, or even in that lesser degree of change which merely consists in the separation and disunion of the parts of the flower, but which in these flowers appears to be, as it were, the first stage towards prolification. I owe to the kindness of Professor Oliver a sketch of a species of *Rudbeckia*? showing this detachment of the calyx from the ovary. In a monstrous *Fuchsia* that I have had the opportunity of recently examining, the calyx was similarly detached from the ovary simultaneously with the extension of the axis. Here the petals were increased in number and variously modified, the stamens also; while in the centre and at the top of the flower, conjoined at the base with some imperfect stamens, was a carpel open along its ovuliferous margins (sketch 7). It appears to me that such instances as these are really the first stages of a change which, carried out more perfectly, would result in the formation of a new bud on the extremity of the prolonged axis.

Intra-carpellary Prolification.—Hitherto those instances have been considered in which either the carpels were absent, or the new bud proceeded from between the carpels. There is also an interesting class of cases where the prolification is strictly *intra*-carpellary; the axis is so slightly prolonged that it does not protrude beyond the carpels, does not separate them in any way, but is wholly enclosed within their cavity. Doubtless in many cases this is merely a less perfect development of that change in which the axis protrudes beyond the carpels. This intra-carpellary prolification occurs most frequently in plants having a free central placenta, though it is not confined to them, as it is recorded among *Boragineæ*. A remarkable instance of this is described by Mr. H. C. Watson in the first volume of the 'Botanical Gazette,' p. 88. In this specimen a raceme of small flowers was included within the enlarged pericarp of a species of *Anchusa*. But the most curious instances of this form of prolification are those which are met with among *Primulaceæ* and other orders with a free central placenta.

Duchartre, in his memoir on the "Organogeny of Plants" with a free central placenta,

* Reissek, Linnæa, vol. xvii. 1843.

† Since this paper was read, I have met with other similar instances in the same species of *Campanula*: in one of these the styles were present, forming below an imperfect tube which surrounded the adventitious bud (fig. 6 c); in another, contrary to what occurs usually in such cases, the ovary was present in its usual position, but surmounted by a bud of leafy scales, enclosed within the base of a tube formed by the union of the styles (fig. 6 d).

in the Ann. des Sc. Nat. 3 sér. 1844, p. 290, among other similar instances mentions two flowers of *Cortusa Matthioli*, wherein the placenta was ovuliferous at the base; but the upper portion, instead of simply elongating itself into a sterile cone, had produced a little flower with its parts slightly different from those of the normal flowers. M. Alph. de Candolle has likewise described somewhat similar deviations, and one in particular in *Primula auricula*, where the elongated placenta gave off long and dilated funiculi bearing ovules, while other funiculi were destitute of ovules, but were much dilated and foliaceous in appearance *.

In speaking of these as cases of intra-carpellary prolification, it is of course impossible to overlook the fact that they differ in degree only from those cases where the lengthened axis projects from the cavity of the carpels; nevertheless they seem to demand special notice, because in these plants the placenta or its prolongation appears never to protrude beyond the carpels, or at least very rarely. There are, however, numerous instances of such an extension of the placenta and prolification occurring among *Primulaceæ* attended by the more or less complete arrest of growth of the carpels †. An instance of this kind has come under my own notice in a monstrosity of the Chinese Primrose, in which the carpels were reduced to a hardly discernible rim surrounding an umbel of five rays, each terminated by a small normally constituted flower bud.

The ovules of a prolified flower, if present at all, are usually unaffected, though occasionally they undergo various transformations.

Under the term prolification of the fruit two or three distinct kinds of malformation appear to have been included. The term seems usually to be applied to those cases where from the centre of one fruit a branch bearing leaves, flowers, or another fruit is seen to project, as happens occasionally in Pears. Now, in many instances, not only the fruit is repeated, but also the outer portions of the flower, which wither and fall away as the adventitious fruit ripens; so that at length the phenomenon of one fruit projecting from another is produced. It is obvious that this form of prolification in no wise differs from ordinary central prolification. Sometimes some of the whorls of the adventitious flower are suppressed; thus M. Duchartre describes some Orange blossoms as presenting alternating series of stamens and pistils one above another, conjoined with the suppression of the calyces and corollas belonging to each series of stamens and pistils ‡. In other cases, doubtless, the carpellary whorl is alone repeated, the other whorls of the adventitious flower being completely suppressed.

Another condition, apparently sometimes mistaken for prolification of the fruit, is that in which the carpellary whorl becomes multiplied; so that there is a second or even a third series within the outer whorl of carpels. If the axis be at all prolonged, then these whorls are separated one from the other, and produce in this way an appearance of prolification. This happens frequently in Oranges, as in the variety called Mellarose §.

Never having had the opportunity of examining any of the flowers or fruits of the

* A. de Candolle, Neue Denkschriften, *op. cit.* p. 9; also Unger as cited in Botanical Gazette, May 1851, p. 70.

† Duchartre, *op. cit.*; Babington, Ann. Nat. Hist. 1844, p. 464.

‡ Ann. Sc. Nat. 1844, vol. i. p. 297.

§ Maout, Leçons Elémentaires de Botanique, vol. ii. p. 488; Ferrari, Hesperides, pl. 271, 315, 405.

famous St. Valery Apples, I am diffident in hazarding any opinion on the subject; but it is surely more reasonable to conceive a second row of carpels placed above the first by the prolongation of the central part of the axis, than to suppose, in the words of Moquin-Tandon, "a prolification combined with penetration and fusion of two or more flowers." Supposing my view to be correct, the inner calyx-like whorl might be considered either as a repetition of the calycine whorl, or, with more probability, it might be inferred that the corolla was present in the guise of a second calyx.

Moquin-Tandon suggests another explanation—feasible, indeed, but based upon no evidence—namely, that though the stamens are absent in these curious flowers, at least in their ordinary shape, they are represented by the lower row of carpels, which become, in process of development, fused with the upper or true carpels. If this were so, surely some intermediate conditions between stamen and carpel would occasionally be present; but such does not appear to be the case*.

In some of the instances of proliferous Pears that are described, the carpels would seem to be entirely absent, and the dilated portion of the axis to be alone repeated. Thus the axis dilates to form the lower fruit without any true carpels being produced; but at its summit a whorl of leaves (sepals) is formed above them; another swelling of the axis takes place also without the formation of carpels, and this, it may be, is terminated in its turn by a branch producing leaves. In these cases there is no true prolification, but simply an extension of the axis. That the outer portion (so-called calyx-tube) of these fruits is really an axile product there can now be little doubt; and, as if to show their axile nature, they occasionally produce leaves from their sides as before mentioned. Some other malformations usually referred to prolification of the fruit seem due to branching of the inflorescence, as in Plantago, Wheat, Maize; or to a simple extension of the axis beyond its ordinary limit, as in the cones of Firs, etc. It is obvious that the true fruits in these cases are in no wise affected.

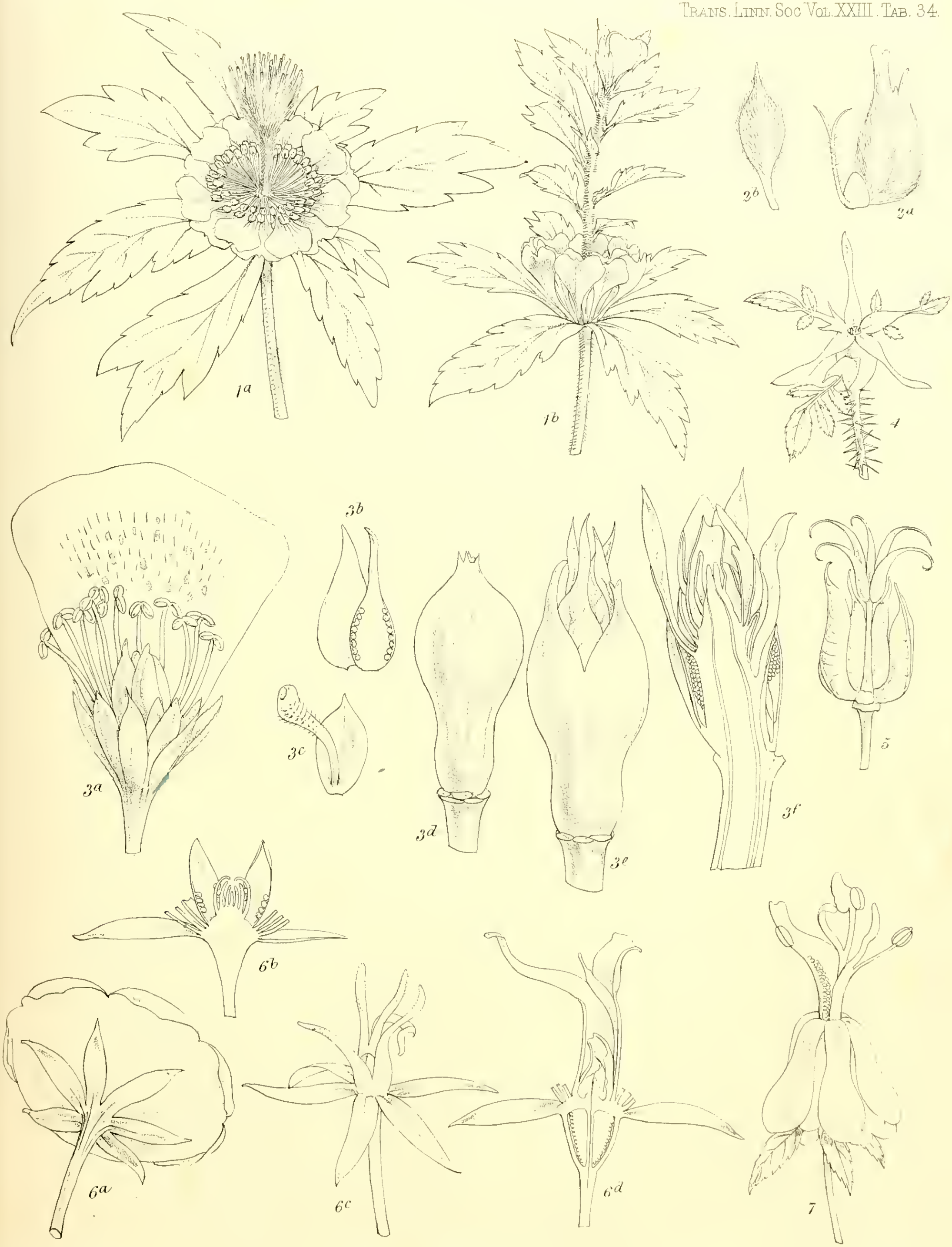
From these considerations it would appear better to abandon the use of the expression prolification of the fruit, as unnecessary where it is really applicable, and as delusive in the numerous cases where it is erroneously employed.

It would lengthen this communication to no useful extent to remark upon the condition of the adventitious growth itself. I have alluded to it when necessary, and shall make no further comment on it than to say it may present itself in the ordinary condition of leaf-bud, or flower-bud, or inflorescence, or that it may be malformed in various ways. Any further notes that bear upon this subject that I may be able to bring forward, I hope to have the honour of laying before the Society in another communication on the kinds of prolification not treated of on this occasion.

* Moquin-Tandon, p. 386, &c. My attention has been called, since writing the above, to the case of an Apple, mentioned by M. Trécul (in the Bull. Bot. Soc. France, tom. i. p. 307), in which the petals were in the same condition as the sepals, and in which there were ten carpels replacing an equal number of stamens. M. Gay, in referring to this specimen, stated that it was of the same character as the St. Valery Apple.

List of Genera in which Median Prolification has been observed.

	Leafy.	Floral.
Ranunculaceæ	Anemone	*Anemone.
	Ranunculus	*Ranunculus.
		Caltha.
		Aquilegia.
Cruciferæ		Bunias.
		*Cheiranthus.
		Erucago.
		Matthiola.
		Sisymbrium.
		Brassica.
		Erysimum.
		Alyssum.
		Peltaria.
		Cardamine.
Cistaceæ		Helianthemum.
Caryophylleæ	Dianthus	*Dianthus.
		Silene.
		Lychnis.
Malvaceæ		Paritium.
Malpighiaceæ		Byrsonima.
Rutaceæ	Genera not specified	*Dictamnus.
Resedaceæ		Reseda.
Aurantiaceæ		*Citrus.
Vitaceæ	Vitis	Vitis.
Umbelliferæ		*Athamanta.
		*Daucus.
		*Torilis.
Rosaceæ	*Rosa	*Rosa.
	*Geum	*Geum.
	Agrimonia	Amygdalus.
	*Pyrus	Prunus.
	Spiræa	Rubus.
		*Pyrus.
Leguminosæ ?		Trifolium ?
		Medicago ?
		Melilotus ?
Cucurbitaceæ		Cucumis.
Passifloraceæ		Passiflora.
Philadelphaceæ		Philadelphus.
Onagraceæ	Epilobium.	
Epacridaceæ	Epacris.	
Convolvulaceæ	Convolvulus.	
Gentianaceæ	Gentiana.	Gentiana.
Apocynaceæ		Vinca.



M.T.Masters, del. Fitch, lith.

Median Prolification, *etc.*

W.West, imp.

	Leafy.	Floral.
Scrophulariaceæ	Genera not specified	Antirrhinum.
		*Digitalis.
		*Linaria.
		Veronica.
Orobanchaceæ	. . . .	Orobanche.
Labiatæ	Genera not specified	Stachys.
		Phlomis.
Boraginaceæ	. . . .	Anchusa.
		Symphytum.
Primulaceæ	*Dodecatheon	*Cortusa.
	*Anagallis	*Anagallis.
		*Primula.
Compositæ	Hieracium	Hieracium.
	Cirsium	Cirsium.
	Hypochæris	Calendula.
		Spilanthes.
Campanulaceæ	Campanula	*Campanula.
Polygonaceæ	Genera not specified	Rumex.
Santalaceæ	. . . .	Thesium.
Urticaceæ	. . . .	Ficus.
Liliaceæ	Genera not specified	Tulipa.
		Hyacinthus.
Gramineæ	. . . .	Phleum.

A mark * is placed against the names of those genera that are most frequently affected with this change.

EXPLANATION OF PLATE XXXIV.

Fig. 1 *a*. *Geum rivale*. Calyx leafy, sepals and petals multiplied, thalamus longer than usual.

Fig. 1 *b*. Shows a similar condition of the calyx and corolla to the preceding; but the thalamus is here represented by a leaf-bearing branch, and the place of the pistil is occupied by a flower-bud.

Fig. 2 *a*. *Phlomis fruticosa*. Calyx, corolla, and stamens removed, to show the adventitious flower-bud and the monocarpellary pistil.

Fig. 2 *b*. One of three or four scales placed between the calyx and corolla.

Fig. 3 *a*. *Digitalis purpurea*. Sepals multiplied; corolla regular; stamens twelve; carpels five, open, with ovules on their margins, and surrounding a slightly prolonged axis on whose sides are scales and imperfect flowers.

Fig. 3 *b*. Scale with ovules on the margin.

Fig. 3 *c*. Scale with small corolla proceeding from its axil.

Fig. 3 *d*. Eight carpels with parietal placentation, surrounding a prolonged axis, with imperfect flowers and bracts.

Fig. 3 *e*. More advanced stage of the same; axis prolonged beyond the carpels and bearing bracts and flowers.

Fig. 3 *f*. Vertical section of the same.

Fig. 4. Fruit of Sweet Briar, showing a leaf springing from the middle of the outer surface.

Fig. 5. *Aquilegia*. Adventitious flower on the end of a stalk, proceeding from the midst of the normal whorl of carpels, one of which latter has been removed.

Fig. 6 *a*. *Campanula*. Outer view of flower, showing the absence of the inferior ovary.

Fig. 6 *b*. Section of the same flower, showing the adventitious bud in its centre, free from the calyx.

Fig. 6 *c*. Another flower with styles partially united into a tube surrounding an adventitious bud.

Fig. 6 *d*. Vertical section of another flower of *Campanula*, showing the presence of an adventitious bud detached from the calyx, surrounded by the styles, and having an adherent ovary in the usual position.

Fig. 7. *Fuchsia*. Sepals and petals leaf-like, bent downwards, to show the central column consisting of stamens variously changed, and adherent to a superior, open carpel, the style of which bears an anther on its margin.

XX. *On the Circulation of the Blood in* Pegea, *as bearing on the question of a Lining to the Vascular System in the* Tunicata *in general.* *By* JOHN D. MACDONALD, *R.N., F.R.S.* *Communicated by* GEORGE BUSK, *Esq., F.R.S., Sec. L.S.*

Read April 18th, 1861.

IN a genus of Salpians which I have identified with the *Pegea** of Savigny, stellate pigment-cells are distributed equally over the parietes of a very perfect vascular system, and are nowhere else to be found. Now, it is natural to conclude that these cells must rest upon the basement membrane, or at least on an extension of some delicate structure that may perhaps be worthy of the name of a vascular lining. In this case the pigment-cells seem to be connected with the inner surface of the canals; for, as dissolution approaches, their caudate processes contract, and they assume the appearance of dark dots, which gradually fall off and commingle with the blood-corpuscles. This circumstance is perhaps rather favourable to the opposite doctrine, but an inspection of the accompanying figures illustrating the scheme of circulation in *Pegea*, will show that some more satisfactory explanation of actual appearances is required, at least in the example given. In the numerous specimens examined, I could discover no irregular blood-sinuses or *lacunæ*, with the exception of the perivisceral chamber, and the canals of the "*elæoblast*" communicating with it; and in fact, though the course of the blood, as in other *Ascidians*, is sometimes in one direction and sometimes in the other, in every part, it is through circumscribed and definite canals with distinct lines of contour.

The heart in *Pegea* (Plate XXXV. fig. 1, *d*), as in other Salpians, is semicylindrical and curved. From its fore part two long trunks (*f* & *g*) take their rise. One of these (*g*) passes forwards above or to the left side of the *endostyle* (*h*), while the other (*f*) curves a little backwards and to the right side, and after having communicated with the perivisceral sinus (*a*), doubles over the posterior extremity of the *endostyle*, below and to the right of which it runs forwards.

The posterior extremity of the heart communicates directly with the perivisceral sinus, and this latter is connected with the canals of the *elæoblast* (*c*) above, while two wide blood-channels are given off from it posteriorly. One of these divides into a principal and several secondary respiratory vessels (1), all of which inosculate freely through an elaborate plexus of capillaries filling up the body of the gill band (*e*). The other trunk (*i*) runs backwards in the median line for some little distance, and then divides into two branches, which pass downwards and backwards, subdividing in the walls of the body.

A star-like sinus, reminding one of the *torcular Herophili* of the human dura mater,

* The species figured (Plate xxxi. fig. 3) in the Atlas of Lesueur and Petit as *Salpa vivipara* is obviously like that observed by me, a gemmiparous member of the same species of which Savigny only figures the oviparous form.

rests upon the nervous ganglion (fig. 2, *e*); and the blood-corpuscles may be always seen to pass above, but never beneath the latter. Many vascular trunks radiate from this point; thus one (fig. 2, *a*) courses directly backwards in the median line; from the fore-part two channels (*b b*) diverge, passing forwards and outwards; while several others pass outwards and upwards on either side (*c*), and two in particular (*d d*) from the upper surface enter the gill. Now, all these vascular channels, according to their position and direction, become continuous with the subdivisions of those already described as arising from the heart, without any interposition of lacunæ properly so called, and the scheme of circulation is thus completed.

A superficial reticulation of vessels occurs between the muscular bands and the delicate membrane which immediately covers them, while the larger trunks evidently lie between the muscular and branchial tunics. The muscular coat is therefore very frequently perforated by communicating canals; so that an arrangement similar to that given in fig. 3, representing a portion of the ventral sinus with its contiguous vessels, is easily demonstrable, and affords a strong indication of a lining to the vascular system, though such has of late been very nearly denied to the *Tunicata* altogether, while it is admitted only in a limited sense in the *Mollusca* proper. (See Von Siebold and others.)

EXPLANATION OF PLATE XXXV.

Fig. 1. Heart and great vessels of *Pegea*. *a*, visceral nucleus; *b*, chaplet of young; *c*, "elæoblast;" *d*, heart; *e*, gill band; *f* & *g*, vessels arising from the anterior extremity of the heart; *h*, endostyle; *i*, great vessel arising from the perivisceral sinus; *k*, diverticula; *l*, respiratory vessels; *m*, mouth with labial folds, &c.

Fig. 2. Nervous ganglion and radiating sinus. *a*, ventral sinus; *b*, antero-lateral trunks; *c c*, lateral truuks; *d d*, respiratory vessels; *e*, ganglion with its radiating nerves and otolithic sac.

Fig. 3. Portion of the ventral sinus, connected with the superficial plexus. *a*, main trunk; *b b*, superficial plexus; *c*, linear-extra-vascular space.

XXI. *On the Physiology of the Pallial Sinuses of the* Brachiopoda. *By* John D. Macdonald, *R.N., F.R.S. Communicated by* George Busk, *Esq., F.R.S., Sec. L.S.*

Read April 18th, 1861.

To Mr. Hancock and Professor Huxley belongs the credit of having first cast a doubt on the nature and office of the so-called Cuvierian hearts of the *Brachiopoda*; and should any further evidence be required to sustain the truth of the position ultimately laid down by those original observers, I have to announce my discovery in *Lingula*, of a determinate circulation of spherical and violet-tinted corpuscles (fig. 5) in all the ramifications of the pallial sinuses (Plate XXXV. fig. 4), not depending upon the contractions of a propulsory cavity, but upon the undulations of a ciliated lining. It, moreover, presented this characteristic peculiarity, that an onward and a returning current are at the same time visible in each canal, as shown by the direction of the arrows in fig. 4.

The white lines which are described as running upon the outer wall of the pallial sinuses of *Lingula*, and about which so much misconception appears to have existed in the mind of Vogt, are nothing more than the septa more or less perfect (fig. 4, *a*), which serve to direct as well as to obviate the friction of two ciliary currents passing in opposite directions in the same vessels. Mr. Hancock's reasoning against Vogt's opinion, that these are vascular ramifications, is simple and conclusive; but, of their real nature as just pointed out, I can entertain no doubt whatever.

The four Cuvierian hearts of *Rhynchonella*, singularly enough, have given place to the five contractile vesicles of Mr. Hancock; and if these latter, with the vessels connected with them, be not really homologous with the water-vascular system of the *Annuloida*, the coincidence in the same animal of another and a purely ciliary circulation in which coloured corpuscles, developed for that special purpose, seem to perform the office of blood-globules, is not a little interesting.

In some of the *Beroidæ* the sinus system exhibits a remarkably beautiful ciliary circulation of a corpusculated fluid, and the ovaria occupy the walls of those ramified and reticulated canals, so much after the fashion of those of the *Brachiopod*, that the homologies of the two systems can scarcely be doubted. There is this difference, however, that in the *Beroidæ*, the main trunks of the sinuses, which form the equivalent of the common cavity, so called, of the true *Polypi*, open directly into the stomach; whereas this communication is altogether cut off in the *Brachiopod*, and the escape of the ova is provided for by the external openings so clearly demonstrated by Mr. Hancock in the organs previously recognized as hearts. The question arises, Is this difference sufficient to destroy the homology here indicated? As well might it be said that the absence of an anal outlet to the alimentary canal of *Waldheimia* militated against its homology with that of *Lingula*; or, that the open water-vascular-system of *Distoma* had no equivalent in the closed system of *Tetrastemma*. On the other hand, if it can be shown that the sinus system of the *Beroidæ* is derived from the alimentary membrane, while that of the *Brachiopod*, like the atrium of the *Tunicary*, has an external origin, analogy alone is all that can be sustained in regard to them.

With the exception of their having an external outlet for the discharge of ova or their products, an ordinary observer would never dream of any homology existing between the pallial sinuses of the *Brachiopod* and the *atrium* of the Ascidian; but this brilliant deduction originated with Professor Huxley, and was supported by Mr. Hancock. The absolute necessity of tracing up the routine development of everything in order to determine philosophical homologies, owes much of the importance which it has assumed in this country to the teaching of the former gentleman; but I am not aware that this test has been yet tried in the case under consideration.

Though it may be affirmed that the perivisceral cavity of the *Polyzoon* and of the *Brachiopod* correspond with each other, that of neither can be said to be homologous with the perivisceral sinus of the *Tunicary*; nor can it be altogether denied that the nutritive function is more or less subserved by the part cited in all. Should the sinuses or *lacunæ* described by Mr. Hancock as included within the stout sheath of the alimentary canal in *Brachiopoda* correspond to the perivisceral sinus of *Tunicata*, their homologue appears to be absent in the *Polyzoa*.

I do not desire to sustain the accuracy of all the deductions drawn in the following summary, but I believe that the points requiring elucidation will be more distinctly perceived in an attempt of this kind than by presenting them in an isolated form.

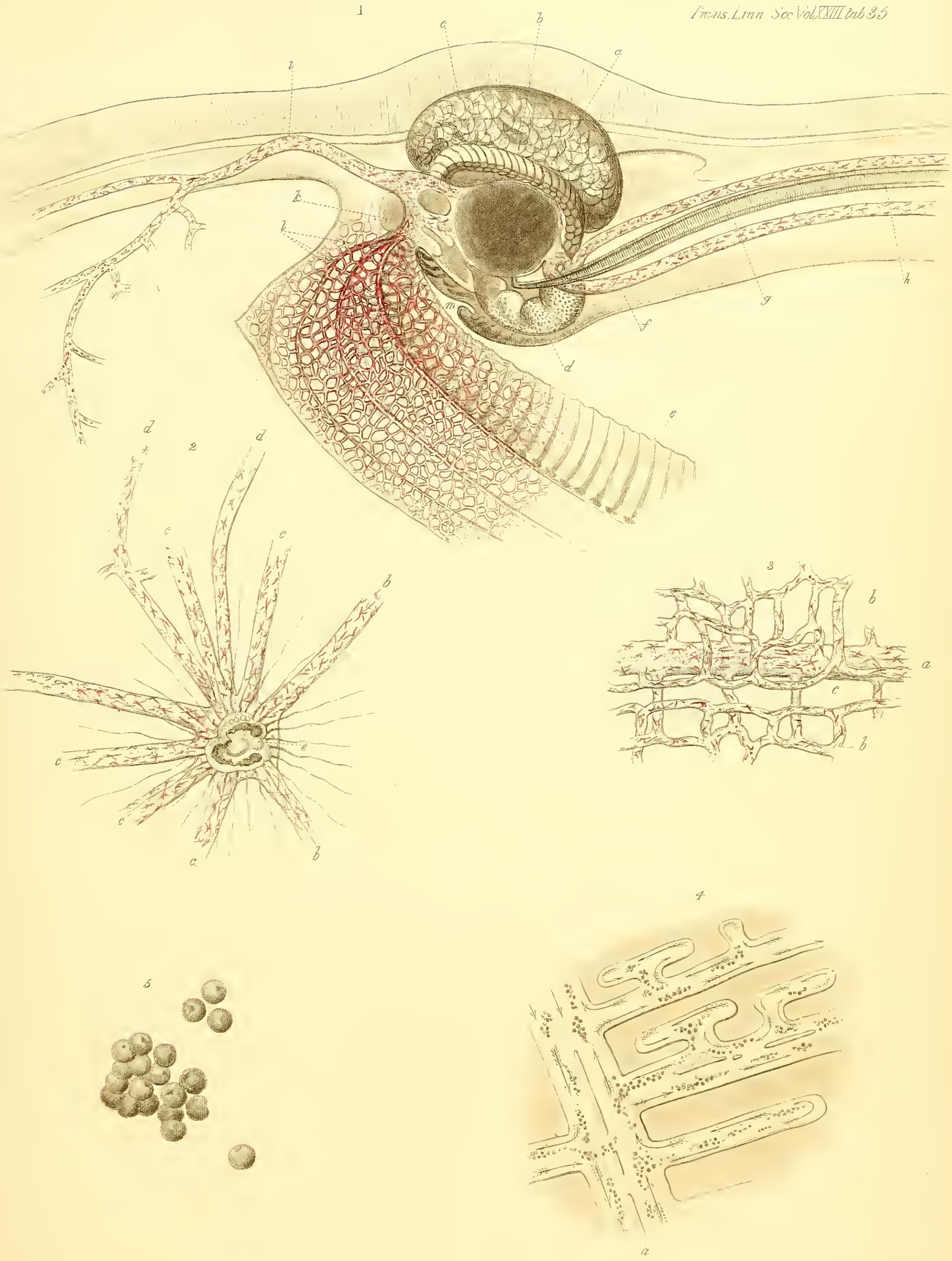
In tracing up the development of the digestive and circulatory systems from the *Hydroid Polyp* to the *Mollusk*, we find a gradually increasing division of labour in the play of the organic functions going hand in hand with a progressive complexity of structure. In the *Hydrozoa* there is no very obvious distinction between the stomach and the common cavity of the body, and therefore the functions of digestion and of circulation are confounded to a corresponding extent.

In the *Actinozoa*, on the other hand, a true stomach is developed within the common cavity, though a communication is still preserved between them. Another step leads us to the *Polyzoa* and their lineal* allies—the *Brachiopoda*, in all of which the communi-

* The word lineal is here used to distinguish between the affinity existing between the two orders noticed and their relationship with the *Tunicata*, which is merely collateral or representative, partaking little of affinity.

The remarkable homologies and resemblance of structure which present themselves when the *Polyzoa* are compared with the *Brachiopoda*, cannot be for a moment denied, from the original hæmal flexure of the intestine, as pointed out by Professor Huxley (and in which particular they depart from the *Tunicata*), to more minute anatomical details. In passing, I think I can mention a new point in which both *Polyzoa* and *Brachiopoda* differ from *Tunicata*. It has been well said that the line of the hinge of the valves is dorsal and longitudinal in *Lamellibranchiata*, while it is dorsal and transverse in the *Polyzoa* and *Brachiopoda*. Now, in an excellent example of what may be called an *Operculated Ascidian* in my possession, the articulation is transverse, but *lateral*.

I must say that due stress has not been laid upon the characters of the cerri, so called, of the *Brachiopod*, as being not only perfectly homologous, but in every respect similar to the tentacula of the *Polyzoa*. All the figures extant of those cerri (to which it would be far better to apply the word tentacula) are stiff and unnatural. Thus, richly ciliated organs, endowed with exquisite sensibility, which curl upon themselves or start back as with a conservative



J. D. Macdonald del.t

cation just noticed is cut off, and an intestine formed, with or without an anal aperture.

Let us now suppose the perivisceral cavity of the *Polyzoa* to be homologous with the common cavity of the *Cœlenterata*, but giving off no canals, and the oscillation or motion of the contained blood (?) depending upon the activity of the animal's movements as well as upon ciliary action, the scheme of circulation exhibits an almost retrograde simplicity when compared with that of a covered-eyed *Medusa*. Nevertheless, having no direct communication with the stomach, its superiority may be asserted as a system so far closed. Now, as this appears to be homologous with the perivisceral cavity of the *Brachiopoda*, the ramifications of the pallial sinuses of the latter, with their ciliated lining and contained corpuscles, present the highest form of this pseudo-circulatory system.

The existence of a true vascular system in the *Polypi* is intimated by M. Milne-Edwards; but it is not improbable that the vascular ramifications observed by him, and which undoubtedly exist, are in reality derived, or, as it were, dismembered from the common cavity. May not the same doctrine be applied to the *Brachiopoda*? If not, the true vascular system, as described by Mr. Hancock, is altogether distinct, both in its nature and origin, from what has hitherto been regarded as the rudiment of the circulatory system in *Cœlenterata*.

In the *Tunicata*, however, a single and simple heart superseding the five vesicles of the *Brachiopoda* offers some little approach to the more perfect organs of the *Mollusca* proper, though there can as yet be no distinction between arteries and veins, as the current of the blood is reversible in the same channels. Finally, it may be affirmed, that a heart with a receptive and a propulsive cavity, furnished with a valvular apparatus to determine an irreversible path for the circulation, as well as the distinctive offices of artery and vein, distinguishes the true *Mollusca* from the *Tunicata*, *Brachiopoda* and *Polyzoa*, constituting the *Molluscoida* of M. Milne-Edwards.

EXPLANATION OF PLATE XXXV.

Fig. 4. Portion of the pallial sinus-system of *Lingula*, showing the course of the ciliary currents. *a*, longitudinal septa dividing the ciliary currents.

Fig. 5. Violet-tinted corpuscles which circulate in the pallial sinuses of *Lingula*. The little pit or depression, observable on one side of these corpuscles, is probably due to exosmosis; but in this particular case it was present in all.

intelligence, at the slightest touch, are represented as possessing the rigidity of the teeth of a comb, or, at least, of bristles. A very far more correct idea of them might be given were the artist to copy the tentacula of *Vesicularia*, or any well-known *Polyzoon*—a piece of dishonesty which, although its perpetration cannot be seriously recommended, might challenge detection in this particular case.

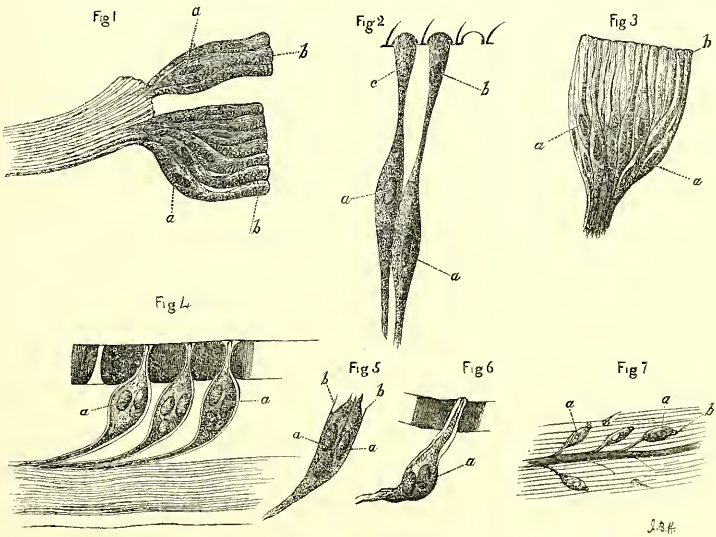
XXII. *On the Nerve proceeding to the Vesicles at the Base of the Halteres, and on the Sub-costal Nervure in the Wings of Insects.* *By* J. Braxton Hicks, *M.D. Lond., F.L.S.*

Read June 20th, 1861.

It is unnecessary to enter into any description of the vesicles of the halteres and wings, as I have already fully noticed them in former pages of the Transactions and Journal. I showed first, also, of any observer, that to them a very large nerve proceeds, next in size to the optic, and that the divisions of this nerve pass to the base of the vesicles.

The additional information, which it is my desire now to lay before the Society, is, that a bipolar ganglionic cell is to be found just beneath these organs.

If, instead of viewing the parts intact, the base of the haltere be broken up, it will be found that, shortly before arriving at the position of these vesicles, the nerve enlarges in the following manner:—Each fibril is developed into an elongated ganglionic cell, generally with a large nucleus (*a*, figs. 1, 2, 3). The distal end becomes contracted again



for a short space, but finally and gradually dilates, until it comes in contact with the inner surface of the vesicle (*b*, figs. 1, 2, 3). In this terminal expansion I have sometimes observed a nucleus (*c*, fig. 2); sometimes, however, the contents have been granular; whether there be a small cell at the very extremity, I am unable to say with any certainty, but comparing it with its homologue in the subcostal nervure, I am inclined to think the existence of such a structure doubtful.

This can be well observed in *Rhingia rostrata* and *Eristalis tenax*. (See figure.)

The nerve in the subcostal nervure is disposed in a somewhat similar manner. But in many instances I have found the ganglionic enlargement to possess more than one nucleus; two or three apparently coexist in the *Coleoptera* (see *a*, figs. 4, 5, 6). The distal end of this enlargement tapers off to a rather fine extremity, so that it may pass up through the canals which pierce the integumental layers.

The mode of termination in these nerves points out a homology to the termination of the optic nerve, as seen in its development in insects, and is, indeed, probably the method by which all nerves of sensation end, as has been shown by M. N. Jacubovitsch in the *Comptes Rendus*, May 7, 1860, p. 859. (See 'Microscopical Journal,' April 1861.)

In some—the Saw-flies for example—the ganglionic enlargement is not elongated, but applied immediately beneath the canals; so that, crowding as they do together, the whole seems as a compact layer of ganglionic cells.

The outer nerve-sheath is attached to the edge of the skin-canal, as is shown in figs. 4, 5 & 6, reminding one of the condition of the nerve-sheath of the compound eyes by which it attaches itself to the facetted cornea.

We are indebted to Leydig for the additional knowledge of the ganglionic enlargement at the termination of the nerve supplying these structures *. Upon reviewing my papers, he states also that he has found little conical "pegs or rods" ("Stifte, Stäbchen") with their bases towards the integument, which are situated in the extremity of the nerve, one or two in each. These, I must confess, after a very careful search through numerous specimens (many being the same as those in which he describes them), I have been unable to discover, and am therefore under the impression that he has fallen into some error—the more so as he admits that it was only after a dozen trials that he himself succeeded. It is a difficult thing to prove a negative; but, though I have frequently traced the nerve to its very end, I have failed to distinguish any such structures as the "Stifte" or "Stäbchen," either in specimens just killed or kept in spirit for different periods. I suspect that the method which he adopts of pulling out the nerve, by withdrawing the organized layer lining the integument internally and which passes within and lines the tube (skin-canal), has possibly led to the appearances described by him. I have noticed in the larger beetles a condition which renders this highly probable. Be this as it may, there can be no hesitation in assigning, as I have already done, an important sensory function to the organs taken as a whole.

Leydig is under the impression that they are of the same nature as the organ in the hinder part of the thorax in the *Acridæ*, &c. first pointed out by Müller, which he considers an organ of hearing. That they may be homologous to those in the *Acrida*, would seem to derive some confirmation from the circumstance that he has not found Müller's organ in the same part in other insects, while I have not found those I have pointed out on the wings of the *Orthoptera*.

But are they, therefore, auditory organs? Have they any similarity to what we know of this organ in the *Invertebrata*? I confess my inability to see any resemblance beyond

* Reichert und Du Bois-Reymond's Archiv, 1860, No. 3, p. 299.

such as appertains to all sensory nerves. To what I have already advanced on this point I have nothing to add.

At the time of writing his article above mentioned, Leydig had not seen my second paper on the antennal organs. Nor had he been successful, as he owns, in applying the bleaching process I have recommended for their examination; consequently neither has he, nor indeed any writer (Lespès for instance, nor his critic in this subject, Claparède), as yet noticed properly the structures I have pointed out in the antennæ. Under these circumstances we must consider their opinion as to the seat of the auditory function liable to revocation.

EXPLANATION OF THE FIGURES.

Fig. 1. Termination of nerve of haltere in *Rhingia rostrata,* showing a row of ganglionic cells, with nuclei *a a*, and their terminations *b*, *b*.

Fig. 2. Two ganglionic cells *in situ* in halteres of *Eristalis tenax*: *a a*, ganglionic enlargement; *b*, terminal expansion with nucleus, *c*, passing to the interior of the vesicles, *d*.

Fig. 3. Row of ganglionic cells, *a a*, in *Eristalis tenax*; *b*, their termination beneath the vesicles.

Fig. 4. Ganglionic cells in a Beetle (one of the *Lamariæ*), the outer nerve-sheath attached to the skin-canal; *a a*, nuclei, two or three in each: a small tube passes through the skin-canal to the closing-in membrane.

Fig. 5. Shows one of the ganglionic cells with three nuclei, *a a*; the nerve-sheath, *b b*, has been attached to the inner surface of the skin-canal.

Fig. 6. Shows another form, where the ganglion, *a*, is not so near the integument as in the preceding.

Fig. 7. Organs viewed *in situ* from above on the nervure of *Strangalia elongata*: *a a*, ganglionic swellings with nuclei; *b*, closing-in membrane and skin-canal.

XXIII. *On Three Oaks of Palestine.* By J. D. Hooker, *M.D., F.R.S., F.L.S., &c.*

Read June 20th, 1861.

During a short tour in Syria, which I made last autumn in company with Mr. Hanbury, F.L.S., we paid especial attention to the oaks of that country which occurred on our route, in the hopes of being able to throw some light on their very intricate and confused history. The brief nature of our visit, and the necessity we were under of moving rapidly almost daily, and always on horseback, rendered it impossible to do more than obtain an accurate idea of the commonest species only: of these one was all but ubiquitous, from the latitude of Tripoli to that of Hebron; and two others appeared in such great abundance in various localities, that we have, I think, obtained a clear conception of their limits of variation in Syria, and, by means of the specimens we procured, have identified them with those of other parts of the Mediterranean. There are *Quercus pseudo-coccifera*, Desf., *Q. Ægilops*, L., and *Q. infectoria*, L., of which three species I find that no fewer than thirteen have been made in Syria alone, and an equal, or probably a much greater number in Asia Minor and other parts of the Levant.

To the following identifications I have been guided either by good specimens or by excellent plates, amongst the very best of both kinds of which evidence I would especially indicate the Syrian and Taurian collections of Kotschy, and his superb folio fascicles entitled "Die Eichen Europa's und des Orients," the plates of which are unrivalled.

1. Quercus pseudo-coccifera, Desf. Atlant. ii. p. 549.

Q. Calliprinos, Webb! It. Hisp. p. 15; Kotschy, Herb. It. Cilic. No. 397; Willd. Sp. Pl. iv. p. 434.

Q. Pseudo-coccifera? Kotschy, Herb. It. Syriac. No. 265!

Q. inops, Kotschy, fid. Herb. Reg. Berol. Lebanon, No. 83!

Q. echinata, Kotschy, fid. Herb. Reg. Berol. Lebanon, No. 84!

Q. Palæstina, Kotschy, *l. c.* t. xix., et Herb. It. Syriac. No. 442!

Q. Aucheri, Jaub. et Spach, Ill. Pl. Or. p. 113, t. 58!

Q. rigida, Willd. Sp. Pl. iv. p. 435; Kotschy, *l. c.* t. viii., et Herb. It. Cilic. No. 404!

Var. *Kotschyi,* Herb. It. Syriac. No. 264!

Var. *microphylla,* Kotschy, It. Cilic. No. 399!

Var. *pungens,* It. Cilic. 400! 806.

Var. *arborea,* Herb. It. Cilic. No. 403!

Cf. *Q. Fenzelii,* Kotschy, *l. c.* t. xxiv. et Herb. It. Cilic. No. 398!

Cf. *Q. aquifolia,* Kotschy, Herb. It. Cilic. No. 402!

Hab. Per totam Syriam, ad 6000 ped. ascendens; copiosissime! Fl. vere; fr. Nov.

Dist. Hispania! et Lusitania! Italia! Algeria! Cephalonia! Græcia! Asia minor! Creta!

Of the above synonyms, *Q. inops*, *echinata*, and *Palæstina* were founded on Syrian specimens by Kotschy; that of *Calliprinos* by Webb, who attempted to discriminate Labillardière's original Syrian specimens of *pseudo-coccifera*, from Desfontaines' Algerian plant of that name. The names of *pseudo-coccifera* and *Calliprinos* are also both applied by Kotschy to Lebanon specimens. *Q. rigida* was founded on Caramanian, and *Fenzelii* on Taurian specimens.

With the exception of *Q. Calliprinos*, there has been little attempt at *diagnostic* discrimination of these species by their several authors; and the chief characters relied on to separate them—those of form of leaf, and length of the gland and involucre—we found to fail and hold on the same tree in numberless instances. With regard to the other so-called species, long descriptions of some have been published; but these contain no contrasting characters, and the specimens show none. Most, if not all, of the forms indicated under the whole seven names may be found in one morning's ride along the crest of Mount Carmel, where the greater number of the series of acorns figured in Plate XXXVII. were collected, all of them from trees which, in habit of growth, foliage, &c., presented little variation.

Q. pseudo-coccifera is by far the most abundant tree throughout Syria, covering the rocky hills, of Palestine especially, with a dense brushwood of trees 8–12 feet high, branching from the base, thickly covered with small evergreen rigid leaves, and bearing acorns copiously. On Mount Carmel it forms nine-tenths of the shrubby vegetation, and it is almost equally abundant on the west flanks of the Antilebanon and many slopes and valleys of Lebanon. Even in localities where it is not now seen, its roots are found in the soil, and dug up for fuel, as in the valleys to the south of Bethlehem. Owing to the indiscriminate destruction of the forests in Syria, this oak rarely attains its full size. We saw but few very good trees, one of which is the famous Oak of Mamre, called "Abraham's Oak," of which I have given a portrait (Plate XXXVI.)*, and I saw other good ones at Anturah on the Lebanon. Leaves and acorns of both these were carefully compared with those of the stunted form that grew around them and elsewhere, and presented no difference whatever.

The "Abraham's Oak" is popularly supposed to indicate the spot where grew the oak or lentisk (for it is disputed which) under which the patriarch pitched his tent; and is reverenced accordingly by Jews, Mahommedans, and Christians. In general habit it much resembles the *Q. Ilex* as grown in this country, but does not branch so much from the base; the bark is similar in colour and fissuring, the branches in direction, and the foliage in colour, &c. I would draw attention to the difference shown in the portrait, between the direction of the branchlets on the two sides of the tree: on the west, where exposed to the winds of the Mediterranean, they are much stunted, denser, and more rigid than on the east, where they are more pendulous.

The diameter of foliage is given, no doubt correctly, by Porter as 90 ft., and girth of trunk as 23 ft.

In the winter of 1856–57, when, in the streets of Jerusalem (elev. 2200 ft.), the snow fell deep and lay for many days, the accumulation upon the Abraham's Oak was so great, that one of the finest boughs gave way under the weight and fell to the ground. Mr. Schembri, the highly intelligent dragoman, of Jerusalem, informed me that he was employed by Mr. Finn, British Consul, to bring the bough to that city for him. Owing to a superstition

* "David's Oak," *Q. Palæstina*, Kotschy, Eichen, tab. xix.

that any person who should cut or maim the Oak would lose his firstborn son, considerable difficulty was experienced in procuring hands to saw up the timber for transportation; these were at last brought from Jerusalem, nearly twenty-five miles off, and loaded seven camels with the wood of the one limb of this fine tree.

The timber of *Q. pseudo-coccifera* is said to be of ordinary value; but I could procure no precise information on this head. How far it is permanently distinct from *Q. coccifera* of Spain and Italy may reasonably be questioned: the characters given, even if constant, amount to no more than enough to establish a variety upon; and it will be seen that in geographical distribution, as in botanical synonymy, the *Q. pseudo-coccifera* completely overleaps *Q. coccifera*, extending from Spain and Algeria to the borders of the Mesopotamian Desert, whereas the latter is not described as inhabiting any country further east than Asia Minor.

With regard to the differences in the acorns of these species, they are very slight, and a long way within the limits of variation of *pseudo-coccifera* observed in Syria; and as the acorns of *coccifera* take two years to ripen, there is much time for variation during development. The European *Q. coccifera* is described as a bushy shrub resembling the Holly, and is browsed on by cattle: this precisely accords with the character of *pseudo-coccifera* in Syria, which is further called Holly by many travellers (Martineau, Porter, &c.). Again, the specimens of *coccifera* cultivated at Kew precisely accord with the Syrian *pseudo-coccifera*, whilst the Algerian specimens of the latter (which, however, are grafted) are of a rather more straggling habit, with larger leaves.

Loudon and others described *pseudo-coccifera* as having leaves twice or thrice as large as *coccifera*, thicker and less wavy, with smaller and shorter spinous serratures rather than teeth. Not one of these characters holds good, with any approach to constancy, in Syria, where large and small, more or less membranous, and more or less waved and spiny leaves occur on individual plants, and, more conspicuously, on adjacent ones. On Carmel, just below the convent, we gathered two forms growing with interlocked branches, with the typical leaves attributed respectively to *pseudo-coccifera* and *coccifera*, but with identical acorns—those of the former plant. The Kermes was not observed by us in Syria.

Q. pseudo-coccifera is an uncommon tree in English gardens. There are young Algerian specimens, which have survived the severe frosts of 1860–61, at Kew, where also the acorns I brought from Syria have germinated. Loudon (1838) mentions but one tree known to him in cultivation as bearing this name, which exists in the Horticultural Society's Gardens at Chiswick.

2. Quercus infectoria, Olivier, Voyage, t. 10; Willd. Sp. Pl. iv. 436; Kotschy, Herb. It. Cilic. No. 363! 371! var. *grossè-serrata*, No. 369!

Q. Cariensis, Willd. fid. Loudon, Arboret. p. 1928.

Q. Boissieri, Reut., Boiss. Diagn. xii. p. 119; Herb. It. Syriac. No. 126!

Q. Pfæffingeri, Kotschy, Eichen Europ. und Orient. t. xxiii., et Herb. It. Cilic. No. 373!

Q. inermis, Ehrb. fide Kotschy, Herb. It. Syriac. No. 364!

Q. Tauricola, Kotschy! *l. c.* t. x., et Herb. It. Cilic. No. 365! et var. fol. undul. No. 367!

Q. leptocarpos, Kotschy, Herb. It. Cilic. No. 372!

Q. polycarpos, Kotschy, Herb. It. Cilic. No. 370!

Q. Syriaca, Kotschy, *l. c.* t. i.
? *Q. brachyphylla*, Kotschy, *l. c.* t. ix.
? *Q. hypoleuca*, Kotschy, Herb. It. Syriac. No. 99 !

Hab. In locis petrosis Syriæ alt. 1500–5000 ped., a Libano ! ad Carmel ! Fl. vere ; fr. October.
Dist. Græcia, Bosnia ! Byzantium ! Asia minor !

Q. infectoria was established by Olivier on plants found in Asia Minor.

Q. Boissieri originated in specimens brought from Zebdany, in the Antilebanon, by Boissier ; *Q. inermis*, founded on Lebanon specimens gathered by Ehrenberg, is also applied by Kotschy to others from the Valley of the Kedisha (Cedars). *Q. Pfæffingeri* is applied both to Syrian and Cilician specimens by Kotschy ; *polycarpos*, *leptocarpos*, and *Tauricola*, all to Taurus specimens by Kotschy. Of *Q. Syriaca* I have no example ; but Kotschy's splendid plate serves to identify it absolutely with *infectoria*, as does the habitat. Of *Q. brachyphylla* also I have no specimens ; it is a Taurus plant, also well illustrated by Kotschy. Of *Q. hypoleuca* I have only one specimen, without flower or fruit, which exactly resembles a young shoot of *infectoria* ; it was collected at Zebdany in the Antilebanon.

Quercus infectoria was met with by us in great abundance on the east slopes of Lebanon, again on the rocky hills of Galilee south of Safed, and, lastly, on the summit of Carmel. In all these localities it occurred as a small tree 15–20 feet high, or, more often, as a bush sparingly branched, with a rather slender rugged trunk, and grey deciduous foliage white on the under surface ; it was rendered very conspicuous by the abundance of those spherical galls of a deep red-brown colour and shining viscid surface which are figured in the 17th volume of our Transactions (plate 22).

Another gall, of smaller size, paler colour, softer texture, precisely similar to the gall of *Q. Cerris*, figured by Loudon and presenting several angular conical protuberances, was sparingly found by us in Syria, and, as we believed, on this same tree ; but we had no opportunity of identifying the specimen with fruiting ones. Neither of these galls is collected in Syria, as far as we could hear : the larger and commoner is probably not different from the Aleppo gall, though it may be inferior in quality. The acorns are of a singularly elegant form and bright amber-colour. It is very rare in English nurseries : Loudon states that he had (1838) never seen it, and knew of no living specimen near London, though, according to catalogues, it was introduced in 1822. Some of those I brought home in damp earth are now growing in the Royal Gardens.

The *Quercus infectoria* is common throughout Asia Minor. Mr. Balansa showed us trees of it near Smyrna, and informed us that it was extremely variable in foliage and pubescence. Its western limit is apparently Bosnia, and its eastern the confines of Persia ; to the north it attains the latitude of Constantinople, and its southern limit is probably the hills of Samaria.

3. Quercus Ægilops, Linn. Sp. Pl. 1414 ; Willd. Sp. Pl. iv. 448 ; Tchihatcheff, As Min. Bot. vol. ii. p. 470, t. xli. and xlii.

Q. Pyrami, Kotschy, Eich. Europ. u. Orient. t. 3 ; Herb. It. Cilic. No. 395 !
Q. macrolepis, Kotschy, *l. c.* t. 16, et Herb. No. 309, *a* !
Q. Ungeri, Kotschy, *l. c.* t. 13, et Herb. It. Cilic. No. 390 ! Tchihatcheff, *l. c.* p. 473.

Q. Trojana, Webb in Jaub. et Spach, Ill. i. t. 54; Kotschy, Coll. No. 391!
Q. Gaedelii, Kotschy, Herb. It. Cilic. No. 387! (et 407!?).
Q. Vallonea, Kotschy, *l. c.* t. 7, et Herb. It. Cilic. No. 80! 391! 394! Tchihatcheff, *l. c.* p. 474.
Q. Ithaburensis, Kotschy, *l. c.* t. 12.
? *Q. Look*, Kotschy, *l. c.* t. 21: vide sub *Q. castaneæfolia*.
? *Q. Ehrenbergii*, Kotschy, *l. c.* t. 15; Herb. It. Cilic. No. 393! Tchihatcheff, *l. c.* p. 474 (vide sub *Q. Toza*).

Hab. In collibus Syriæ in Galilee! et Samaria! Fl. vere; fr. October.
Dist. Hispania, Græcia! Asia minor! Creta!

Of the above names, the original, *Ægilops*, is that in general use for this the Vallonea Oak. Grisebach identifies Olivier's plant (*Vallani*, Oliv., *Ægilops*, L.) with *Q. Libani*, Oliv., and *Q. castaneæfolia*, C. A. M. (*Trojana*, Webb), a plant of Lebanon which we did not observe in Palestine. Tchihatcheff, As. Min. Bot. vol. ii. p. 470, however, refers the *Vallani* of Olivier to *Ægilops*, L. *Q. Trojana* was applied by Webb to specimens from Phrygia; *Q. Ithaburensis* by Decaisne to specimens from Tabor; and Kotschy has also applied the name to the same plant from the vicinity of Nazareth, by which, no doubt, Tabor is meant. Of *Q. Look*, which inhabits Hermon, I have seen only one specimen, without flower or fruit, which altogether resembles small examples of *Q. Ægilops*, but may be referable to *Q. castaneæfolia*, C. A. M. The other four names are all applied by Kotschy to Taurus forms, except *Ehrenbergii*, of which a fine specimen is in the Kew Museum, resembling *Ægilops* in the acorn, but the leaves broader and more deeply cut: this species was founded on a plant gathered by Ehrenberg at Massa, in the Antilebanon.

The Vallonea Oak is, like the *Q. pseudococcifera*, very gregarious in Syria, though growing in a widely different manner, never forming a bush or growth of underwood, but rising, on a stout gnarled trunk 3–7 feet in girth, to the height of 20–30 feet. Wherever we saw it, as on the hills east of Nazareth, on Tabor (where it is abundant), to the east of Caifa, and on the N.E. flank of Carmel, it forms scattered, rather round-headed, densely leafy trees, giving an open park-like appearance to the landscape. From its stout habit and sturdy limbs, and from a specimen of the wood of the Basan Oak given to the Kew Museum by Cyril Graham, Esq., I should be inclined to suppose that this was the Oak of Basan. The wood is said to be excellent; and the tree is, like all other timber in Syria, indiscriminately cut for house-fitting and fuel. At the foot of Tabor, almost all the largest trees were mutilated by ineffectual attempts on the part of the Turks and Arabs to fell them; none of these were more than about 6 feet in circumference.

The gland of the acorn of this species often attains a very large size: some we gathered were $2\frac{1}{2}$ inches long, and 3 inches in girth; but they vary extremely on the same tree, some being so small that I have had difficulty in discriminating between them and large ones of *Q. pseudococcifera*. I have examples which, had they not been taken by myself from an *Ægilops* tree which also bore large acorns, I should have attributed to hybridization between the two. When fully ripe the gland is still green; and in this state it germinates, the pericarp never hardening. These may be seen in all the bazaars, raw and boiled, in which state they are eaten by Turks and Arabs; rude ornaments are also made of the shell. The seeds of this species which I brought home have germinated in the Royal Gardens. Loudon states that a gall similar to that of *Q. infectoria*, but more angular, is found on *Q. Ægilops*: this was not observed in Syria.

The Vallonea Oak, though abundant in Asia Minor, &c., is almost limited in its range to the countries east of the Adriatic and west of Persia, except it should prove that *Q. Persica* is a form of it, which to me appears quite possible. Nyman gives Spain as a habitat. It is rare in British gardens, though plants 50–60 feet high exist.

It may be well to mention here what I know of the other Oaks said to inhabit Syria. These, which are all confined to the northern mountain ranges, are—

1. Quercus Cerris, Linn. Sp. Pl. 1415; Willd. Sp. Pl. iv. 454.

Q. *Cerris* var. *Caramanica*, Kotschy, Herb. It. Cilic. No. 80! & 385!—Var. *Cilicia*, Herb. It. Cil. No. 386!

Q. *crinita*, Bosc, Mém. Chên. p. 19, fid. DC. Flor. Franc. vi. p. 354.

Q. *Austriaca*, Willd. Sp. Pl. iv. 454; Kotschy, Eich. Europ. u. Orient. 20.

Q. *Haliphlœos*, Juss., Lamk.! fid. Herb. Benth.

Q. *Pseudocerris*, Boiss. et Reut.! Kotschy, Herb. It. Syr. No. 328!

The original *Q. Cerris* is a native of Spain, France, Italy, Austria, Greece, and Asia Minor, and *Q. Haliphlœos* of Asia Minor; *Q. Pseudocerris* of Mount Casius in North Syria, and the Valley of the Kedisha above Tripoli.

2. Quercus Toza, Bosc, Journ. Hist. Nat. ii. p. 155, t. 32. f. 3, fid. DC. Flor. Franc. vol. vi. p. 352; Kotschy, Eichen Europ. und Orient. t. xxii.

Q. *subalpina*, Kotschy! Herb. It. Syriac. No. 335.

Q. *Pyrenaica*, Willd. Sp. Pl. iv. 451.

Q. *Tauzin*, Persoon, Kotschy, Herb. It. Syriac. No. 336!

Kotschy gives *Q. Toza* (*Tauzin*, Pers.) as a native of the Kedisha Valley; and his specimens appear in no way different from South European ones; they do not differ from his *Q. subalpina* from the same locality. His *Ehrenbergii* (vid. sub *Ægilops*) may be referable here. *Q. Toza* is a native of the Pyrenees and South of France also.

3. Quercus castaneæfolia, C. A. Meyer in Eichwald Caucasus, fasc. ii. p. 9, t. 1; Jaub. et Spach, Illust. t. 54.

? Q. *squarrosa*, Kotschy, Herb. It. Syriac. No. 100!

? Q. *Look*, Kotschy, *l. c.* 172.

? Q. *carpinea*, Kotschy, *l. c.* No. 98!

This handsome species (the true *Ægilops* of Linnæus, according to Grisebach) is a native of the regions south of the Caucasus, Asia Minor and Persia, it having been originally described from Mazanderan, on the south shore of the Caspian. Kotschy's Oak No. 98, from Zebdany in the Antilebanon, appears to be the same plant, as far as can be judged by leaves alone, as may also be the *Q. Look* alluded to under *Q. Ægilops*.

4. Quercus Libani, Oliv. fid. Kotschy, *l. c.* t. 5; Herb. It. Cilic. No. 380! et var. foliis obscurioribus, *l. c.* 384!

A noble species, allied to *Q. castaneæfolia*, if not a mere form of it. It is a native of Cilicia, and Kurdistan according to Kotschy, but was originally discovered in the Lebanon by Olivier, who sent specimens to Desfontaines.

5. QUERCUS MANNIFERA, Lindl.! Bot. Reg. 1840, Misc. p. 40; Kotschy, Herb. Syriac. nullo numero (Herb. Reg. Berol.).

Q. Dschorochensis, Koch! Kotschy, Herb. Syriac. sine numero (Herb. Reg. Berol.).

The *Q. mannifera* was established by Lindley on a plant brought from Lake Van, and its close affinity with *Q. sessiliflora* indicated. Our specimens so called by Kotschy (Herb. Reg. Berol.) seem identical with his *Q. Dschorochensis* from Syria, a plant also found in Asia Minor.

EXPLANATION OF THE PLATES.

PLATE XXXVI.

Tree of *Quercus pseudo-coccifera*, Desf., near Hebron, called Abraham's Oak.

PLATE XXXVII.

Acorns of various forms from trees of *Quercus pseudo-coccifera*, Desf.

PLATE XXXVIII.

Acorns of various forms from trees of *Qurcus Ægilops*, L.

XXIV. *On* Fissicalyx *and* Prioria, *two recently published Genera of* Leguminosæ. *By* George Bentham, *Esq., Pres.L.S.*

Read June 20th, 1861.

1. Fissicalyx Fendleri, Benth.

When I gave the characters of this remarkable species, forming a very distinct genus of Dalbergieæ, in a recent Part of the Journal of the Society's Proceedings (vol. v. p. 78), I stated that the loose fruits distributed with the specimens were those of a *Guaiacum*. In this I was misled by the fruits of the *Guaiacum arboreum*, distributed in the same set, having been accidentally exchanged with them in my parcel. I have now ascertained that the loose fruits generally sent with the *Fissicalyx* really belong to it, and confirm the very distinct character of the genus. Not only are the calyx and anthers exceptional among Dalbergieæ, but the broad wings do not, as is usually the case in that tribe, and in other 1- or 2-winged legumes, arise from the sutures, but from the centre of the valves themselves, like the secondary wings in the 4-winged *Loti* and *Clitoriæ*, or in *Psophocarpus*, *Tetrapleura*, *Gagnebina*, and other 4-winged Leguminosæ. Here, however, the sutures are not at all dilated, and the legume has only the secondary wings, the cavity of the pod remains very narrow for its length, and the single seed in the one I opened had linear cotyledons, of which one was longer than the other and hooked over it at the extremity. The embryo is perfectly straight, as in Cæsalpinieæ; but that is the case in several Dalbergieæ.

The following is the technical character of the genus, with the description of the species, as completed by that of the fruit.

Fissicalyx, Benth.

Char. Gen.—*Calycis tubus* turbinatus; limbus acuminatus, integer v. apice brevissime bidentatus, per anthesin hinc fissus, spathaceus. *Petala* ad apicem tubi cum staminibus inserta, papilionacea. *Vexillum* ovatum. *Alæ* eo vix breviores, oblique oblongæ. *Carinæ* petala subsimilia, paullo minora, libera. *Stamina* 10, monadelpha, vagina supra fissa. *Antheræ* versatiles, apice biporosæ. *Ovarium* breviter stipitatum, biovulatum. *Stylus* filiformis, apice minute stigmatosus. *Legumen* cum alis planum, ovali-ellipticum, ipsum tamen angustum, suturis parum prominulis, valvulis medio longitudinaliter late alatis. *Semen* unicum, prope apicem affixum, oblongo-lineare. *Albumen* 0. *Testa* tenuis, hilo parvo. *Embryo* rectus, radicula brevi supera, cotyledonibus linearibus.

Species unica, F. Fendleri, Benth. Arbor. Folia imparipinnata. Foliola (11) opposita, exstipellata, petiolulata, inferiora ovata, superiora oblonga, acuminata, 3–4-pollicaria, basi rotundata v. subcordata, glabra, membranacea. Panicula terminalis, molliter pubescens. Bracteæ stipulares, ad basin ramulorum parvæ, sub floribus minutæ. Flores conferti. Pedicelli ad singulas bracteas solitarii v. gemini, vix lineam longi. Bracteolæ parvæ, acutæ, persistentes. Calyx semipollicaris, pubescens, subfoliaceus, apice longe, basi brevius attenuatus, summo apice minute penicillatus. Petala aurantiaca, calycem paullo superantia, breviter unguiculata. Vexillum basi complicatum, nec auriculatum nec appendiculatum, erectum, lateribus reflexis, glabrum. Alæ et petala carinalia basi hinc rotundato-auriculata, supra basin transversim rugulosa, versus apicem pilosa. Legumen breviter stipitatum, puberulum, cum alis 2 poll. longum, $1\frac{1}{2}$ poll. latum, apice late rotundatum et emarginatum, valvulorum alis membranaceis, transversim parallele venosis. Cotyledones in semine examinato inæquales, longior apice uncinata.

Hab. In Venezuela, between Turmero and Maracai, at an elevation of 1700 feet above the level of the sea (*Fendler*, n. 2223).

Tab. XXXIX. fig. 1. Flower; fig. 2. the same with the petals removed, showing the stamens; fig. 3. Vexillum; fig. 4. one of the Alæ; fig. 5. one of the Petals of the Carina; fig. 6. a Stamen, front view; fig. 7. the same, back view; fig. 8. Ovary and Style; fig. 9. Ovary, longitudinal section showing the ovules; fig. 10. Fruit; fig. 11. the same, cross section; fig. 12. the same, longitudinal section showing the seed; fig. 13. Seed, showing the hilum; fig. 14. Embryo; fig. 15. the same with one cotyledon removed, showing the plumula.

2. Prioria copaifera, Griseb.

This plant, forming a distinct genus allied to *Copaifera*, was dedicated by Dr. Grisebach to Dr. Alexander Prior, so well known for his botanical researches at the Cape, in the West Indies, and Southern Europe, and was described by him in the last Part of his 'Flora of the British West Indies,' p. 215, from specimens gathered by Mr. Wilson at Bachelor's Hall, near Bath, in Jamaica. The tree is there rare, and the fruit was unknown. Since then, however, we have received specimens, both in flower and in fruit, of evidently the same species, from Mr. Sutton Hayes, who found it growing in swamps in Panama, near the Barbacoa station of the Panama Railroad. He states it to be there known under the name of *Cativa*. The tree, which was felled to obtain the specimens, was near 100 feet high, and the trunk measured 5 feet in diameter. The pod confirms in many respects the affinity of the genus with *Copaifera*; it is, however, very much larger and flatter, woody rather than fleshy; the single seed is very flat, without any albumen; the cotyledons, of a somewhat hard fleshy consistence, adhere so closely that, after thoroughly boiling and soaking the seed, I was unable to separate them except close round the edge; the radicle forms only a slight protuberance, at no great distance from the hilum; and altogether the seed shows none of that approximation to the Connaraceous seed observable in *Copaifera*. We find in the Kew Museum some of the same fruits, deposited there by Dr. Seemann as those of the "Amanza muger" of the Isthmus of Panama, sold in the markets there for their exciting properties. They do not, however, agree with the description of the "Amanza muger" fruits given in the "Botany" of the 'Voyage of the Herald' (p. 90), which are there referred to a *Hippocratea*.

The following are the technical characters of the plant.

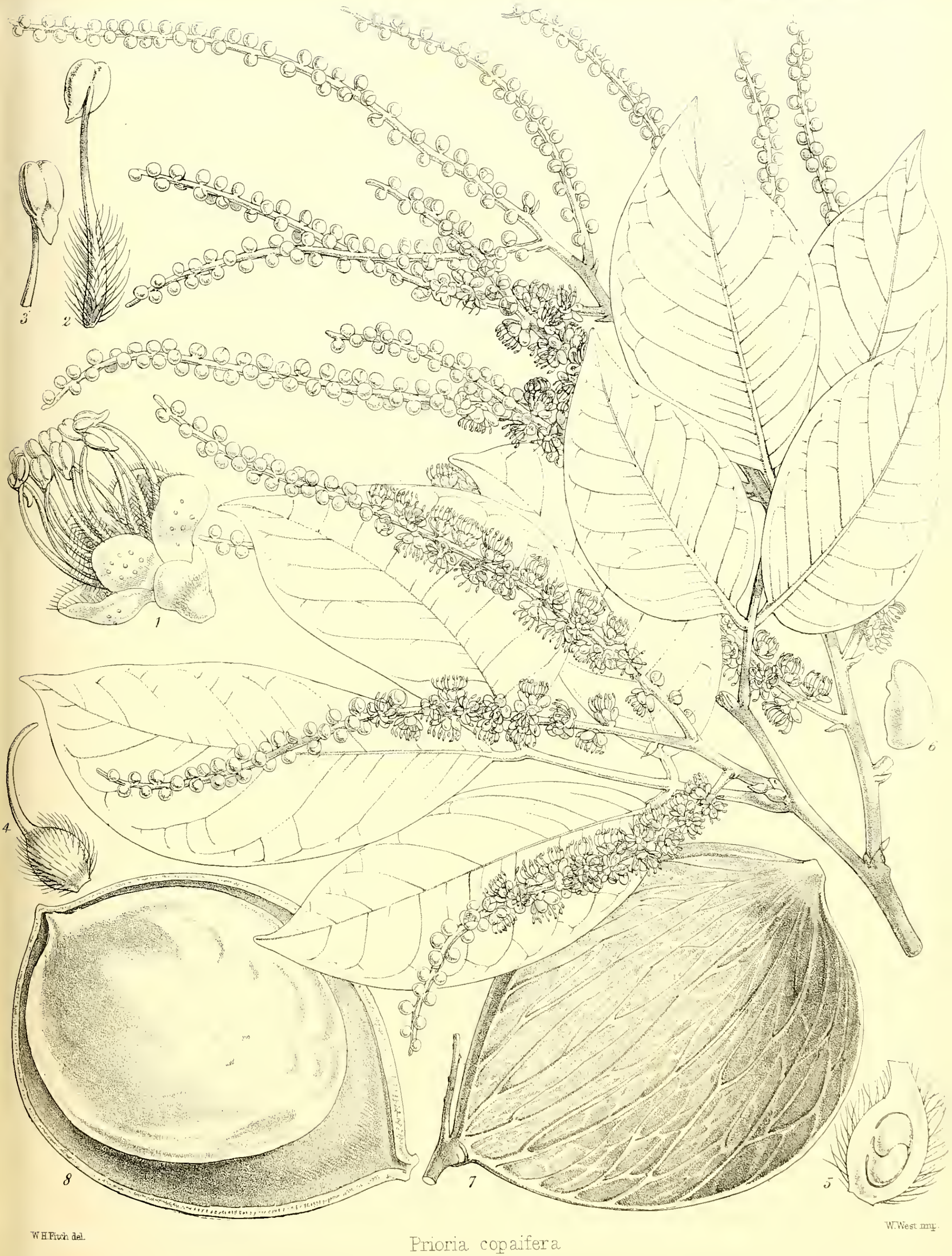
Prioria, Griseb.

Char. Gen.—*Calyx* tubo brevi cupulato, lobis 5 orbiculatis subpetaloideis valde imbricatis, infimo exteriore. *Petala* 0. *Stamina* 10, libera, subæqualia. *Antheræ* versatiles, 2-loculares, 2-rimosæ, con-

W.H. Fitch del.

W. West imp.

Fissicalyx Fendleri.



W.H.Fitch del.

W.West imp.

Prioria copaifera

nectivo crasse apiculato. *Ovarium* sessile, biovulatum. *Stylus* breviter filiformis, apice minute stigmatosus. *Legumen* planum, coriaceo-sublignosum, obovato-orbiculatum, reticulato-venosum, tardius bivalve. *Semen* ab apice pendulum, orbiculatum, cavitatem implens, planum. *Albumen* 0, *Testa* tenuis. *Cotyledones* carnosæ, induratæ, arcte cohærentes; radicula brevissima, mammiformis, a hilo parum remota. *Plumula* inconspicua.

Species unica, P. COPAIFERA, Griseb. Arbor procera, glabra, ramis patentibus. Stipulæ squamæformes, caducæ. Folia alterna, abrupte pinnata, petiolo communi $1\frac{1}{2}$–2-pollicari; foliola 2-juga, rarius 1-juga, opposita, oblique v. falcato-ovata, 3–6-pollicaria, breviter et obtuse acuminata, basi rotundata v. cuneata, petiolulo 2–3 lin. longo, coriacea, utrinque reticulato-pennivenia, pellucido-punctata. Paniculæ terminales, amplæ, parum ramosæ, ramis interrupte spiciformibus 2–6-pollicaribus. Flores parvi, sessiles, dissiti v. subfasciculati. Bracteæ inconspicuæ. Bracteolæ in cupulam bilobam calycis tubum æquantem connatæ. Calycis tubus vix $\frac{1}{2}$ lin. longus; laciniæ concavæ, lineam longæ, margine minute ciliolatæ. Filamenta ad marginem tubi inserta, laciniis longiora, basi ciliato-hirsuta. Antheræ ovato-oblongæ, loculis curvulis; connectivi apiculus carnoso-conicus, *Humirium* quodammodo referens, terminalis, sed anthera reversa inferus. Ovarium villosum. Legumen $3\frac{1}{2}$–4 poll. longum, 3–$3\frac{1}{2}$ poll. latum, basi subcuneatum, facie altera convexa, altera concava, venis elevatis longitudinalibus reticulatis, ad apicem et versus basin convergentibus. Semen maturum 3 poll. longum, $2\frac{1}{2}$ poll. latum, undique fere 2 lin. crassum.

Hab. Jamaica (*Wilson*); Isthmus of Panama (*Seemann, Sutton Hayes*).

TAB. XL. fig. 1. Flower; fig. 2. Stamen with a back view of the anther; fig. 3. Anther, front view; fig. 4. Ovary and Style; fig. 5. Ovary, longitudinal section, showing the ovules; fig. 6. Ovule: all the above magnified. Fig. 7. Fruit, natural size; fig. 8. the same, with one valve removed, showing the seed.

XXV. *The Foot of the Fly; its Structure and Action: elucidated by comparison with the feet of other Insects, &c.*—Part I. *By* TUFFEN WEST, *Esq., F.L.S.*

Read March 21st and June 6th, 1861.

THE structure and action of the Fly's foot have been so frequently treated of, and are so generally considered to be fully understood, that it may appear, at the first glance, as if nothing further could be done with so hackneyed a subject. Whilst, however, in consequence of some investigations which have been recently made to determine its *structure*, opinions may now be considered as pretty well fixed with regard to this portion of our subject, authorities still differ widely respecting the *action* of the parts of which the foot is composed. Nor has it appeared that any satisfactory progress was making towards a reconcilement of the differences of opinion on the subject,—each succeeding author setting aside, more or less, the opinions of his predecessor in point of time, only to be himself again contradicted by his successor. On reflection, it occurred to me that this probably arose in great measure from the attention of observers having been confined too exclusively to the *Fly's* foot, and that perhaps, amongst the teeming myriads of insect-life, structures might, on careful search, be met with resembling those under consideration in every respect but that of their being on a larger scale. Supposing this to be the case, the advantages gained, both for purposes of observation and of reasoning, will be very great, as will be best appreciated by those who have had large experience in microscopic researches on very minute parts. The high powers necessary for investigations under such circumstances demand so many appliances in the instrument of research, with such great skill in the use of them—all these tending to introduce new sources of error—that the student feels it a relief indeed when he can assist his mind towards forming conclusive opinions by availing himself of larger examples of similar structures. That this advantage may be gained in the present instance will appear to some extent during the course of the following remarks, and still more strongly when I come to speak, on a subsequent occasion, of other modifications of the parts now to be noticed, of the types of feet in Insects which characterize, with few exceptions, the grand divisions in a systematic classification, and of the analogies and homologies respectively of the parts. It is intended now simply to indicate the leading divisions of the subject, and to show that parts similar to those on the Fly's foot, but on a larger scale, are to be met with abundantly in other insects. And, this advantage being gained, it is hoped that a fuller understanding of the nature and purposes of these structures in the insect economy will also be reached, and that the conclusions to be drawn will, from the wider basis on which they rest, satisfy more completely than hitherto all the conditions of the question.

It will be necessary to give a brief sketch of the labours of previous observers on this subject, before stating the results of my own investigations.

The earliest mention which I find of any minute examination of the feet of the Fly is in an interesting little work by George Power (1664)*. He held that the claws enabled the Fly to take hold of any roughness of the surface on which it might be moving; and when the latter was too smooth to afford any advantage of this kind, that there was "a fuzzy kind of substance like little sponges, with which she" (Nature) "hath lined the soles of her" (the Fly's) "feet, which substance is always repleated with a whitish viscous liquor, which she can at pleasure squeeze out, and so sodder and be-glew herself to the plain she walks on, which otherways her gravity would hinder (were it not for this contrivance) especially when she walks in those inverted positions."

The near approach gained by Power, at one stride, towards the true structure of the minute parts in question, as well as towards what I believe to be the true explanation of their action, is indeed remarkable, when the early date of his observations is considered. Had he only seen the hairs on the Fly's cushions, nothing would have been left for succeeding observers to discover, except such minute details of structure as are revealed by the higher powers of our modern microscopes.

The next observer was the well-known Hooke, who wrote only three years later (1667)†. He saw, in addition to what Power had made known, the minute hairs on the under surface of the "soles," and recognized (as later observers hardly appear to me to have done) the importance of the grasp gained by the claws, when drawing against the strong, forward-pointing and sharp spinous hairs (one at either side of the basal line of each tarsal joint, underneath), wherever any projections, or a yielding surface, are presented by the plane on which the insect may be moving. The effect gained in such an action of the claws, when drawn backwards and inwards against the "soles with their small bristles or tenters, which have their points looking the contrary way, that is, forwards and outwards," is distinctly mentioned and insisted upon. "If there be any irregularity," he continues, "or yielding in the surface of the body, the Fly suspends itself very firmly and easily, without the access or need of any sponges filled with an imaginary *gluten*."

Further on, he proceeds to show how these "tenters" (a better name could not be devised for them)—*how* these "tenters or points, whereof a Fly has about ten in each foot, to wit two in every joint," assist in the action. This was the "mechanical theory," in its purest expression, as the preceding had been the "viscid" one. It was a decided advance towards a complete explanation, although manifestly insufficient for all the facts of the case. He believed in the existence of a "smoky substance on glass," into which he thought that the minute hairs of the "soles" penetrated, and so assisted the Fly in holding on to that smooth and slippery material. This belief in a "smoky substance on glass" has been considered a mistake by every successive writer on the subject; and yet it is certain that glass very frequently undergoes a slow decomposition on its surface in a moist atmosphere, from the excess of alkali in its composition. Such a change is speedily produced in glass exposed to the action of the weather, as in our window-panes, and conveys the appearance as if a "smoky substance" were condensed upon it. It has been proved by most careful observations, which may be readily verified by any one desirous of getting at the truth, that this tarnish does very materially assist a Fly when in a weak state in maintaining its hold, and in freely moving upon the glass. To keep our windows

* Experimental Philosophy, p. 5.

† Micrographia, p. 170.

clear for the admission of light, it requires to be constantly removed. To opticians, a similar deposition of moisture on the glasses of their lenses is but too well known; they call it the "sweating of glass."

Hooke clearly foresaw the difficulties presented by the "viscid secretion" theory, and put them in the following forcible manner: "I could not well comprehend how, if there were such a glutinous matter in those supposed sponges, as most (that have observed that object" [the Fly's cushions] "in a *Microscope*) have hitherto believ'd, how, I say, the Fly could so readily unglew and loosen its feet."

Leeuwenhoek (*circa* 1690)* brought to this, as he did to every other subject he investigated, his usual clear-headed sagaciousness. He saw flies, "almost as large as a bee," "every year" . . . . "in the month of August, sitting on a glass, at the backside of" . . . "his house" (*Eristalis tenax*). "The extremities of their feet," he found, "were covered with an incredible number of hairy parts, by the help of which they are better able than other flies to climb up a glass though it be ever so free from impurities or irregularities of which they might take hold. I have therefore," he says, "often placed the feet of those flies before the microscope, in order to view the means by which they can fasten themselves to the glass, and run up it; and I have for some years past thought that I could discover that these hairs were each of them provided with crooked parts like hooks, by the help of which they can take the firmer hold on glass; but which parts have never, to my knowledge, been described by any person, though the figures of those hairs may be seen in many authors."

Here there is a distinct reference to the peculiar flexure downwards of these parts, which will presently have to be mentioned in the description that I shall give of them from my own observations.

Leeuwenhoek, thinking that the action of these hairs was purely mechanical (*i. e.* that they acted only like so many minute hooks), illustrated his views by a description, which follows the above, of his observations on some remarkable hairs on "the hind-feet" of "large crabs" . . . . "caught among the rocks in Norway;" which hairs are "many of them provided with a double row of parts like teeth, placed in very exact order beside each other, in like manner as if we were to imagine the back of a knife cut into a double row of teeth or notches." . . . . . "This wonderful formation, I am persuaded, is intended for this purpose, that when the crab is climbing up the rocks, he may be enabled by this assistance to fix his feet firmly on the rocks or stones†."

He also describes another form of insect-foot which bears distinctly on our present purpose, in the notice of a "Fly" infesting "the blossoms of fruit-trees, particularly apples" (*Anthonomus pomorum*?). "Observing," he says, "that these insects "could run along or stand for a long time on any side of the glass, even with their feet upwards, I was desirous to examine accurately the formation of their feet, and, in this little creature, I saw such perfectly formed limbs, enabling it to adhere to the glass, and to run along upon its surface, as distinctly as I had ever seen in other larger flying animals."

* Collected Works (translated by Samuel Hoole, 1800-1807), vol. ii. part 3. p. 71.

† Ibid. pp. 71, 72.

A figure which is given of the part is then described at length, but it is not necessary to repeat the details here. The figure purports to be a representation of "almost a fourth part of one of the legs, consisting of four distinct joints: there "are two claws or nails, which are in some sort transparent, like a piece of horn or tortoise-shell seen with the naked eye," and "organs" (on the 'deeply-bilobed third tarsal joint'*) "by the help of which the animal can run along the smooth surface of the glass, and also hang to it a whole night. The formation of these organs is very wonderful, for all those parts with which they are covered, and which one would conclude to be hairs, are so exactly and regularly sloped off, and particularly of such regular lengths, as if they had been clipped with scissars, that when the animal places its foot anywhere, they all touch the place at the same time, and what is more, all these particles, which seem to the eye to be hairs, have at their extremities a hook, and at a little distance from thence, two other hooks; but by reason of their extreme minuteness, though the limner confessed he saw them through the microscope, he declared he could not represent them through the drawing. Now if we consider, what I have always experienced, that a glass, though washed ever so clean, will have many particles adhering to it, though these are so small, that the claws on the feet of flying insects cannot take hold of them, we may easily conceive that these small hooks may take hold of the small particles of water or motes from the air adhering to the glass. And here we may discover the error of those, who formerly supposed there were cavities in glass, wherein flies could fix their claws, and climb up†."

I form no opinion of the absolute correctness of Leeuwenhoek's description of the parts which "seem to the eye to be hairs," with "at their extremities a hook, and at a little distance from thence, two other hooks," which, "by reason of their extreme minuteness, though the limner confessed he saw them through the microscope, he declared he could not represent them through the drawing," until I have been so fortunate as to obtain living specimens for examination. I have scarcely, as yet, detected one error of observation in the descriptions by the present author, of his extended microscopical researches into objects embraced by the three grand kingdoms of Nature, and am therefore unwilling to ascribe error to this portion of the present observation, without feeling perfectly clear that such error exists. An instance of an analogous structure will be mentioned presently, which perhaps may help to explain the meaning of the appearance which he thus describes.

By his careful, and at the same time lively, description of the remarkable *holding* and *climbing* organ of the "Sea-Mussel" (byssus of *Modiola vulgaris*) he shows that he was fully acquainted with one instance at least of organs acting really by suction: his observations on this head will be mentioned further on, in the course of my own remarks upon such organs when presented by insects.

Derham's claim (1798)‡ to rank as an original observer rests, so far as I can ascertain, on very slender grounds. Yet, to judge from the influence which his remarks have had in the forming of the opinions of men of the highest scientific acumen, even at the present

* Westwood, *statim*. † *Op. cit.* part 3. pp. 186, 187. ‡ Physico-theology, Part ii. p. 289.

time, their importance would seem to have been considered paramount. He compared the Fly's foot with that of *Dyticus*; but the superficial observations he made of the latter go to prove that he cannot have used a magnifier of any kind in examining the great Water-beetle; or he could not have failed to observe parts (viz. the great suckers: to an eye practised in minute observation, the whole set of small suckers as well) clearly enough visible to the naked eye. His words shall speak for themselves. After simply saying, "I might here name divers flies and other insects, who, besides their sharp-hooked-nails, have also skinny palms to their feet to enable them to stick on glass and other smooth bodies, by means of the pressure of the atmosphere," he adduces the following proof of the correctness of his explanation respecting the action of Flies' feet:—"But because the example will illustrate another work of Nature, as well as this, I shall chuse a singular piece of mechanism in one of the largest sorts of *Hydrocanthari*. Of these large ones there are two sorts, one largest all black, with *antennæ* handsomely embossed at the ends" (*Hydrophilus*). "The other somewhat lesser, hardly so black, with capillary *antennæ*; the forehead, edges of the *vaginæ*" (elytra), "and two rings on the *thorax*, of a tawny colour" (*Dyticus marginalis*). The female hath *vaginæ* prettily furrowed; the male, smooth. But that which is most to our purpose in this male is a flap, or hollowish cap near the middle joint of the forelegs, which, when clapped on the shoulders of the female *in coitu*, sticks firmly thereon. And then follows the comparison which, for want of duly weighing the value of the evidence, has misled, more or less, every succeeding author on this subject:—"after the manner as I have seen boys carry heavy stones, with only a wet piece of leather clapped on the top of the stone."

Derham has not a word further on this head! His observations and remarks evidently possess no intrinsic value; but it was necessary to ascertain distinctly what amount of credit was their due, before proceeding further in our inquiry.

Gilbert White (1788) * was no microscopist, and in writing on this subject he did but repeat the prevalent opinion of his day. He was, however, a shrewd, painstaking observer of facts in natural history, who noted the habits of flies as carefully as of the other animals that came under his eye. And because a construction has been put upon his words which was never intended by their author, and for another reason that will appear, it is necessary just to see what he really did say on the present subject.

Joining, then, in the general belief, he states that "in the decline of the year this resistance" (the pressure of the atmosphere) "becomes too mighty for their diminished strength; and we see flies labouring along, and lugging their feet in windows, as if they stuck fast to the glass, and it is with the utmost difficulty they can draw one foot after another, and disengage their hollow caps from the slippery surface."

This paragraph, when connected with one which precedes it, points to a very curious fact in the Natural History of Flies. "As they grow more torpid" (through the advance of cold weather) "one cannot help observing that they move with difficulty, and are scarce able to lift their legs, which seem as if glued to the glass; and by degrees many do actually stick on till they die in the place."

It becomes evident from the above that the *temporary* and *voluntary* attachment of

* Natural History of Selborne, edition with Bennett's notes, 1837, pp. 474, 475.

flies to the objects on which they rest or walk, was confounded by Gilbert White with, and explained by a reference to their *permanent* and *involuntary* attachment when dead or dying from the attacks of the remarkable parasite called '*Empusa Muscæ*' by Cohn.

Mr. John Blackwall (1830)* sent three communications to the Linnean Society, bearing upon this subject. In the first is given a description of the peculiar structures met with on the feet of such spiders as are capable of ascending polished perpendicular surfaces, so far as he had opportunities for making observations upon them. He at this time expressed the opinion that "the minute bristles with which the tarsal cushions of many insects, remarkable for their ability to walk up glass, are furnished, appear to possess an organization closely analogous" to that of the feet of these Spiders†. The importance of attending to the amount of development of the structures for holding, in connexion with the relative size of the body, and to the state of physical strength at the time of the experiments, is clearly pointed out. My limits will not permit me here to explain the way in which the appendages to the legs of spiders having this remarkable climbing power act; but on a future occasion I shall enter upon this branch of the subject.

In his second communication the parts entering into the composition of the Fly's foot are described. The discovery that the hairs clothing the lower surface of the tarsal cushions have their extremities enlarged in this insect was now announced. "The production of a vacuum between each membrane" (tarsal cushion) "and the plane of position . . . . was at once seen by Mr. Blackwall, on examining the parts with a compound microscope, to be clearly impracticable, unless the numerous hairs on the under side of these organs individually perform the office of suckers." The quotation continues —"there does not appear to be anything in their mechanism which in the slightest degree countenances such a hypothesis. When highly magnified, their extremities, it is true, are seen to be somewhat enlarged; but whether they be viewed in action or in repose, they never assume a figure at all adapted to the production of a vacuum."

I shall proceed to explain, in due course, my own view of these interesting facts and statements. With respect to the action of these parts, an air-pump experiment is mentioned, by which it was considered to have been "demonstrated, to the entire satisfaction of several intelligent gentlemen present, that the House-fly, while it retains its vital powers unimpaired, can not only traverse the upright sides, but even the dome of an exhausted receiver; and that the cause of its relaxing its hold and ultimately falling from the station it occupies is a diminution of muscular force attributable to impeded respiration."

Mr. Blackwall felt the desirability of a minute examination, for purposes of comparison, of analogous structures in other insects, and appears to have examined the cushions on the tarsi of several beetles, respecting which he says:—"If the slender bristles on the inferior surface of the pulvilli of some of the larger Coleoptera, *Prionus cervicornis* for example, be very highly magnified, each, beside the numerous short hairs which project from its sides, will be found to have a small dense brush of exceedingly minute hairs at its extremity; and as the hairs on the pulvilli of flies, and many other insects belonging to various orders and genera, with which I have experimented, perform a function similar to that exercised by the bristles, and also exhibit a striking resemblance to them in external

* Transactions of the Linnean Society, vol. xvi. † Ibid. p. 471.

appearance, it is extremely probable that they are analogous in structure, though from the smallness of their dimensions I have not yet been able to satisfy myself that this is the case by direct observation, notwithstanding I have employed the highest magnifying power at my command*." It appears to me that an error has crept in here, through the inadequacy of the instrument employed in these investigations into structures so minute and delicate as those in question. The *under* surface of the enlarged ends of the hairs is always perfectly smooth in beetles, and all other insects, though the same surface is minutely serrate in the climbing spiders. There are a few small scale-like processes on the *upper* surface of the same part in species belonging to the Silphidæ, Staphylinidæ, and Cerambycidæ; but, from the difference in their structure, I am compelled to think that the hairs on the under surface of the tarsi of these spiders and beetles must differ materially in their action. In *Prionus coriaceus* this serration on the upper surface of the hairs forming the tarsal cushion presents an appearance somewhat like that described by Mr. Blackwall, but there are certainly no serrations on the under surface. Mr. Blackwall admits that "whoever examines the most carefully polished glass in a favourable light, with a powerful lens, will speedily be convinced that it is not free from flaws and imperfections," whence "the hold which insects are enabled to take of any roughness or irregularity of surface must be very considerable." "The mechanical theory of the movements of flies on polished perpendicular surfaces," considered to have been "established," did not prove quite satisfactory on still further experiments being tried. Accordingly Mr. Blackwall sent a third communication on the subject, which will be found amongst the "Extracts from the Minute-Book" of the Society†. In it is announced the further interesting discovery, that flies walking over well-cleaned glass leave such indications of their steps as would be produced by the emission of a fluid from the tips of the hairs on the under surface of the tarsal cushions. On further trials with the air-pump, it was "observed" ...... "in experimenting upon the House-fly" ...... "that individuals frequently remained fixed to the sides of an exhausted glass receiver after they had entirely lost the power of locomotion, and an evident distension of the abdomen had been occasioned by the expansion of the aëriform fluids it contained. To detach them from these stations, the employment of a small degree of force was found requisite."

With respect to the circumstance of flies remaining attached to the bell-glass of the air-pump, it may suffice to advert to their very low specific gravity (a large Blue-bottle Fly not weighing more than a grain), which renders it evident that a very slight degree of viscidity in the fluid emitted from the tips of the hairs—a quality which it undoubtedly possesses—would effect such an adhesion as occurred in the cases mentioned.

Experiments were then made to determine the effects of moisture, oil, and powders of an *innoxious* nature ("flour of wheat," "finely pulverized chalk or gypsum"), in preventing the flies from adhering to the surface of the glass, and their results are mentioned. It appears to have been forgotten in these experiments that the particles even of what we call 'impalpable' powders are mostly quite as large as, and often vastly larger than the applied extremities of the hairs; so that the attempt by a human being to walk up vertical precipices covered with rolling shingle, were such precipices possible, would not in-

* *Loc. cit.* p. 487.

† Ibid. p. 767.

aptly represent the condition of a fly struggling ineffectually to ascend a bottle strewed with these powders. So with watery vapour and oil in minute quantity; whatever the true explanation, whether by vacuum, by viscid secretion, or by mechanical means, these substances, by preventing intimate contact between the acting parts of the foot and the fixed surface of support, *i. e.* the glass, would interfere equally with the Fly's ascent on all three suppositions.

The belief that the presence of an adhesive secretion was requisite to explain all the observed facts led to the discovery that "spiders, and insects in the *larva* and *imago* state, when moving in a vertical direction on clean glass, leave" a "visible track behind them." This was found invariably to be the case, though sometimes very difficult of detection, on account of the minute quantity present. The truth of this assertion can be readily verified, if due precautions be observed to ensure a satisfactory result. "On submitting this secretion to the direct rays of the sun in the month of July, and to brisk currents of air whose drying power was great, I ascertained," says Mr. Blackwall, "that it did not suffer any perceptible diminution by evaporation under those circumstances." The probable reason why it did not, I shall mention in due course.

To the experiment with a *noxious* powder (nitrate of silver), mentioned subsequently by Mr. Blackwall in another place*, the objection, similar in kind, though still stronger in effect, must be made as to the other experiments with powders: the moisture (which is admitted to be present, although varying in its quantity at different times and under different circumstances) *must* cauterize the parts after a little while, and so destroy their action, of whatever kind it consist.

"Now it is reasonable to infer, from the foregoing researches, that the hair-like appendages constituting the brushes of spiders, and occurring in such profusion on the inferior surface of the pulvilli of insects, are tubular," is the just inference drawn from the above. Mention is also made of the means by which larvæ, some apodous, others with both true and false feet (*prolegs*), and others again with true legs furnished with "hair-like appendages," are enabled to ascend perpendicular glass surfaces. In the case of the larvæ destitute of legs, a viscid mucus is emitted in great abundance, respecting which, and its action *per se* and *as an aid in producing a vacuum*, I shall have some remarks to make from independent observations.

The general possession of "hair-like appendages" by climbing insects was recognized, as was also the important fact that, "in structure and function, the apparatus by whose instrumentality" spiders "accomplish their movements" "on highly polished perpendicular surfaces" "bears the closest analogy to the pulvilli of insects, which, if named in reference to the most important office they perform, should be termed holders or supporters." A note-worthy observation this, which I can but further exemplify by going more into detail respecting the minute structure of the parts.

These remarks by Mr. Blackwall possess a very high value; his experiments and observations were made with the express desire to ascertain simply the hard, dry facts of the case, "eschewing all mere conjecture, however plausible," as "the bane of Natural History:" they were frequently repeated, and the greatest care was taken to avoid every

* Annals and Magazine of Natural History, vol. xv. p. 119.

possible source of error. The influence they have had in the formation of opinion since the date of their publication is the best test possible of the esteem in which they are held. And, in addition, the merit may fairly be claimed for them, of having stimulated other inquirers to a closer examination of the questions under consideration.

E. Newman (1841)* speaks, from independent observations, of the "almost infinite number of minute hairs" composing "the soft cushions or *pulvilli*, on the under surface of the joints of the tarsus," in insects generally, which, at their ends are slightly dilated, and constantly exude an adhesive gummy matter. By means of these gummy *pulvilli*, "insects possessing them are enabled to walk freely on smooth surfaces, even with their backs downwards, against the power of gravity." . . . . "Until lately discovered by Mr. Lister," it is added, "the true cause" by which they are enabled to do this "was unknown."

Kirby and Spence do not appear to have used the compound microscope in their investigations into the minute structures of insects. In the earlier editions of their great work they seem to have been guided in the formation of their opinions by the weight they attached to Home's authority, and subsequently by Mr. Blackwall's latest published observations. Mr. Kirby makes some valuable observations on the action of the parts composing the Fly's feet, as deduced from the habits of the insects, both when in what we may term the natural condition of the foot, and when it is defiled by the insect's attempting to walk on a surface slightly moistened by the breath, or coated with flour, or when the same material was powdered over them.

It is added "that these observations on the way in which flies are able to support themselves against gravity cannot be considered as wholly settling the question as to the precise way in which these pulvilli and those of insects generally act in effecting a similar mode of progression; and my main reason for here giving these slight hints is the hope of directing the attention of entomological and microscopical observers to a field, evidently as yet so imperfectly explored."

Under date "July 11th, 1842," Kirby adds an observation of considerable interest. Shortly after writing the remarks above quoted, he observed a "fly on the window, whose motions seemed very strange. I approached it," he says, "and found that it was making violent contortions, as though every leg was affected with St. Vitus's dance, in order to pull its pulvilli from the surface of the glass, to which they adhered so strongly that though it could drag them a little way, or sometimes by a violent effort get first one and then another detached, yet the moment they were placed on the glass again they adhered as if their under side were smeared with bird-lime. Once it succeeded in dragging off its two fore-legs, when it immediately began to rub the *pulvilli* against the tarsal brushes; but on replacing them on the glass, they adhered as closely as before, and it was only by efforts almost convulsive, and which seemed to threaten to pull off its limbs from its body, that it could succeed in moving a quarter of an inch at a time. After watching it with much interest for five minutes, it at last by continued exertions got its feet released and flew away, and alighted on a curtain, on which it walked quite briskly,

* Entom. Mag. vol. i. p. 447. Grammar of Entomology, a Familiar Introduction to the History of Insects.

but soon again flew back to the window, where it had precisely the same difficulty in pulling its *pulvilli* from the glass as before; but after observing it some time, and at last trying to catch it, that I might examine its feet with a lens, it seemed by a vigorous effort to regain its power, and ran quite actively on the glass, and then flying away I lost sight of it." This observation it is not easy to explain, at first sight. Kirby thought "one might conjecture that from some cause (perhaps of disease) the hairs of the *pulvilli* had poured out a greater quantity of this viscid material than usual, and more than the muscular strength of the fly was able to cope with*.

Revolving the subject in my mind, I have come to the belief that the fly in question was struggling against its impending death from "Empusa"; some facts I have observed tend to confirm the idea, but time has not allowed of my working it out.

The great knowledge of the habits of insects possessed by the author whose labours we are now considering, and of the remarkable adaptive modifications of different structures to their varying economy, enabled him to feel the necessity of always studying these in their mutual relations.

He also recognized the importance, for the purposes of a Natural Classification, of a thorough knowledge of the feet in insects; and especially in the Coleoptera. His observations on this head have been so thoroughly incorporated by Mr. Westwood† (1839–40), who has largely added to them, that the student will best consult the former through the last-named author. It does not consist with my present purpose to quote these observations, which are rather for the entomologist; but the value of the remarks on the feet in the different orders and genera, where they appear each under its proper head, is very great, and a valuable clue is thus furnished to one desirous of a guide to these parts in this numerically immense section of Animal Life. Mr. Westwood's work is not a microscopical one; yet the entomological descriptions of the feet given in it are so apt and expressive, that I shall avail myself frequently of them in the course of the following pages.

The possession of a special apparatus by insects having climbing habits is mentioned as having been already skilfully pointed out; and a remark also occurs of interest from its showing a recognition of the similarity between the feet of the Diptera and of some of the Coleoptera:—

"They [the Brachinides] are also characterized in many instances by having the tarsi dilated, and the penultimate joint more or less bilobed in both sexes, a peculiarity resulting, as Bonelli has observed . . . . . from the situations in which they reside, this structure being in fact analogous to the cushioned feet of flies as well as of those of the true herbivorous beetles."

I shall show how completely microscopic examination confirms the justice of this analogy, by the minute details of the respective structures.

In Dr. Burnett's Translation of Siebold and Stannius's 'Comparative Anatomy' (1854), there appears in a foot-note a brief sketch of what the authors of this work considered the then state of knowledge on this subject.

"Many of the Curculionidæ can grapple objects by means of the immoveable hooks on

* Introduction, 7th edit., p. 451. † Introduction to the Modern Classification of Insects.

their tibiæ. But with the Strepsiptera and Physopoda all the hooks are wanting. The Diptera and many Hymenoptera have moreover under these hooks softl obules (*arolia*) provided with numerous small papillæ, by means of which these insects can fix themselves to objects."

To this, the editor of the American edition adds:—"The Tenthredinidæ have a lobule of this kind on each of their legs, and the Diptera have even two to three." . . . . "According to Blackwall the papillæ of the *arolia* secrete a viscid substance, which enables the Insecta having these organs to walk on smooth and steep surfaces. But this assertion requires further proof, though admitted by Spence."

It must not be imagined that the above is a correct representation of the knowledge possessed in this country on these structures. Not one statement is quite correct. Thus—

1. The structure of the tarsi in the Curculionidæ was correctly described nearly two centuries ago; they do not grapple objects by means of the immoveable hooks on their tibiæ, chiefly, but by their tarsi, in which action the former will of course sometimes bear a part, but even then only a very subordinate one.

2. The feet of the Strepsiptera and Physopoda differ so essentially that a comparison instituted between them solely on the ground of the presence or absence of claws cannot be considered a happy one. The tarsal joints of the Strepsipterous feet somewhat resemble a series of fly's pulvilli strung together; a dense brush of hairs covers the under-surface of the joints. The legs of the Physopoda are terminated by minute, naked bladders.

3. The comparison between the feet of Diptera and of Hymenoptera is equally unfortunate. The structure of the former had been, as I have shown, repeatedly described with a near approach to accuracy, even before Blackwall's observations; the latter was, I believe, correctly described for the first time by myself. The observations will be given in a future communication.

4. The Tenthredinidæ are Hymenoptera, with the type of foot of their Order, and with, in addition, small cushions underneath each tarsal joint; which peculiarity, though it at once attracts the attention of any one who looks carefully at the feet of an example of this genus, is not mentioned by the editor of the work in question.

About the same time a series of brief descriptions of the microscopic structure of Insects' feet was published by Dr. Inman*, who describes the feet of not less than thirty-one species of Articulata, mostly of the order Insecta. Allusion will have to be made to these remarks presently; from the figures given, I judge that many of the descriptions were made from preparations of the parts, mounted as "objects for the microscope." These are selected for their beauty alone; and, from the way in which they are prepared, it not unfrequently happens that they tend to convey ideas of structure and relations of a very erroneous nature. I gladly bear my testimony to the real merits of this paper, and to the benefit I have derived from the suggestive nature of many of the remarks in it; at the same time an expression of regret cannot be withheld, that the illustrations are so unworthy of the remarks to which they are appended.

* "On the Feet of Insects," by Thomas Inman, M.D., 8vo., pl. 10, Proceedings of the Liverpool Literary and Scientific Society, No. 6, 1851.

Mr. John Hepworth (1854)* also, nearly at the same time, and in near neighbourhood with the last-named author, was repeatedly examining the feet of some large flies, and other insects, in the *living* state. The terminal enlargements of the "hair-like appendages" were now for the first time clearly represented: their mode of action is compared with that of the suckers of the male Dyticus. The general form of the flaps, their thickened base, and thinned-out margins were described from several flies, as they appear when viewed under the compound microscope. The scale-like hairs occasionally found on their upper surface are also noted, as well as, from independent observation, the marks left on glass by the "trumpet-shaped extremities of the appendages to their flaps." A portion of the edge of the flap, which had got turned in mounting, "is figured," which shows the suckers more distinctly.

The descriptions are brief to a degree which renders it difficult sometimes to understand the exact meaning of the author; this is, however, remedied, in some degree, by the abundance and general clearness of the illustrations; in remarking on which, we are told that "the parts are too obvious to require description" (!).

Mr. Hepworth's opinions possess much value because they were founded on independent observations, with the microscope, on the parts as they appear during life, in action and in repose, and were repeated frequently and with care.

Mr. Tyrrell (1855)† suggested the use of the "*hooks* on the feet of flies," as "intended not to attach the fly to anything, but to be used as fulcra or props which the fly can push against when it wishes to detach the cushions." Careful investigation proves that they are used for the purpose of detaching the foot; but it was a very imperfect view of the matter to think that this was their only use.

Mr. Hepworth (1855)‡ in replying to remarks, in continuation of the above, which evince a misapprehension of his views, takes occasion to go into some detail respecting his opinions. He says that each sucker is under the influence of the will, and adduces some valuable observations by Ecker, on contractile structures in their earliest manifestations, as representing exactly what he wishes to express in this matter. An objection to the viscid-secretion theory, when carried to the excess it was by some of its advocates, and which will readily occur to the student, is well put. "If," he says, "the foot were to be attached for some time (twenty or thirty minutes, as I have often seen it) to the same spot, it would get so firmly fixed that, if forcibly raised by the leverage of the hooks, these exceedingly delicate structures" (the "hair-like appendages") would be destroyed. A computation is then given of the number of "suckers" on "the flap of the Blow-fly," which I believe to be correct when the number allowed for "the triangular part, extending for attachment up to the leg" has been deducted. This deduction is necessary because none of these organs are present on a part which can never be applied to any surface for the purpose of holding to it; with this allowance, the number will be about 12,000 on each foot of the fly in question. The paper continues, by explaining a "diagram," of "Hairs from the pad of the foot of a small *Curculio* beetle; they expand into the form of a trumpet, and where the expansion commences they appear corrugated, and the corrugation is continued

* Quarterly Journal of Microscopical Science, vol. iii.

† Ibid. vol. iv. p. 230.

‡ Ibid. p. 312.

to their extremities; the expanded parts are extremely attenuated, so much so as to require a high power and oblique light to make them out. These insects (not being aquatic) also secrete a fluid for the same purpose as the Fly: and I can imagine that if, after the ends have been attached and moistened, these folds could be put upon the stretch, thereby lengthening the tubes, and consequently having a tendency to produce a vacuum, they would form an excellent apparatus for attachment."

There must be some mistake here; hair-like organs of this kind, *with corrugations*, are (I believe, as the result of numerous observations) only present on the tarsi of those beetles which possess them for sexual purposes. Misled by preconceived ideas, although the correct term was applied to the appearance presented, a hypothesis is started to account for it, of which the least that can be said is that it is quite inconsistent with the structure of the parts concerned.

Gosse (1859)* describes the "strong divergent hooks" of the Fly's foot as being themselves well clothed with spines†; the difference in outline of the flaps in different species of flies; their being "thin, membranous, and transparent," so that "when a strong light is reflected through them" . . . . "their structure is seen very distinctly." The appearance of "lozenge-shaped areas" on "the inferior surface of the palm" is also mentioned, and a conjecture is started as to their real nature. "From the centre of each area proceeds a very slender, soft, and flexible pellucid filament, which reaches downwards to the surface on which the fly is walking and is there slightly hooked and enlarged into a minute fleshy bulb. Those from the areas near and at the palms arch more and more outwards, so that the space covered by the bulbs of the filaments is considerably greater than that of the palm itself. Now it is evident that the bulbous extremities of these filaments are the organs of adhesion. We notice how they drag and hold, as the fly draws its foot from its place;" the marks left on the glass by these "filaments" when "the foot is suddenly removed" are supposed to show "that the adhesion is effected by means of a glutinous secretion poured out in minute quantities from these fleshy tips." The necessary vitiation of the results when an insect is confined in a "nearly air-tight glass cell" is observed upon with a view to caution against building too much upon them. As already stated, however, the experiment is easily repeated with flies moving on plane glass surfaces, where errors from this cause cannot arise.

The inquiry is extended to the "similar appendages" on the "joints of the foot" of some Beetles. *Timarcha tenebricosa* is adduced as the first example; unfortunately the specialization of structure of these holding appendages is not well marked on the tarsi of this insect, though the "velvety cushion of a rusty-brown colour," is present, and very dense. The outline of the joints composing the tarsus is then mentioned; with the absence of cushioned soles from the last, which "carries two stout hooks." "The first three" are described as "flat or even hollowed beneath into soles, something like the hoof of a horse;" an excellent comparison, which may be extended even to the structure itself. It is only necessary to imagine the parts cemented together by an elastic material to have

* Evenings at the Microscope, pp. 131–143.

† See also Inman, p. 8, who considered this appearance of being "imbricated or covered with scales" to be owing to the claw having "its formation originally by cells."

a really good idea of the nature of the "frog" in a horse's foot. "The whole interior" of the joints "bristles with close-set minute points, the tips of which terminate at the same level and form a velvety surface. Now these points are the whitish bulbous extremities exactly answerable to those on the palms of the fly, and doubtless they answer the very same purpose. Only here they are set in closer array, and are a hundred times more numerous, whence we may reasonably presume a higher power of adhesion to be possessed by the beetle. The structure is best seen in the male, which may be distinguished by its smaller dimensions and by its broader feet." Two errors exist here, which, on reflection, would have at once occurred to the author from whom I quote. 1. As to the number of hairs, allowing for the different proportionate size of the part to which they are attached in the fly, and of a single tarsal joint of the beetle. According to the above assertion, this would exceed 120,000 on each joint of the latter; the real number I have not computed, but it would not be difficult to obtain complete accuracy on this point: I believe them to be about alike on *relative* areæ; if anything, somewhat fewer in number on the beetle. 2. The assertion that "a higher power of adhesion" is possessed by the beetle" (than by the fly) is contrary to easily ascertained facts.

The second example of a beetle's foot which is adduced, is that of the "hand" of *Dyticus*. The parts constituting this organ are correctly described, and the proportionate increase in number of the holding appendages, as they diminish in size, is mentioned; this latter interesting fact proves to be nearly universally the case.

Besides the observers already cited, I might refer to numerous others who have left notices respecting the feet of insects, and the mode of progression of the Fly; but as for the most part these observations contain nothing of real importance, I shall content myself with merely citing their names for the benefit of those who may wish to refer to their writings.

Homberg, Recueil de l'Académie des Sciences, 1710.

Reaumur, Mémoires pour servir à l'Histoire des Insectes, vol. iv. p. 259, 1738.

Roesel, Entomologie, 1746–61.

G. Adams, senior, 1746, Essays on the Microscope (merely a paraphrase of Hooke's description).

J. C. Keller, 1764, Geschichte der gemeinen Stubenfliege; the illustrations in which are remarkably fine.

G. Adams, junior, 1787, Essays on the Microscope, new edition.

And last, though not least,

J. Lister, 1833, in some remarks on Mr. Blackwall's observations, in which the mode in which the hairs of the pulvillus are employed, and the greasy marks left by each, are clearly pointed out. The conclusion drawn by Mr. Lister from his observations is that the pulvilli are attached by simple adhesion of the enlarged ends of the hairs, assisted by a fluid that is probably secreted there. He also clearly describes the mode of detachment of the foot.

My desire has been, in making this enumeration of the labours of others, to do justice to all parties. It will be seen in what an interesting way each successive observer has corrected some point in the statements of his predecessors, added his own contribution to the knowledge of the subject, and yet, from one cause or another, still left the account of the structure incomplete. It was not necessary to my purpose to mention the opinions of those who merely wrote without making observations on which to found their opinions, or who, although they did make observations, have yet added nothing to our knowledge of the structures now being treated of.

Having thus cleared the way, and ascertained distinctly what has been already done, I shall proceed to mention the results of my observations.

It will have been seen that scarcely anything was left to be discovered respecting the Fly's foot, and that what was really needed was to extend the inquiry to the structure of the feet in other insects.

As the additions to the knowledge of the Fly's foot have been given above in scattered notices, when mention was made of the labours of the successive observers who have contributed to the building of it up, it will be necessary that I should collect them now. This shall be done in the briefest manner possible; and in order to save repetition, I shall intercalate my own observations at the same time.

The foot of a Fly, then, consists of a deeply bifid, membranous structure (fig. 1, Pl. XLI.), to which the term "pulvillus*" has been applied; anterior to the point of attachment of this part to the fifth tarsal joint, on the upper surface, are seated two claws, or "tarsal *ungues*," which are freely moveable in every direction, and may be closely approximated or widely separated. These *ungues* differ greatly in their outline, size, and relative degree of development to the tarsi, and to the bodies of the insects possessing them, and in their covering; most are naked over their entire surface, having, however, a hexagonal network at their bases, which indicates a rudimentary condition of minute scale-like hairs, such as are common on some part of the integument of all true insects; these decrease in size in passing forwards towards the points of the claws, on approaching which they cease somewhat abruptly. Of the *ungues*, the outer one is always a little the stronger; the spines terminating the tibiæ, or the *calcaria* attached to the same part in insects where these are present, show proofs, equally with these *ungues*, of the universal prevalence of the law, that of two corresponding processes on any limb, the outer is invariably the more robust. To the human or comparative anatomist, examples of this remarkable fact will occur so directly, that it will be unnecessary for me to remark further respecting it, than that the difference in the relative degrees of development of the femoral trochanters furnishes one of the best instances of it that could be adduced. It may probably be connected, in some degree, with the greater risk of injury from extraneous causes to the *outer*, as compared with the *inner* aspect, of a limb. Flexor and extensor muscles are attached to both the *ungues* and the flaps. These flaps, corrugated or arranged on the ridge-and-furrow plan, are in some cases perfectly smooth on their superior surface, in others this surface is covered with minute scale-like hairs. The thickness of the flaps in the Blow-fly does not exceed ·0002 inch at the margin; thence they increase rapidly in thickness in passing inwards and backwards towards the point of attachment. Projecting from their inferior

* The statements of authors do not appear to me to be clear, as to whether they apply this term in the singular or plural number to this appendage to each tarsus. Examination of the parts, conducted with due care, shows, however, at once that it is, as I have stated, a single, deeply-cleft organ.

surface are the organs which have been so frequently mentioned as "hairs," "hair-like appendages," "trumpet-shaped hairs," &c. That these are the immediate agents in holding is now admitted by almost all; it will be convenient to term them '"tenent" hairs,' in allusion to their office. The delicacy of their structure in the fly; the bend near their extremity, after which on each supervenes an elastic membranous expansion, capable of close contact with a highly polished surface, from which a very minute quantity of a clear, transparent fluid is emitted when the fly is actively moving; all this is now admitted by the best observers. It simply remains to add that the tubular nature of the shaft of the tenent hairs on the foot of this insect has been surmised, although its minute size and homogeneity hardly permits of the surmise being actually confirmed by visual inspection. At the root of the pulvillus, on its under-surface, is a process, which in some instances is short and stout, in others long, greatly curved, and tapering to its extremity (*Scatophaga*), setose (*Empis*), plumose (*Hippoboscidæ*), or, in one remarkable example (*Ephydra*), so closely resembling in its appearance the very rudimentary pulvillus with which it is associated, that I was for some time unable to decide whether it was a third lobe of this organ, or, with the other examples named and to be more fully described hereafter, a peculiar tactile hair, which is present, in some modification or other, in all insects, so far as my present experience goes. This tactile hair has been considered by two excellent observers* to be a spring, by the help of which the Fly is enabled to detach its cushions from any surface to which they have been applied; but I shall in due course proceed to show that this opinion is erroneous.

Just at the base of the fifth tarsal joint, on its under surface, there is present, in *Eristalis*, a pair of short, very slightly curved hairs, which point almost directly downwards. These were first shown to me by Richard Beck; but the discovery of their existence is so recent that time has not yet permitted of further search for analogous structures. In the instance named, they appear as if they might be little props.

It will be best now to take into consideration the large appendages to the hands (fore tarsi) of the Harpalide Beetles. These are also tenent hairs, on a comparatively gigantic scale: from this very fact of their size, and our consequent ability to dissect them, and to submit their parts to varying treatment, we shall be enabled to feel confidence in the deductions which may be drawn from them, when applied to tenent hairs even of the minutest size or the most rudimentary character.

The largest of these appendages which I have been able to study on the living insect were found on the hands of a species of *Pterostichus*† (fig. 20*a*, Pl. XLII.). Their number

* Lister; Blackwall.

† "Latreille and Dejean have divided this subfamily HARPALIDES into three groups, which, from the structure of the anterior tarsi of the males (upon which they are chiefly founded), they term Quadrumani, Simplicimani, or -pedes, and Patellimani." "Audouin and Brullé have noticed (without acknowledging the observation as that of Léon Dufour," "a peculiarity in the construction of the Patellimani (Chlæniens), the males of which have the cushion-like clothing of hairs on the under surface of the foot generally distributed over the sole of the tarsus............ In the Quadrumani (Harpaliens), the dilated joints of the anterior male tarsi are furnished beneath with a double series of narrow cushions, which, in *H. rufipes*, appear to be fleshy and transversely striated, and to be destitute of pilosity. This character, although it may be sufficient to separate the Chlæniens from the Harpaliens,"................, does not, however, appear to be a fixed character, being liable to much variation in the Féroniens: thus, in *Abax striola*,

here, taking all on each fore tarsus together, is 144; they are arranged as follows: on each side of the first joint 20; of the second joint 16; and of the third joint 12. They are the "vesicles" of authors. Those of each series appear to me generally to differ a little in size, the larger being generally proximal. The points of attachment form elegant, very slightly curved lines, as follows: on starting from the odontoid process at the proximal end of a joint, they are near together, but rapidly diverge; so that those which arise just within the truncated or incised anterior margin of the joint are widely separated.

When viewed from the side, these large tenent hairs are seen to leave the joint from which they arise, at a very oblique angle (fig. 22 *b*): they proceed with a gentle curve forwards, until, on approaching their fore end, their direction becomes changed from nearly horizontal to almost vertical; near the end of this bend downwards, the texture, which was previously horny, begins to alter, becoming like a very firm membrane, or even tendon, at the same time increasing rapidly in width, so as from a rounded form to assume a broad fan-shape, becoming continually thinner from above downwards.

It can be distinctly seen, with due care, that the shaft of each of these modified hairs is tubular; but at the bend, the central hollow is imperceptibly lost to the eye, and a granular structure becomes visible, the granules having a tendency to assume a linear arrangement. At the extreme end both the texture and the direction again change suddenly: the part is flattened out into an extremely translucent, soft, and elastic structure, of a membranous texture, and narrowly reniform in its shape when seen pressed against the glass of the live-box: faint radiating lines are visible in it, and its direction becomes, when in use by the insect, once more horizontal. In *P. niger*, the diameter of one of the largest of the membranous expansions is, in its major axis, ·0032 inch, in its minor axis ·0012 inch; entire length of the tenent hair, ·0145 inch.

The soft membranous expansions, when not in use by the insect, point downwards; when applied to a surface of which it is desired to take hold, their direction is at once changed, and their form becomes altered through the flattening effect of the pressure.

The colour of these tenent hairs is at their origin of a clear chestnut-brown, which gradually passes into straw, and at the broadest part is so faint as to be scarcely perceptible. This is worth remarking, because it serves as an index to the relative amount of chitinous impregnation of the different parts. It is best seen when the tarsus has been made partially transparent, and will prove of importance when the action of the different parts of the tenent hair comes to be considered.

It will be well now to pause a little, and see what has, up to the present stage of the inquiry, been ascertained respecting the composition of each tenent hair on the hand of a large Geodephagous Beetle. Putting all the observations together, it becomes clear that there are:—

1. A tubular shaft, of a rounded form, which curves downwards very gently until

each joint is provided with a double hairy cushion, extending beyond the extremity of the joint . . . . ; but in *Broscus cephalotes* the cushion of each joint is entire and nearly circular. And Burmeister figures a tarsal joint of *Zabrus*, with cushions transversely striated, as in *Harpalus*.—Westwood, Introd. vol. i. p. 84.

"Two anterior tarsi of the male alone dilated" ("Harpalides"); "first division, Feronidea." "Four anterior tarsi dilated in the males;" second division (Harpalidea).—*Ibid.* p. 85.

near its end, when it suddenly bends downwards. Here the actual cavity ceases, and the shaft assumes a mechanical texture, such as would be capable of transmitting minute quantities of fluid by exosmosis; its form now becomes altered into that of a broad thin blade, and its direction again suddenly changed to a horizontal one, as it expands into

2. A very thin, elastic membranous expansion, perfectly smooth on its under surface, with faint radiating lines in its substance, capable of adjustment to a smooth, flat, or slightly undulating surface, on which, when pressed, it will take firm hold.

It became desirable to endeavour to ascertain how far the structure of these appendages, which I have called tenent hairs, agrees with that of true hairs, on which some valuable critical observations were made last year by Dr. Hicks *. His remarks cannot be improved upon; so I quote them entire. He is discussing some "peculiar modifications of true hairs," . . . . "not processes of the cuticle."

"It is requisite to bear in mind the true nature of the hair in Insects—namely, that it is situated in a depression caused by the absence of the inner layers of the integument, into which the cuticle is continued. In the centre of this cuticular depression a small elevation or papilla arises, which is the true root of the hair, which rises from it of various length. By means of this arrangement, the hair itself is capable of some degree of motion. The interior of the root of each hair is in connexion with the internal parts of the member on which it is situated; commonly fibres run to it, probably always including a branch of a nerve; and this is decidedly the case in those hairs situated near the prominent parts and extremities of the various members, as, for instance, the tips of the antennæ, the palpi, pads of tarsi, &c.; and this branch of the nerve does not run into the interior of the hair, but only to the inner aspect of the root, which separates it entirely from the interior. The difference between this structure (true hairs) and cuticular processes must be particularly borne in mind: the latter, having no *root*, and not being situated in a depression, evidently only spring from the surface. The spine must also be distinctly separated from the true hair, being a tapering process of the whole integument, into the interior of which the contents of the body can freely pass †."

With these clear indications for a guide, it was not difficult to ascertain, by carefully making very thin sections, that the tenent hairs agreed in their structure with the characters of true hairs as defined by Dr. Hicks: sections of some of the undoubted hairs on the lateral margins of the tarsal joints, obtained at the same time, were found to agree in structure. This proved the correctness of Dr. Hicks's observations on the structure of true Insect hairs; and, at the same time, it proved also that tenent hairs must be classed in the same category.

These facts are illustrated in sections from *Carabus* (fig. 21, Pl. XLII.).

* Trans. Linn. Soc. vol. xxiii. part i. p. 143.

† The facts of the case could not be better put; yet it must always be borne in mind that all organized structures are formed out of the same tissue, and that the differences they present are due solely to a greater or less amount of differentiation of that tissue. On the Cricket's leg are spines which show at their bases of attachment the earliest indications of that kind of differentiation which is characteristic of true hairs. So also the calcaria, which are, when greatly developed, very moveable, probably possess muscles and nerves, and in some cases have a membranous sucker-like expansion at their ends—modifications of true hairs: in many other insects they are simply spinous continuations of the tibia.

A few words will describe all that need be said, in the present place, respecting some modifications of tenent hairs for sexual purposes.

An example is given from *Amara* (fig. 22), to show that there is no essential difference between these and the large tenent hairs which have just been described at length, other than as relates to their size; in their number, 144 on each hand, the two entirely agree. They are arranged thus: on each side of the first tarsal joint, 26; of the second, 26; of the third, 20. Greater diameter of the membranous expansion of a large one, ·002 inch; entire length of shaft, ·008 inch.

The next example, from the hand of the male *Carabus granulatus* (fig. 23), possesses an especial interest from the features which it presents, in relation both to the size and to the number of the tenent hairs*. In size they stand about midway between large and small; diameter of expanded part, which is orbicular in outline, ·0007 inch; extreme length of a tenent hair from this beetle, ·0055 inch. Speaking of their number, it may be said that they are very numerous; I have not yet counted them. They arise from the first three joints only of the tarsus. Towards the free end, for half their extent, they are greatly corrugated, just like stiff leather, as a strap, when much bent about, becomes covered with transverse wrinkles. This corrugation is present on all tenent hairs destined for sexual purposes; observations on the habits of the beetles possessing them satisfactorily account for the appearance, and prove that the mode of its formation is as above supposed. When in the live-box, beetles having such appendages to their hands press them firmly against the glass cover, and then, upon these as fixed points, the body is continually swayed about in every direction. And whoever has observed the males of the large *Carabi* attached to their mates in *copulâ*, by whom they are dragged about in stony or gravelly places, will see that the rude shocks to which these tenent hairs must be constantly exposed, under such circumstances, will readily account for the corrugations described, on parts having a leathery texture.

Amongst the Staphylinidæ, the "anterior tarsi" are "often dilated in the males†." The tenent hairs for sexual purposes are often very well developed; in some species they are very numerous, in others very few in number. Where present, they are of a softer texture than those last named, so that indications of corrugation are but very slight. In *Ocypus olens* (fig. 24) and *Creophilus maxillosus*, the tenent hairs form a dense cushion on the under-surface of the four basal joints of the anterior tarsi. Their free ends are especially soft, so that it is difficult to say what should be considered their real shape. When viewed in action, from the closeness with which they are packed, they have a tendency to assume a form varying from orbicular, even to slightly hexagonal; when dragged over the glass they become lengthened into oval, elliptic, and fusiform shapes. R. Beck has noticed that the expansions shrink and almost disappear when these insects are placed under the influence of chloroform: this I had not myself noticed; but the almost complete disappearance of the expansions in dead specimens is satisfactorily accounted for by it. On the upper surface of the expansions, in the two examples above named, there are some

* "Carabidæ." "Anterior tarsi greatly dilated in the males."—Westwood, Introd. vol. i. p. 89.

† Ibid. vol. i. p. 163.

minute, scattered, scale-like hairs. Length of tenent hairs, from the anterior inferior margin of a tarsal joint of *Ocypus*, ·009 inch.

On the hands of a very small Staphyline, I found only about 7 or 8, proportionally very large tenent hairs; I think they arose only from the fourth tarsal joint. The specimen was unfortunately given away before careful notes or drawings were made, and I have not yet succeeded in recovering it. It appeared worth record, however, to show what interesting modifications may be looked for when a complete examination of insects' tarsi has been made.

The Staphylinidæ are very interesting objects to the microscopist, in connexion with various points in their minute structure. Nowhere will better examples of the earliest modifications of hair to suit tenent purposes be found than amongst many of the smaller examples of the family. Some of these are figured (figs. 25, 26). From observations on such of these brachelytrous insects as possess tenent hairs in the most rudimentary development of this special type of structure, where they are not connected with sexual purposes, we ascertain that the specialization consists essentially in a simple flattening of the hair from above downwards, and an absence of chitinous ossification towards its extremity.

The male of *Cicindela campestris* has cushions on its anterior tarsi, the hairs composing which well illustrate the above statement by the slight degree of this modification which they present (fig. 27).

The suckers of the male *Dyticus* furnish a remarkable example of appendages for sexual purposes *. It now became desirable to ascertain the exact structure of these. All are circular in their outline, and concavo-convex in form (fig. 33), the concavity being on the under surface; the two proximal ones are much larger than the remainder, which are nearly alike in size: the outer of the two great ones is $\frac{1}{25}$ inch in diameter; these two are fringed round their outer margin with remarkable branching hairs (fig. 35), which, when the apparatus is used in the water, will by preventing too close contact also prevent the water from insinuating itself so as to destroy the vacuum; and if the female struggle out of water, by retaining liquid for some time around the sucker, they will in like manner under these altered conditions equally tend to preserve the effectual contact. There is no direct connexion between the tarsal joints and the centre of the suckers, whether of a muscular nature or otherwise, as has been asserted. The pedicles of the two large suckers are so short that the latter appear to be sessile; these latter pedicles are of a densely membranous texture, cutting like tendon; and my present belief is that they are quite solid, though I have not yet had time to verify this supposition. All the suckers are supported in an extended condition by rays of a firmer consistency than the remain-

* "In many species" (of the Dyticidæ) "the basal joints of the four anterior tarsi are dilated, whilst in some of the larger species the two anterior male tarsi have the three basal joints enlarged into a broad and nearly circular shield, convex above, fringed with fine hairs, and cushioned beneath, or, rather, covered with a number of minute inverted caps [? cups] with several larger portions resembling suckers, varying in number and size in the various species. . . . . This structure enables the male to retain his situation upon the back of the female during copulation, the rugosities upon the thorax and elytra of the latter being also similarly serviceable."—Westwood, Introd. vol. i. p. 96.

The remarkable increase of holding power which is obtained by the traction of these limbs to each other, and, when acting conjointly, to the body of the beetle, does not appear to have been specially noticed.

der of the membranous expansion. In the function they perform, these rays may be aptly compared to the ribs of an umbrella. In the large suckers they are very strongly marked; in the smaller, which are only $\frac{1}{200}$ inch in diameter, they are but faintly to be traced. An interesting indication of bilateral symmetry may be observed in both the great suckers. These are freely and to a great extent moveable on their very short membranous pedicles. The mode of attachment of the small suckers to their pedicles, by means of a very narrow tendinous cord, is also such as to admit of free motion (fig. 36). It will be seen, on reflection, that much power of adaptation to varying surfaces will thus be gained*. The pedicles of the smaller are strong, horny columns, ·005 inch in length; ·0007 inch in thickness at the centre; they expand a little towards either end, the lower or outer being the larger.

The pedicles of the small suckers were found so closely to agree with the description already quoted of the structure of true insect hairs, that it is unnecessary to describe it or do more than refer to the figures given of it and of the base of one of the fringing "guard-hairs" (figs. 37, 38).

There was hence no resisting the remarkable and unlooked-for conclusion, that the suckers of the male *Dyticus* are extreme modifications, in one direction, of true hairs for holding purposes—that therefore they must be classed with all modifications of hairs, however different in external appearance, for similar purposes.

It is curious to observe how a truth, when once obtained, receives support from all other truths with which it may be connected. It occurred to me to examine, in connexion with this part of my subject, the singular hand of the male *Hydrophilus* (fig. 40, Pl. XLIII.), which is entirely for sexual purposes—so much so that the insect walks on the end of the tibia alone, and drags the tarsus after it. This portion of the limb has the usual number of five joints, the last of which is alone enlarged into the form of an irregular hollow shield. On the under surface of this shield are a few true hairs, not spines, as the papillæ on which they are seated and the articulation at their points of attachment to these papillæ distinctly show. The longest of these hairs are proximal; they are all pointed, and appear loose, ill-formed, and, as it were, dragged backwards. Yet this unquestionably represents the hand of *Dyticus*,—the last the most completely suctorial organ of its kind we are acquainted with.

I now come to mention briefly the subject of tenent hairs specially subservient to climbing or holding, as distinct from sexual purposes. None of these are so large as most of the appendages which have been hitherto mentioned. They are also more slender in the shafts, generally very numerous, and horny almost to the very tip, where the small membranous expansion suddenly commences. The remarkable bending downwards near the tips attains its maximum amongst the tenent hairs of this section.

Clytus elongatus, one of the Cerambycidæ (fig. 41, Pl. XLIII.), furnishes a characteristic example†. After the minute descriptions which have been already given of several forms

* I have seen a male *Dyticus* swimming about with the shell of a *Paludina vivipara* attached to the suckers of one of its hands.

† "The tarsi" of the Longicornes "have the three basal joints cushioned beneath, the first and second being dilated, the third deeply bilobed, the fourth small and nodose and inserted between the lobes of the third, and the fifth long and slender."—Westwood, Introd. vol. i. p. 356.

of tenent hairs, it will be unnecessary to do more than state the size. Length ·0056 inch, of subtriangular expansion ·0006 inch, breadth of ditto ·0004 inch.

All the Longicorn beetles which I have examined have the tenent hairs composing their tarsal cushions formed like the above; I figure additional examples from *Aromia moschata* (fig. 42) and *Prionus coriarius* (fig. 43).

On the tarsi of *Cantharis vesicatoria* (fig. 28, Pl. XLII.), and *Mylabris Cichoriæ* (fig. 29, Pl. XLII.), a similar modification of hairs for tenent purposes is met with.

I figure hairs of this kind from the tarsi of *Phosphuga* (fig. 44, Pl. XLIII.), of *Timarcha* (fig. 45), of *Telephora* (fig. 46), *Coccinella* (fig. 47), and *Forficula* (fig. 48).

The Curculionidæ, it has been already mentioned, have their tarsi well furnished with tenent hairs (fig. 49)*.

In the Chrysomelidæ, these parts differ from the above in no respect but size (fig. 50).

An elegant form is presented by the tenent hairs of some beetles, which have them bent downwards, almost in a vertical direction, towards their bifurcate tips (figs. 51, 52). The hairs on the hinder part of these tarsi are simply bifurcate and terete; and the various stages of specialization, from this to the perfectly developed tenent hairs, may all be traced on these appendages to a single tarsal joint.

Niptus hololeucus has a small brush of tenent hairs in the neighbourhood of the claws, mostly underneath (fig. 53). If we imagine them to be cemented together, a rude idea of the Fly's foot would be the result.

In a species of *Haltica* (fig. 54) the expansion of the tenent hairs has generally, for the purpose of obtaining additional hold, two (or sometimes three) minute claws. I think this may explain Leeuwenhoek's description of the parts in the Weevil from apple-blossoms, to which allusion was made in p. 395.

The larva of *Coccinella* presents, on the under surface of its robust tibiæ (the tarsi are in the most rudimentary condition, as single, very indistinctly-defined joints), a moderate number of large well-marked, trumpet-shaped tenent hairs (fig. 56). They are most numerous on the hind pair of legs, fewest on the anterior pair. The length of the largest is ·005 inch; of the expansion ·0006 inch; width of the latter, ·0004 inch. About four or five, and these the largest, arise from the rudimentary tarsus, on its upper surface, and arch gently over the *unguis*; those which are seated near the extremity of the joints have a very peculiar abrupt bend, at about one-third from their extremities. These tenent hairs are distinctly moveable; I have repeatedly watched them (especially the long ones over the claw, in which it is most clearly to be observed) bend towards the glass of the live-box, attach themselves by pressing their expansions upon the glass, remove, and again fix themselves in the same way. For a long time I thought I must have been deceiving myself, though it is not easy to see how those which are seated on the upper surface of the limb can be made use of unless such a power of moving them be possessed by the insect. R. Beck, however, noticed similar facts, at a time when I had no idea that he was working in the same direction. I am compelled to the belief that a minute muscle is attached to the root of every well-developed tenent hair, as well as of every ordinary true insect-hair, and

* "The structure of" the "cushioned tarsi" of the Curculionidæ "indicate strong adhesive rather than cursorial powers."—Westwood, Introd. vol. i. p. .

that the fibre which can be so readily demonstrated, passing to the root of each of these structures represents chiefly muscle rather than nerve.

Tenent hairs are constantly liable to be injured from extraneous causes, especially in insects of cursorial habits. Wherever met with, they are invariably found to be accompanied by hairs arranged in series along the margins of the tarsal joints to which the tenent hairs are attached. From the office they perform in the economy of the insect, these may appropriately be termed "guard-hairs." I have ascertained, by direct observation, that the male Carabidæ and Harpalides, in which they are remarkably stout and strong (see figs. 20 to 23, Pl. XLII.), walk upon the ends of these guard-hairs; the much-worn condition in which they are found on Ground-beetles captured in the usual way also testifies to the above fact. During progression, the tenent hairs touch but slightly, if at all, the general surface of the ground; but during the powerful excitement of the male of these beetles at the time of coitus, the guard-hairs are pressed aside, and the tenent hairs brought into close contact with the surface of the female, so as to form a powerful apparatus for adhesion. The habits of some amongst the Carabidæ, of living upon trees, of others, "amongst the branches of umbelliferous and other plants during the autumnal months, where it is not improbable that they ascend for the purpose of feeding upon the ripe seed*," point perhaps to the possession of tenent hairs by both sexes amongst beetles having these habits.

Even climbing insects, as distinguished from the ground-loving beetles, have the guard-hairs well developed, though on a slighter type of structure; and the marginal hairs without expansions on the flaps of the Fly's foot are a still more delicate form of guard-hairs. It is these latter, which are far more readily visible than the tenent hairs on the Fly's foot, which have, I suspect, led to some errors of the earlier observers of this structure; they are fine, sharp, slightly bent downwards towards their points, and might very readily be taken for minute hooks.

Notwithstanding the protection afforded by the guard-hairs, the delicate organs which they enclose are in some insects never to be found perfect. This is the case with *Necrophorus* (fig. 57); and I have found a specimen of *Ocypus* in which they were almost equally injured (fig. 24, *i.*); in *Harpalus* I have less often met with this condition of the organs.

I figure the tarsi of various Insects, of a *Podura*, and of *Acari*, in which tenent hairs are present in small number, varying from one to five; it will be seen how generally, in these cases, they are situated *above* the single, double, or triple claw.

The remarkable scale-like organs on the anterior and middle pairs of legs and round the body of *Chelymorpha testudinaria* are examples of another modification (so far as is yet known, unique) of tenent hairs. In addition to these, there is present at the end of each distal tarsal joint, arching over the *ungues*, a pair of tenent hairs, like those mentioned in the last paragraph (fig. 64).

By favour of my friend G. Hodge, I am enabled to present a figure of some appendages to the legs of a marine *Acarus* (fig. 68) taken in deep water off Seaham harbour, and

* Westwood, *loc. cit.*, *passim.*

which is as yet undescribed. The specimens have got a little spoilt by the medium in which they are mounted, but they still show a pair of organs beneath some of the finely pectinate much bent *ungues*, which represent either a pair of tenent hairs or a rudimentary *pulvillus*. This can hardly be determined without further specimens, in better condition; but in any light the structure is interesting as being unique, so far as I am at present aware, amongst marine Articulata.

Tenent hairs are so usually present in some modification or other, that it is really difficult to name a beetle which has not some form of them; the only one I yet know, that seems to me really to possess nothing of the kind, is a species of *Helops*, which lives on sandy heaths; I suppose the dense cushion of hairs on the tarsi here to be for the protection, simply, of the joints to which they are attached. I have detected them on the tarsal joints of species of *Ephydra*, and on the first basal tarsal joint of the Drone of the Hive-bee. A very rudimentary form of tenent hairs is present on the under surface of some of the Tree-bugs (Pentatomidæ), which have, in addition, a large deeply cleft organ at the extremity of the tarsus, which appears to be a true sucker, and will be afterwards described.

To return now to our first subject, the Fly's foot.

I do not see that it is necessary to add much to the observations which have been already made, or which will have suggested themselves, on the action of the parts of which it is composed.

When a Fly is not making use of its pulvilli, as on a surface sufficiently rough to afford it foot-hold with its claws alone, these only are made use of,—remembering of course what has been already said on the greatly increased hold gained by parts mutually opposed, drawing towards each other. When walking on such a surface, the foot represents that of a Coleopterous insect without any tenent appendages.

On a smooth surface, perpendicular or horizontal, the pulvilli are brought down, and the tenent hairs applied to such surface: a slight push forwards of these, succeeded by a gentle draw backwards, at each application, removes the air between their soft, elastic expansions and their plane of motion, and thus a firm hold is gained. Access of air is prevented by the minute quantity of moisture which exudes from the expanded tips of the tenent appendages; and thus a vacuum is formed, on the same principle as in the "Atmosperic Hat-peg," the "Plate-holder" of the Photographer, or the "Artificial Gums" of the Dentist. When the Fly wishes to move a leg from its place of attachment, the claws are brought down and pressed against the surface; from their position they raise the hinder part of the pulvillus, where the tenent hairs are least developed, first, and so on forwards. If the claws were attached to the fifth joint, as it has been supposed, they could not act equally well in the way I have mentioned; and I think a fly when once stuck fast, if it had no claws, might remain so*.

This introduces the curious question, "What *is* the pulvillus of a Fly?" The analogy between this part and the bilobed joints of some of the beetles has been noticed by previous observers†; it will readily suggest itself on a reference to the figures given in illustration of the present paper.

* See also Tyrrell and Lister, *loc. cit.*

† Westwood; Inman; *passim*.

But there is a yet closer relationship—a true homology.

The lobed *pulvillus* of a Fly is the homologue of a tarsal joint; it is a *sixth tarsal joint*, which for special purposes remains membranous, unimpregnated with chitine. This joint is attached to the fifth tarsal joint at an obtuse angle, and then, at some part of its length (it may be a third or one-half), it is bent upon itself, so as to bring the tenent hairs, with which this part is covered, into a proper position for their taking hold of a surface when the insect is in motion or at rest.

The *ungues* are always attached to the last joint of an insect's tarsus. They are *not* attached to the fifth tarsal joint of a Dipterous insect (see Pl. XLI. figs. 1, 10, 16, 19); neither are they attached to the fifth tarsal joint of a Hymenopterous insect, but to the terminal sucker, which, again, in this great Order, is a sixth tarsal joint, membranous, flexible, elastic in the highest degree, retractile to almost its fullest extent within the fifth tarsal joint—a joint modified to an extraordinary degree for special purposes!

I have not had time to look much about for examples amongst other Insects in support of these views; but the *plantula* of *Lucanus*, with its pair of minute claws, at once occurred as a case strictly in point.

The *ungues* are hairs modified for special purposes *. They have the structure of true hairs. The sustentacula of *Epeira*, the analogous structures on the entire under surface of the last tarsal joints in *Pholcus* (fig. 69), the condition of the parts in the hind limbs of *Notonecta* in both its mature and earlier condition, as well as in *Sarcoptes*, *Psoroptes*, and some other Acari (figs. 70–72), all contribute to the proof of this fact.

I believe the fluid emitted to be neither more nor less than the ordinary sudor. It is admitted that it has two components, the one of which is watery and evaporates immediately, the other is greasy and remains†. Perspiration from the tip of a finger, pressed on clean glass, behaves in precisely a similar way; and the marks bear much resemblance, under the microscope (allowing for the great difference in size between the two), to the corresponding marks left by a Fly in walking over glass. Nitrate of silver in weak solution, I do not doubt, though I have had no time for trying it with the requisite degree of care, would probably equally prove the presence of a chloride in each: in human perspiration we know this to be chloride of sodium; and, reasoning from strict analogy, it is not likely to be any other salt in an Insect. The slight degree of viscidity possessed by weak animal fluids, as saliva and sudor, would satisfactorily account for another set of the phenomena presented by the fluid from a Fly's foot. The increased amount of secretion, on exertion, in both cases, hardly requires to be pointed out.

That the pressure of the atmosphere is the *main* agent by which a Fly is enabled to adhere to perfectly smooth surfaces cannot, I conceive, after all that has been said, be doubted. Careful experiments on the weights of numerous Flies, compared with the area of their pulvilli, both of the membranous portions and of the surface covered by the organs of holding, show the following curious facts. That atmospheric pressure, if the area of the flaps be alone considered, is equal to just one half the weight of a Fly. If the area covered by the tenent hairs be added, an increase of pressure is gained, equal to about one-fourth the weight of a Fly. This still leaves one-fourth to be accounted for

* This was perceived by Inman, and has no doubt been noticed by other observers as well.

† Blackwall, Hepworth, &c.

by slight viscidity of the fluid, by the action I have so often alluded to, which may be called "grasping," by molecular attraction, and, doubtless, by other agents still more subtle, with which we have at present scarcely any acquaintance.

The Orders of Insects have, for the most part, each their own type of foot. Thus there is the Coleopterous type, the Hymenopterous type, the Dipterous type, the Homopterous type, &c. &c.: and these types are very distinctive, so that in critical instances they will sometimes serve at once to show to which Order an Insect should be referred. Thus, amongst all the Diptera, I have as yet met with but one subdivision which presents an exception to the structure already described and figured. This exception is furnished by the *Tipulidæ,* which have the Hymenopterous foot. With hardly an exception, then, I believe the form of foot described will be found universal amongst the Diptera, and will be found amongst the members of this Order alone. One exception I thought I had met with, really goes to prove the universality of the rule.

It occurs in an example of the aberrant family *Hippoboscidæ*; the species I have not yet determined. Here at first sight there appeared to be no *pulvilli* at all at the end of the tarsi (the typical Coleopterous foot). But more careful examination revealed two minute rudiments of a pulvillus. And the true state of the parts proved to be, that the sixth tarsal joint was present, but in a most rudimentary condition, the part for holding being cleft in twain; these parts, membranous in their texture, apparently removed quite away from each other, and soldered to the under surface of the fifth joint, near the roots of the *ungues*: these claws, which are largely developed and very powerful, appear here to be articulated unmistakeably to the fifth joint: the structure of the cleft rudimentary *pulvillus* at first sight presents nothing unusual in appearance; but more careful examination shows that the hairs on its under surface are pointed, and apparently not soft at their tips, and have no membranous expansions (fig. 18, Pl. XLI.). In another species, belonging to the same family, the *pulvillus* is present, very thin, narrow, and deeply cleft, with minute tenent hairs of the Dipterous type: that the *ungues* have no connexion with the fifth tarsal joint is admirably shown by this specimen (fig. 19).

A foot of a *Sargus* in my possession is interesting in more than one respect (fig. 12, Pl. XLI.). The *pulvillus* is trilobate; the central lobe the largest and subtriangular, with the base distal; the lateral lobes are also subtriangular, but with their bases proximal. From the central lobe arises a comparatively small number of tenent hairs, which are much larger than those on the lateral lobes; they are, in fact, the largest and strongest I have as yet met with on any Dipterous foot. From the base of the fifth tarsal joint arise 11 long, overarching setæ (guard-hairs), which bend downwards towards their points. The claws have scales at their bases, and are sharply pointed and abruptly curved towards their free end like Chamois-horns.

The only example which has occurred to me of a foot formed on the Dipterous type, not belonging to that natural order, was in an *Acarus,* of undetermined species, but which I believe to be a *Leptus* or *Trombidium.* This had an uncleft *pulvillus,* with Dipterous-like tenent hairs; the robust *ungues* were furnished with several long tactile hairs on their under surface, as occurs on the same part in many of the Hymenoptera (fig. 73, Pl. XLIII.).

It may be desirable to add a few words on the best plan of conducting observations on these parts. Their action should be studied in living insects under the influence of chloroform, careful notes being taken of anything which may appear noteworthy, and accurate drawings prepared from the life as well. It is of the greatest advantage to preserve carefully all the parts that are examined; for this purpose Deane's medium or glycerine jelly suits exceedingly well; some of the very delicate preparations, however, can only be kept satisfactorily in a solution of chloride of zinc. The old plan of soaking in caustic potash, crushing, washing, putting into spirits of wine, (or pressing and drying first, and) then into turpentine, and lastly into Canada balsam, is perfectly useless, except in rare instances where points connected with the structure of the integument have to be made out. Of course the parts should be viewed from above, from below, and in profile, in order to gain exact ideas of their relations. The binocular microscope, however, promises to diminish vastly the difficulties which had until quite recently to be encountered, as by its use the parts may be clearly viewed, just as they are, without preparation of any kind.

EXPLANATION OF THE PLATES.

Plate XLI.

DIPTERA.

The figures represent the feet of different flies as named:—*a* indicates the view of the parts on their under surface; *b*, the same on their upper surface; *c*, profile view. The foot represented is always that of the anterior leg, on the left side, unless it is otherwise distinctly stated; the sex of the insect, when certainly observed or known, is also mentioned. R is used for a leg of the proper right side; L, of the proper left side: 1, 2, 3, for the anterior, middle, and hind legs respectively.

Fig. 1. Blow-fly (*Musca vomitoria*), ♀.
Fig. 2. House-fly (*M. domestica*), ♀: *d*, appearance of the parts when in action, from behind.
Fig. 3. Baker-fly (*Sarcophaga*): L 3.
Fig. 4. Drone-fly (*Eristalis tenax*).
Fig. 5. *Asilus crabroniformis*, ♀: L 3
Fig. 6. Gad-fly (*Tabanus bovinus*), ♀
Fig. 7. *Rhagio scolopaceus*.
Fig. 8. *Echinomyia grossa*.
Fig. 9. *Volucella plumata*.
Fig. 10. *Scatophaga stercoraria*,
Fig. 11. *Syrphus balteatus*, ♀.
Fig. 12. *Sargus cuprarius*, ♀
Fig. 13. *Bibio Marci*, ♀.
Fig. 14. *Borborus equinus*.
Fig. 15. *Piophila casei*.
Fig. 16. *Ephydra riparia*.
Fig. 17. Midge (*Psychoda*).
Fig. 18. Sheep-tick.
Fig. 19. Hippobocide fly.

Plate XLII.

COLEOPTERA.

These figures represent feet or their appendages, in whole or in part, from different beetles; similar letters are affixed to the parts as on the preceding plate.

Fig. 20. *Pterostichus niger*, ♂: a', view of some of the appendages ("vesicles") more magnified; a'', one of these still more enlarged; a''', extremity of one, flattened by pressure against the glass; *e*, section, lengthwise, of joint.

Fig. 21. *Carabus granulatus*, ♂: *f*, transverse section of a tarsal joint; f', portion of the same, more enlarged.

Fig. 22. *Amara communis*, ♂: e'', one of the appendages (tenent hairs), in profile; additional letters as with fig. 20.

Fig. 23. *Carabus granulatus*, ♂: tenent hairs projecting from the third basal tarsal joint, at its anterior edge.

Fig. 24. *Ocypus olens*: *e*, section lengthwise; *i*, portion of tarsus of another specimen, showing injury to the tenent hairs.

Fig. 25. Small Staphyline beetle: hand.

Fig. 26. Another small Staphyline (*Tachyporus hypnorum*). This has proportionately large tenent hairs on the hands; on the middle and hind legs these appendages are much smaller; a few bifurcate hairs are present with the latter, at the distal extremity of the third tarsal joint (*g*).

Fig. 27. *Cicindela campestris*, ♂: two of the tenent hairs from the hand.

Fig. 28. *Cantharis vesicatoria*: tenent and guard hairs at the margin of one of the tarsal joints.

Fig. 29. *Mylabris cichoriæ*: tarsal hair, in two aspects.

Fig. 30. *Byrrhus fasciatus.*

Fig. 31. An Elateride (*Lacon murinus*).

Fig. 32. *Cychramus fungicola*: hand (L 1).

Fig. 33. *Dyticus marginalis*: dilated portion of hand (L 1).

Fig. 34. „ : sucker, in two aspects, from tarsus of middle leg (L 2).

Fig. 35. „ : part of a large sucker, from below.

Fig. 36. „ : a small sucker, in profile and full face.

Fig. 37. „ : section through one of the small suckers, at its root.

Fig. 38. „ : section through a guard-hair, at the same part.

Fig. 39. Small water-beetle (*Exoletus hæmorrhoidalis*): tarsus of L 1: of ♂. This supplies a most interesting transition-link between the suckers of the Great Dyticus and such tenent hairs as occur on the Harpalide beetles, &c.

Plate XLIII.

COLEOPTERA (*continued*), with ACARI, &c.

Fig. 40. *Hydrophilus piceus*, ♂: tarsus of L 1.

Fig. 41. *Clytus elongatus*: tenent hairs projecting from the third tarsal joint of one of the legs.

Fig. 42. Musk beetle (*Aromia moschata*): tenent hair in two positions.

Fig. 43. *Prionus coriarius.*

Fig. 44. Carrion beetle (*Phosphuga lævigata*): portion of L 1 of ♂.

Fig. 45. Bloody-nose beetle (*Timarcha lævigata*): tenent hairs projecting from the third tarsal joint of the legs.

Fig. 46. Soldier-beetle (*Telephorus rusticus*): group of tenent hairs from an anterior tarsus.

Fig. 47. Lady-bird (*Coccinella 7-punctata*): tarsus of L 1: a'', e'', tenent hairs more enlarged.

Fig. 48. Earwig (*Forficula auricularia*).

Fig. 49. A Curculionide (*Hylobius abietis*): *k*, the appearance presented by the soft globular ends of tenent hairs on another Curculionide, when not pressed upon the glass.

Fig. 50. A Chrysomelide (*Phædon clavicornis*).

Fig. 51. A Cassidide (*Omoplata normalis*) : bifid tenent and ordinary hairs from one of the tarsal joints.

Fig. 52. *Donacia bidens.*

Fig. 53. *Niptus hololeucus.*

Fig. 54. A Halticide beetle : tenent hairs on enlarged joint of hind tarsus. These hairs have in some cases two, in others three, minute claw-like appendages at their extremity, in addition to the expanded membrane.

Fig. 55. Biscuit-weevil (*Anobium paniceum*).

Fig. 56. Larva of *Coccinella* : portion of hind leg. The tenent hairs are most developed on the hind legs of these larvæ, not so much on the middle, and least on the anterior legs.

Fig. 57. Burying-beetle (*Necrophorus*) : fore tarsus.

Fig. 58. Harpalide, ♂ : injured tenent hairs.

Fig. 59. *Condylopus clavipes*, Herm., portion of leg of.

Fig. 60. Scale-insect (*Coccus*?).

Fig. 61. Aphide insect taken from a Cactus.

Fig. 62. Acaride larva of a *Coccus* from currant-bush.

Fig. 63. *Tetrarynchus telarius.*

Fig. 64. Maple-leaf insect (*Chelymorpha testudinaria*).

Fig. 65. *Coccus* from orange : tenent hairs on leg of larva.

Fig. 66. Acaride from a small beetle : part of the leg.

Fig. 67. *Podura plumbea.*

Fig. 68. *Pachygnatha*, sp. nov. : part of a leg.

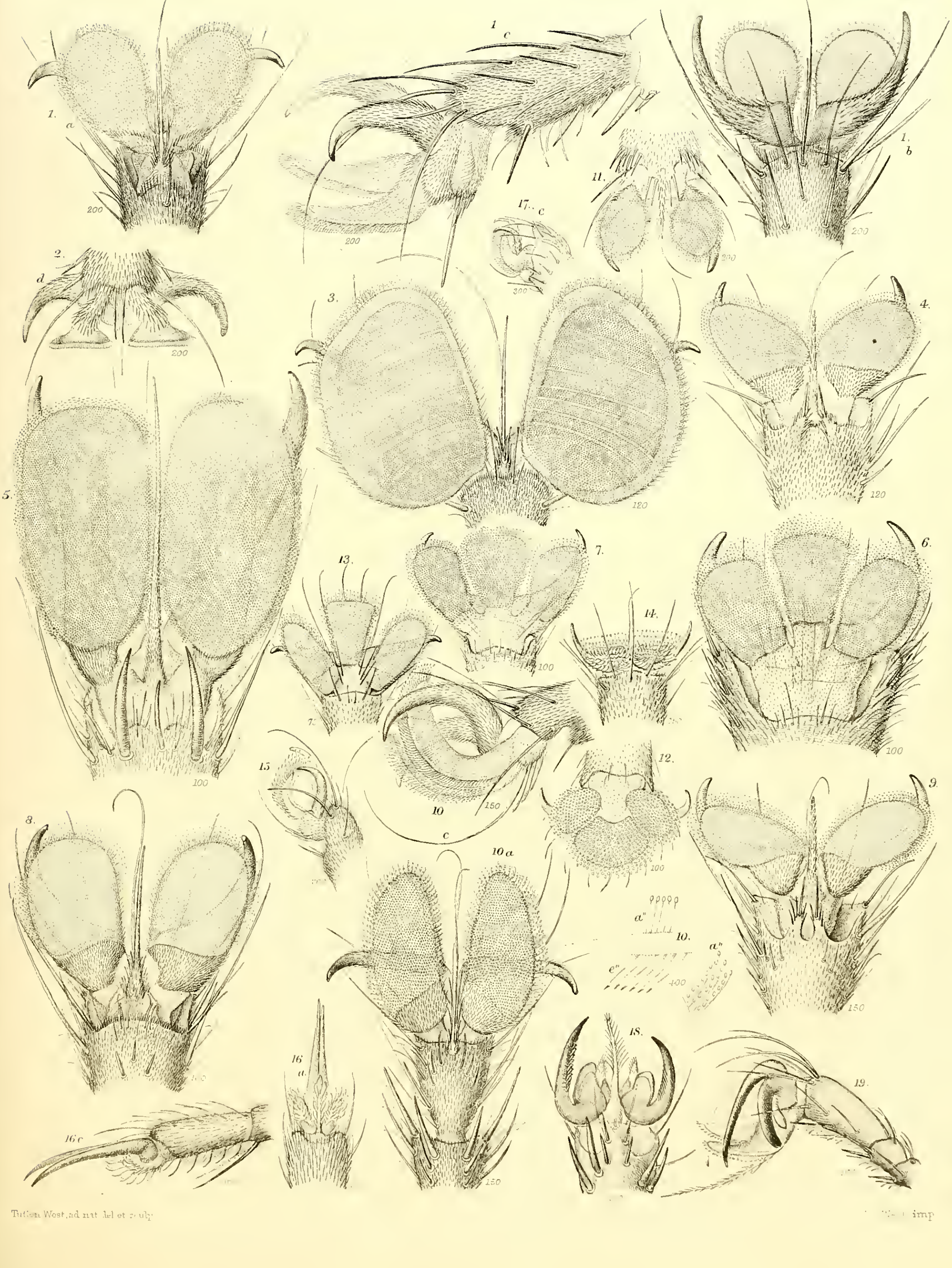
Fig. 69. *Pholcus phalangioides* : portion of tarsus of L 3.

Fig. 70. *Sarcoptes scabiei*, fore and hind leg of.

Fig. 71. *Psoroptes equi*, „

Fig. 72. Acarus from Sand-wasp (*Xylocopa*), fore and hind leg of.

Fig. 73. *Acarus*, small red, found on dried cow-dung : foot in two different positions.



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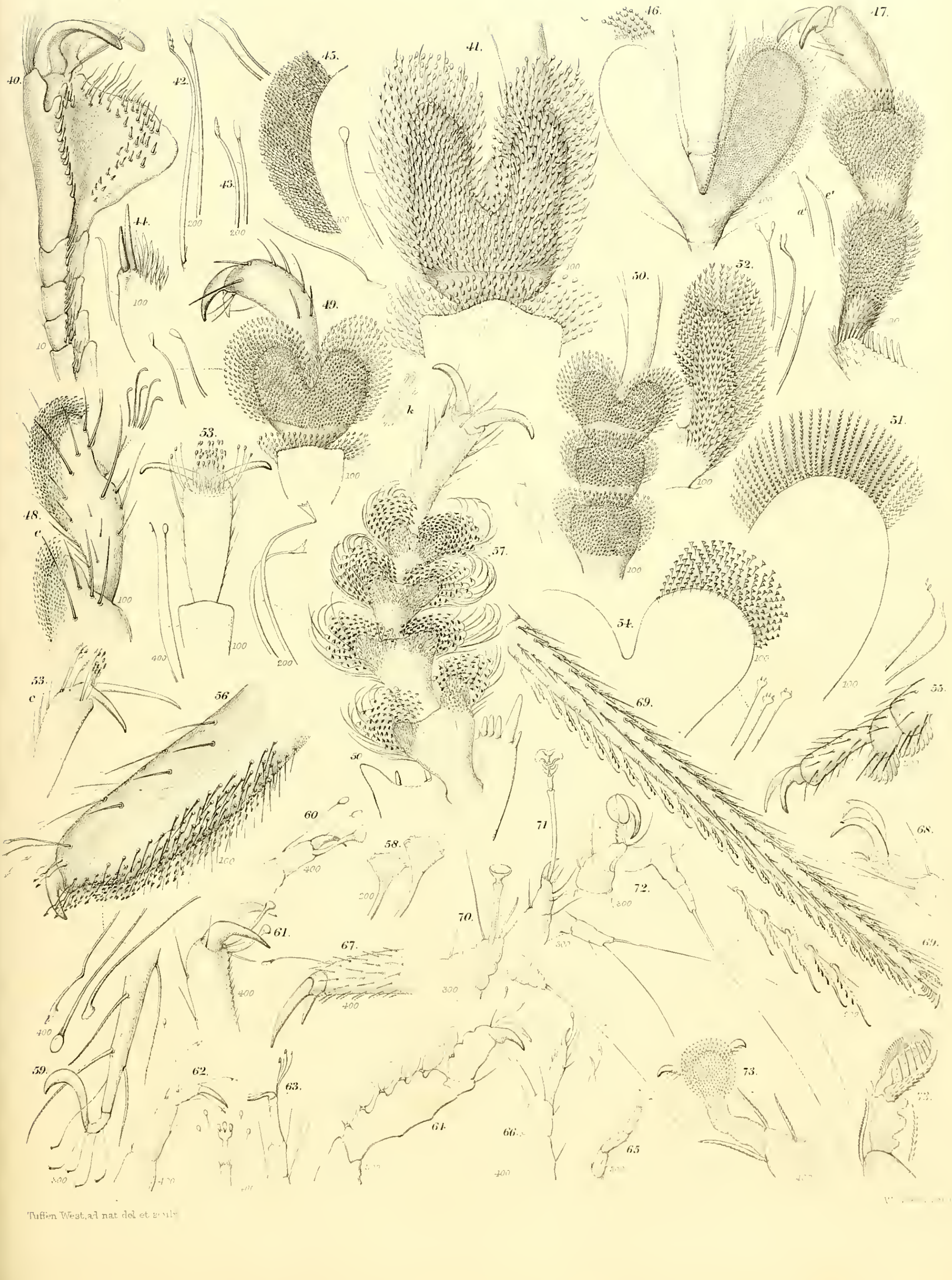

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XXVI. *Note on the Structure of the Anther.*

By DANIEL OLIVER, *F.L.S., Professor of Botany in University College, London.*

Read November 7th, 1861.

A GERANIUM growing in my garden, apparently the Common Meadow Crane's-bill (*G. pratense*), has borne during the past autumn very numerous abnormal flowers. Many of these exhibited the stamens in various degrees of retrogression, from tolerably perfect, anther-bearing, to petaloid and anantherous forms. I examined some of the flowers while they were fresh, and sketched a curious form of anther which they presented, but did not until late in the season (September) undertake a more complete examination of a larger series; and then, unfortunately, the remaining ones were withered and decaying. However, I was still able to make several drawings, exhibiting different stages in the development of polliniferous lobes, and I now have the honour to lay some of these before the Society. I am induced to this because these imperfect anthers seem to me to afford some additional evidence upon an obscure point in the morphology of the staminal leaf, especially interesting, being derived from an order seldom presenting graduated series between the floral whorls, and also one in which the anthers are, normally, versatile*.

I am not aware that any clear view has been as yet generally accepted as to the morphological import of the sutures or lines of dehiscence of the anther-cells. I may be wrong in supposing the matter to be yet imperfectly understood; but, at any rate, the explanation of the structure of the anther, as given in the text-books on morphology which I have seen, appears to me to be unsatisfactory, and I do not recollect to have met with any evidence bearing upon the point derived from teratological facts, further than that furnished by H. v. Mohl in his important essay, "Beobachtungen über die Umwandlung von Antheren in Carpelle"†, published in 1836; and by Neumann, "Ueber Antheræ anticæ und posticæ, und deren Uebergänge in einander"‡. M. Gris, in 'Annales des Sciences'§, describes and figures imperfect stamens from the "*Rose verte*" which correspond very nearly indeed with those which I found in the *Geranium*; but he does not enter upon the question of their morphological bearing further than merely to point out the confirmation which they afford to the opinion entertained by botanists,

* Mr. Masters, in his paper on Prolification (Linn. Trans. xxiii. 359), does not include Geraniaceæ among the orders in which median prolification has been observed. In many of the flowers of this *Geranium* the axis was prolonged beyond the three outer whorls of the flower, bearing, at a short interval, a second flower. The abnormal stamens which I describe were formed, I believe, in both the outer and inner flower.

† Bot. Zeit. 1836, pp. 513, 529, 545; Vermisch. Schrift. p. 28, and tab. i.; also a translation in Ann. Sc. Nat. sér. 2. viii. p. 50.

‡ Bot. Zeit. 1854, p. 353.

§ Sér. 4. ix. 76.

that the anther results from a metamorphosis of the lamina of the leaf*. From the examination of a transverse section of the form of anther generally prevailing in flowering plants, in its young state and prior to the absorption of the vertical septa which pass from the connective through each lobe, thus rendering it four-celled, it may reasonably be supposed that the margins of these septa, answering to the longitudinal sutures and lines of dehiscence of the anther, correspond likewise with the margins of the lamina of the stamen-leaf—the septa, however, being plates of untransformed tissue of uncertain homology. The opinion that the sutures of the anther correspond to the margins of the leaf, and that the pollen-cavities, separated by the septa of unchanged tissue, originate in its parenchyma, was advanced, according to Von Mohl, by Cassini†; and the same view has been maintained by Roeper‡, Schlechtendal§, Grisebach, and others. Among botanists holding this opinion, who have recently expressed themselves definitely upon the subject, I find Prof. Grisebach, in his "Grundriss d. syst. Botanik"‖, says, "The layers of the anther in which the pollen is formed answer to the four parenchym-layers of a leaf, in which the midrib and the vascular bundles correspond, in respect to their situation, to the parenchymatous septa in the anther between the pollen-originating layers." Dr. Asa Gray, in his 'Introduction to Botany' (1858)¶, says, "A transverse section of the forming anther shows four places in which the transformation of the parenchyma into pollen commences, which answer to the centre of the four divisions of the parenchyma of a leaf,—viz., the two sides of the blade, distinguished into its upper and lower stratum. So that the anther is primarily and typically four-celled,—each lobe being divided by a portion of untransformed tissue, stretching from the connective to the opposite side, which corresponds to the margin of the leaf and the line of dehiscence." And further, "Viewed morphologically, therefore, the filament answers to the petiole of a leaf, the anther to the blade; the connective represents the midrib, the lobes or cells of the anther represent the two symmetrical halves of the blade, and the line of dehiscence is normally along the margins of the transformed leaf." Dr. Lindley, in 'Introduction to Botany**,' says, "The line of dehiscence in ordinary circumstances is the margin of the modified leaf." Neumann, in the paper before referred to, upon anticous and posticous anthers, expresses the opinion very decidedly that the anterior and posterior cells of each anther-lobe correspond to opposed strata of the metamorphosed leaf, and that the suture answers to its margin. Somewhat different from the foregoing is the theory of Bischoff††. He maintained that the suture of the anther does not correspond to the leaf-margin; that the loculaments develope upon its superior surface, within the

* He says, referring to these monstrous stamens, "Cependant ces anthères, ... n'ont pas en général la structure anatomique propre à ce système d'organes. Ainsi le plus souvent les renflements ne présentent pas des points où la couche fibreuse interrompue pourrait permettre la libre sortie du pollen. Cependant on voit dans la figure . . . . que la couche fibreuse très-amincie en *a* [this refers to a cross-section of one of the anthers, showing a thinning at the collateral junction of the lobes] semble inviter la lobe à s'ouvrir." Somewhat similar abnormal anthers from the Rose are figured by Raspail (Mém. Soc. d'Hist. Nat. Paris, iii. tab. 2, 45-6).

† Opus. Phytol. ii. p. 551.

‡ Enum. Euphorb. p. 44.

§ Linnæa, i. (1826), p. 602. In "Obs. on Monstrosity of a Garden-Tulip."

‖ (1854), p. 40.

¶ Pp. 284–5.

** Ed. 4. i. p. 349.

†† Lehrbuch, i. 334.

margin, upon each side of the median nervure, as is well shown, in stages intermediate between the stamens and petals, in *Atragene alpina* (taf. xiii. 316 B.). Upon each of the two lobes of thickened parenchyma a longitudinal suture is found, which answers to their line of dehiscence. That this line does not correspond to the leaf-margin he further endeavours to show from a monstrous flower of *Colchicum* (p. 336, taf. xiii. 319). Treviranus * considers Bischoff's modification required to suit Cassini's theory to nature. He concludes his observations on anther-morphology, however, thus :—"Dass jedoch dieses nicht als allgemeines Bildungsgesetz aufgestellt werden könne, zeigt z. B. *Paris*, wo augenscheinlich der Pollensack durch den Rand des zu einem Träger verschmälerten Blumenblattes, und die beiden Klappen von den beiden Oberflächen desselben gebildet werden." With regard to *Paris*, vide infrà, p. 427. H. v. Mohl's paper, referred to above, contains an excellent exposition of the state of the question of anther morphology. The cases which he especially refers to of metamorphosis of stamens into carpels—the anther-sutures becoming ovuliferous—do not, as he himself observes, afford conclusive evidence in favour either of the theory of Cassini or that of Bischoff. The circumstances alluded to by Roeper, of the red colour of the leaf-margin of certain Euphorbiaceæ being found again in the anther-suture, and the presence of cilia on edges of leaves and on the lines of suture in the anther, Von Mohl admits to be very important, if not decisive, evidence that the latter answer to the leaf-margins in some cases; while, on the other hand, transitional forms presented by the Rose, as cited by Bischoff, by the Poppy, and *Nigella damascena*, incontestably show that the anther-cells in these plants do not originate opposite to each other in the leaf-parenchyma on each side of the midrib of the leaf, but at distinct points on the face of the lamina—the anterior cells nearer to the median line, the posterior to the margin. In *N. damascena*, described by Von Mohl, the anterior cells are parallel to the midvein, the posterior and marginal cells having their lower extremities contiguous to them, while their upper ends are remote. H. von Mohl does not commit himself exclusively to either view of anther-structure in this essay.

Mr. Bentham has kindly called my attention to the observations upon the homology of the anther-cells contained in a review of Dr. A. Gray's "Genera of the Plants of the United States" †. The reviewer considers that the anthers are homologous with the 'glands' which frequently occur at the top of the petiole, or near the base of the limb, in several genera of Dicotyledons, remote in the order of their natural affinity. He says, "In the leaves forming the *andrœcium* a partial return to the system of stem-leaves takes place, inasmuch as the filament is entirely reduced to the vascular system, its glands are converted into anthers, and the cellular parenchyma is only occasionally represented in an expanded connectivum, or slight membranous expansion of the filament." I have not made the minute structure of these curious appendages my study; I have merely inspected them with a lens in *Elæococca*, *Aleurites*, and allied genera of Euphorbiaceæ, and in *Pithecolobium*. I must acknowledge, however, that I am unable to view the question of their homology in the same light with the reviewer, whose theory appears to rest upon a curious analogy in respect chiefly to the position of these glands and anther-lobes, rela-

* Phys. d. Gewächse, i. p. 277.

† Kew Misc. vol. i. (1849), p. 359.

tive respectively to the petiole or the filament. A consideration of the transitional organs between petals and stamens normally occurring in some plants, as well as in double or abnormal flowers, as, *e. g.*, in the subject of the present paper, compels me to regard the anther as a metamorphosed lamina; while, further, the pollen is undoubtedly an altered condition of the internal cellular tissue of the leaf, not an external production. I am ignorant of the true nature of these remarkable petiolar "glands," which deserve complete examination. A comparison of some of the above Euphorbiaceous plants suggests the possibility that they indicate, in their case, rudimentary lateral veins, and a tendency in the leaf to become peltate. The opinion that the anther-cells are a formation distinct from lamina or petiole was also held by Link *. After referring to the views of Cassini and Bischoff, he says, "Equidem hasce explicationes nimis hypotheticas et fere mechanicas dixerim. Ubi petalum e stamine oritur, lamina petaloidea e filamento excrescit, connecticulum dilatatur et extenuatur, anthera vero ad latus removetur, ubi diminuitur, donec pereat. Nova igitur est formatio antheræ, loco folii aut potius loco laminæ folii enatæ, quæ cum folii structura interna vix aliquid commune habet."

As confirmatory of the theory of Bischoff, that the sutural lines of the anther do not coincide morphologically with the margin of the leaf, I consider the evidence afforded by the abnormal stamens of this *Geranium.* The accompanying outline sketches show transitional forms, from a petaloid lamina slightly thickened at its upper edges only (through a series bearing, besides marginal thickenings, a pair of oblong, more or less thickened masses of parenchyma at each side of the midvein of the leaf, and considerably within its edge), to tolerably perfect stamens with longitudinally lobed anther-cells. And, further, examination of these intermediate forms, I think, clearly shows *that the sutures of the anther answer to the lines of junction of the outer and inner thickened portions of the lamina* on either side of the midrib, and that the septa of "untransformed tissue" may be regarded morphologically as resulting, in part at least, from the inflected epiderms of the adjacent anther-cells. A transverse section of one of the thickened and distinct masses of these abnormal anthers exhibits no median plate of tissue dividing the pollen-parenchyma into anterior and posterior portions, as might, on Cassini and Roeper's view of anther-structure, have been expected. Although it is true that in foliage-leaves it is usual to find the cells of parenchyma towards the upper surface closely packed and often elongated perpendicularly to it, while those of the lower layers are irregular in form and traversed by intercellular passages, yet there can hardly be said to be a clear differentiation of two layers of tissue, or of an intermediate third layer separating these, to which the septum extending from the connective to the longitudinal furrows on each side of the anther might homologically be referred. On the view which the examination of these imperfect stamens would tend to lead us to adopt of anther-structure, I conceive that many of the less usual forms are more readily explicable than on that commonly received. The anthers of Lauraceæ, for example, often present the simple condition normally of four lobes—two superior, two inferior—approaching some of the forms figured from the *Geranium.* As in this order the thickened pollen-cells are not laterally approximated, there is no collateral junction or "suture" which may offer a line of dehiscence, as in the

* Elementa Phil. Bot. 1837, ii. p. 185.

usual form of anther, and we find that an exceptional mode of dehiscence, by valves opening from below, characterizes the order*. With regard to *Paris*, referred to by Treviranus (*suprà*, p. 425), I have examined several species (*P. quadrifolia*, *P. hexaphylla*, *P. obovata*, *P. incompleta*, and *P. polyphylla*†); and I certainly cannot agree with the opinion expressed by him, that the valves of each anther-cell answer to upper and lower surfaces of the leaf. The dehiscence is, it is true, apparently almost quite marginal, while in *Trillidium Govenianum* it is distinctly extrorse; but here I find no difficulty further than may be explained by a slight dilatation of the inner face of the connective, or by the development of the lobes answering morphologically to the inner pair of thickenings of parenchyma upon the outer, or lower, face of the metamorphosed lamina, instead of upon the inner or upper surface. In *Smilax* it would seem probable that the anther-cells originate from but two thickenings of parenchyma, one on each side of the midrib of the stamen-leaf. Dehiscence is along this median line, on the face of the anther (*vide* Pl. XLIV. fig. 18). I consider, indeed, the structure of the anthers in *Paris* to be as easily explicable as in *Geranium* itself; in fact, the anthers in the latter present, from their versatile attachment and inconspicuous connective, the more specialized structure of the two. And it is from this circumstance especially that I think the evidence which they afford on the question of anther-morphology to be important, since in *Papaver*, *Nymphæa*, and some other genera, in which the anther-cells have been observed to originate upon the upper surface of a petaloid lamina, the anthers are innate or adnate, and the connective sometimes quite conspicuous. And further, as Neumann (*l. c.*, p. 358) remarks, the anther-sutures of *Geranium* present the dark line which Roeper noted in some Euphorbiaceæ, and which he considered to be confirmatory of his view, that the suture corresponded to the leaf-margin. Robert Brown, in his paper on *Rafflesia*‡, in discussing the structure of anthers generally, says, in a note, ". . . . the principal point in which the antheræ and ovaria agree consists in their essential parts (namely, the pollen and ovula) being produced in the margins of the modified leaf." But though the exterior, or upper, anther-lobes originate as thickenings of the parenchyma, parallel and coincident, or nearly so, with the margin of the leaf, the inner and lower lobes have no such necessary marginal relation. With regard to the origin of anthers from portions of tissue morphologically corresponding to the outer lobes only, or inner lobes only, of the anther-

* It is true that the upper pair of anther-cells (in *Cinnamomum* at least) have their bases slightly included between the upper points of the lower cells, and that the portions of the stamen-leaf thickened, in their case, cannot precisely correspond in position with those prevailing in the abnormal forms which I figure; but this I believe to be quite unimportant. In Berberideæ (*Berberis, Epimedium, Leontice, Bongardia*), besides dehiscence along the line of junction of the posterior and anterior lobes, the walls of the former separate round their base and, dorsally, along each side the connective. The inner margins of the anterior cells remain attached, as is usual. The chambered anthers of *Viscum, Ægiceras,* and some species of *Rhizophora*, the pore-dehiscence of several groups, distractile, appendaged, and "one-celled" anthers, the anthers of Coniferæ and Cycadeæ, do not offer for explanation greater difficulties on this theory than on that of Cassini, Roeper, and others; indeed some, I think, are clearly more easily explicable on this view.

† The amount of depression of the line of suture previous to dehiscence may vary slightly in the species. In *P. hexaphylla* I have seen it scarcely perceptible, excepting towards the extremities of the lobes; but this was in a dried specimen. In *P. incompleta* the connective is scarcely produced, as is often the case in *P. polyphylla*. Conf. Hooker, Ill. Himal. Plants, pl. xxix.

‡ Linn. Trans. xiii. 211.

leaf, and to the development of the lobes in some cases upon the under rather than the upper surface, I am not prepared at present to enter upon any discussion. It seems probable that, in these respects, there may be many modifications of the prevailing structure.

The circumstance that the anterior pollen-cells of anthers are generally slightly lower than the posterior ones*, and that anthers are so commonly introrse, conforms entirely to the view that anther-cells morphologically correspond to thickenings of the parenchyma of the metamorphosed leaf in a manner essentially the same as we find indicated in the abnormal *Geranium*. In reference to the margin of the staminal leaf, I ought to observe that, when I have been able satisfactorily to trace it down the outer thickened portion of the lamina in the *Geranium*, I have found it to lose itself on the rounded outer surface of the exterior pollen-lobes, and not to become in any way coincident with the sutures; but this observation I have been unable to repeat easily, from the withered state of the specimens which were left me to examine in September. There has appeared to be some frequent, if not constant, connection between the inner or lower anther-lobes of the abnormal stamens and the lateral veins of the lamina, as is the case, I believe, with the thickened lobes at the base of the petals in the Barberry; but upon the relation of the anther-cells to the vascular bundles of the stamens, I have nothing to suggest.

* In some plants, *e. g.*, *Loranthus europæus*, the anterior cells are remarkably lower than the posterior. In this species the line of dehiscence is, in part, along the junction of the anterior and posterior lobes, in part continued above the former, along the inner face of the connective (*vide* fig. 17, *a* to *b*).

EXPLANATION OF PLATE XLIV.

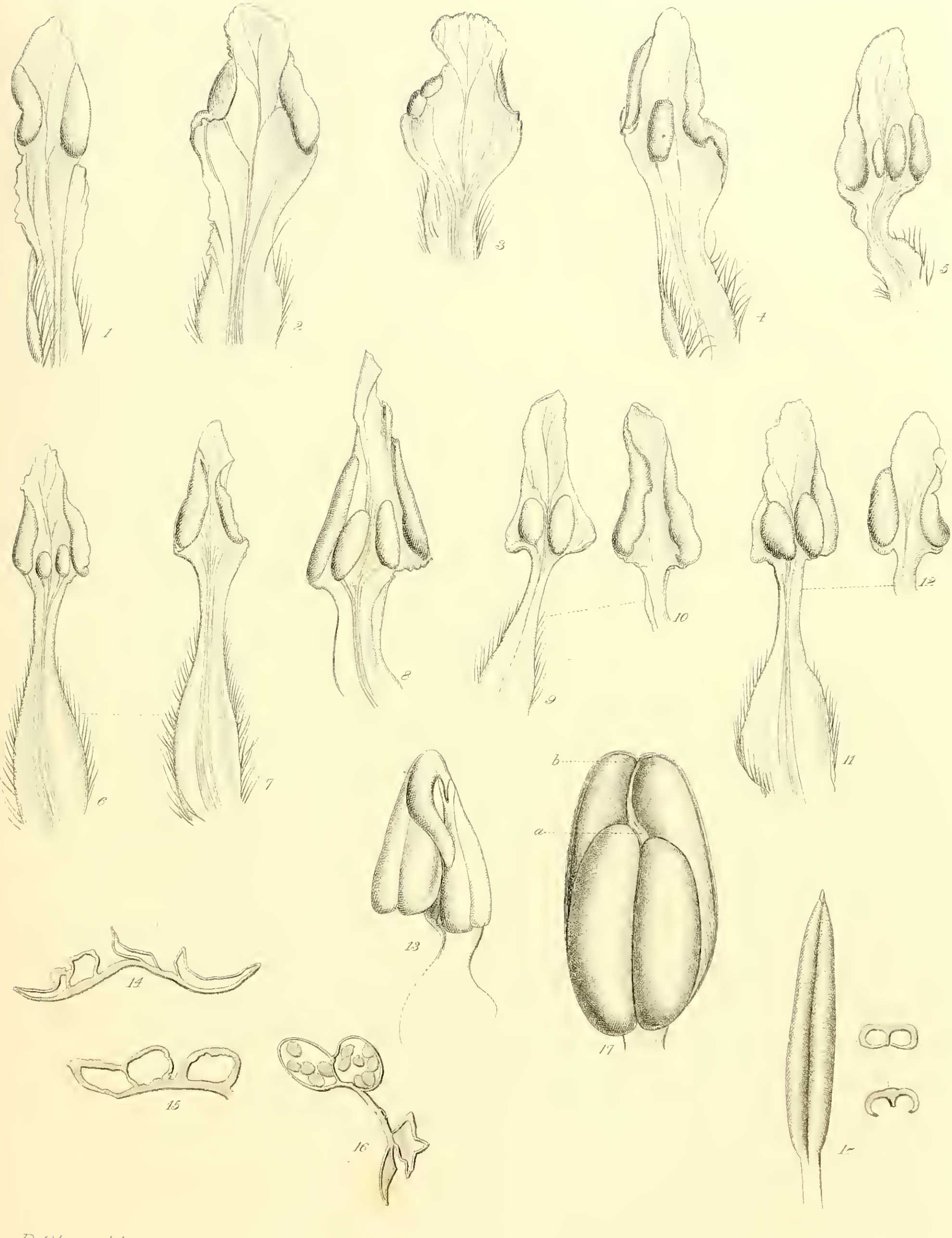
Figs. 1 to 3. Petaloid stamens, with marginal thickenings only.

Figs. 4 to 13. Various stages intermediate between the above and nearly perfect stamens. In fig. 4 but one inner lobe is formed.

Figs. 14 to 16. Transverse sections of anthers similar to those of figs. 11–13.

Fig. 17. Anther of *Loranthus europæus,* front view.

Fig. 18. Anther of *Smilax,* with cross sections of same.



D. Oliver del.

G. Jarman Sc.

XXVII. *Notes on the* Thysanura. *By* John Lubbock, *F.R.S., &c.* Part I. Smynthuridæ.

Read February 6th, 1862.

The small but interesting group of animals to which Latreille gave the name of "Thysanoura" has, by different systematists, been placed in very different parts of the subkingdom Annulosa. Without recording all the successive places which have been assigned to these little creatures, I may mention that Fabricius classed them among his Synistata, which correspond in great measure to our Neuroptera,—a view as to their affinities which was also adopted by Blainville. Lamarck considered them to be allied to the Arachnida rather than to the Insecta, while Cuvier placed them between the Myriapoda and Parasita. Von Siebold does not adopt the order Thysanura, but considers that the two families of Lepismidæ and Poduridæ, together with the Pediculidæ and Nirmidæ, form the order Aptera, which he regards as the first among the true Insects—the Myriapoda forming, in his system, part of the Crustacea. Latreille considered them as a separate order of Insects, connecting these latter with the Myriapods:—"Par la masse de leurs caractères, les Thysanoures appartiennent à la classe des Insectes. La composition du thorax, des organes de la locomotion, et de la bouche, l'indiquent suffisamment. A l'égard même de ces dernières parties, et surtout de l'oviducte extérieur du plus grand nombre de femelles, les Thysanoures ont la plus grande affinité avec divers Orthoptères. Mais sous d'autres considérations, comme l'absence de métamorphoses, les organes de la vision, les appendices abdominaux et les habitudes, ils se rapprochent aussi des Myriapodes et des Arachnides. D'après un tel mélange de rapports, il est naturel de conclure que ces animaux font la transition des Myriapodes aux Insectes, et que vu leur plus grande ressemblance avec ceux-ci, ils doivent être placés à leur tête. Point de transformations, abdomen terminé par des soies, tel est, suivant le docteur Leach, le caractère essentiel de l'ordre des Thysanoures: mais il nous semble, par son extrême concision, un peu trop vague; et aussi d'écarter tout embarras, nous le signalerons ainsi: point de métamorphoses, ni de stigmates apparents; corps généralement recouvert de petites écailles, avec l'abdomen terminé par trois filets ou par une queue fourchue, servant à sauter." Of these four characters, only one is general to the whole group, as *Smynthurus*, *Petrobius*, and (according to Nicolet) *Podura* have spiracles; *Smynthurus*, *Achorutes*, *Podura*, *Isotoma*, and some other genera have no scales; while, finally, in the Lipuridæ the spring is absent or rudimentary, so that the power of jumping is entirely lost. Finally, Carus, in his useful work, 'Bibliotheca Zoologica,' places the Thysanura among the Orthoptera.

For the present I will offer no opinion of my own as to the position and affinities of the group; but while there is so much difference of opinion on the subject, we might reasonably have supposed that they would have been carefully studied by our naturalists. Suspected, however, of having passed the Rubicon of Entomology, and of not being true and proper Insects, they have been not only neglected, but absolutely ignored by our entomologists; so that, to my amazement, I found that (excepting a very brief notice of *Petrobius maritimus*, by Dr. Dickie *) Dr. Leach's original description of that species †, and Mr. Templeton's ‡ "description of the Irish species of Thysanura," with an introduction by Mr. Westwood, are the only British contributions to the natural history of this group §. We have thus not added a single fact to the anatomical and other details given by Continental observers, and we have at this moment only sixteen Irish and actually *only one English species* recorded. When it is considered that these animals are easily preserved, are in many cases prettily coloured, are numerous in winter, when the field-naturalist is less distracted by the number of objects than at other times of the year, and, finally, that they are so common that it is impossible to pick up a handful of dead leaves, or turn over an old log of wood, without disturbing many of them, I think that every one must be astonished at the neglect they have experienced; and I hope I need make no further apology for calling the attention of the Society to this subject.

The Thysanura have generally been divided into two families:—the Lepismidæ, characterized principally by the presence of many-jointed appendages at the posterior end of the abdomen; and the Poduridæ, which have on the under side of the abdomen a flexible spring, by means of which they can jump to a considerable distance.

M. Nicolet proposes to divide the Poduridæ into three tribes,—the "Smynthurelles," in which the body is more or less globular; the "Podurelles," in which it is linear, and composed of eight or nine segments; and the "Lipurelles," in which the springer is absent or rudimentary. These three groups seem to me to constitute three well-marked families, which would naturally bear the names Smynthuridæ, Poduridæ, and Lipuridæ. For the present, however, I confine my remarks to the Smynthuridæ, and must defer the consideration not only of the natural position of the Thysanura in the animal kingdom, but also of its division into families, until I shall have had time and opportunities to make a thorough examination of the whole group.

SMYNTHURIDÆ.

The characters attributed by M. Nicolet to his "Smynthurelles" are as follows:—Body globular or ovoid. Thorax and abdomen forming one mass. Head vertical or inclined. Antennæ of four or eight segments; elbowed at the middle. Sixteen eyes, eight on each side, situated on a black patch, a little behind the antennæ, and on the top of the head. Legs long and slender. Saltatory appendages with a supplementary segment.

* Brit. Assoc. Report, 1855. † Zool. Misc. vol. iii. ‡ Trans. Ent. Soc. vol. i.

§ Since the above was written, Mr. Westwood has kindly called my attention to Samouelle's 'Entomologist's Useful Compendium' (1819). In this volume (pp. 140, 141) five species are recorded, viz. *Lepisma saccharina, Forbicina polypoda, Petrobius maritimus, Podura plumbea,* and *Smynthurus fuscus.*

It must, however, be observed that, in a new genus about to be described, the antennæ cannot properly be called "elbowed," though they are often held in a bent position. The same is the case with the *Smynthurus viridis*, figured in Cuvier's 'Règne Animal,' pl. xiii. fig. 3, which, as M. Nicolet suggests, is not a true *Smynthurus*, but belongs probably to my new genus.

The family at present contains only two genera, *Smynthurus* and *Dicyrtoma*, to which, however, I am now about to add a third.

SMYNTHURUS, Latr.

Antennæ four-jointed, bent at the insertion of the fourth, which is nearly as long as the other three, and appears to consist of many small segments. No conspicuous dorsal tubercles.

Of this genus I have to record a new species.

DICYRTOMA, Bourlet.

Antennæ eight-jointed, five before, three after the bend. Two dorsal tubercles on the abdomen.

PAPIRIUS, Lbk.

Antennæ four-jointed, without a well-marked elbow, and with a short terminal segment offering the appearance of being many-jointed.

I have to describe two new species of this genus.

I may, however, be permitted to remark that this is, to my mind, far from being a natural classification of the group. The great differences in the organs of respiration existing between *Smynthurus* and *Papirius* appear to me to indicate a separation of more than generic value; and we can never hope to obtain just ideas of the affinities of different groups of insects until more attention is paid to the internal organization. On the principles which ought to guide us in the classification of the Thysanura I can, however, only express myself in a provisional manner.

For the present, I have only to record three English species of Smynthuridæ, all of which are, I believe, as yet undescribed. Doubtless many others exist in this country; and I am indeed myself acquainted with two or three, of which, however, I have not yet been able to obtain a sufficient number of specimens.

SMYNTHURUS BUSKII, Lbk. Body globular, with scattered hairs; abdomen with a re-entering angle. Colour brown, with a light patch in the form of a V on the posterior half of the abdomen. Apical portion of spring and end of the tarsi whitish. Basal part of antennæ three-jointed, and about of the same length as the terminal ringed portion.

This short description is enough to distinguish it from any of the species hitherto described. In general colour and form of body it approaches nearest to *S. signatus*; but the antennæ of that species are longer, and have the basal part consisting of three small segments between two longer ones—a character which is at once sufficient to distinguish them. The colour also differs a little. It must, however, be observed that *S. signatus* of Templeton is quite a different species from *S. signatus* of Nicolet, as I shall presently point out more fully.

Length $\frac{1}{8}$th of an inch.

Common in Kent, under logs which have been felled and left lying among long grass and underwood.

I take this opportunity of expressing my thanks to my two neighbours, Messrs. Janson and Solly, who have not only allowed me free access to their woods, but have also arranged logs of wood to serve as protection to the Smynthuridæ. These facilities have enabled me to obtain plenty of specimens, and have saved me a great deal of time.

They feed principally on the spores and first shoots of Fungi. Many specimens were infested by a small mite, which adhered to the underside of the body, and was sometimes present in considerable numbers.

The hairs, which cover the head as well as the body, stand at a distance of about ·0047″ from one another. They are gently curved, about ·0075″ in length, and roughened with small asperities or projections. The larger hairs on the antennæ are of the same size and structure, while those on the legs are smoother.

The eyes, as in all the species of the genus, are eight in number on each side. The anterior five are arranged in a quincunx, which is not quite regular, however, one of the posterior pair being a little too far back; the other three form a triangle. This arrangement agrees with that figured by M. Nicolet as characteristic of the genus (*l. c.* pl. ii. fig. 26); but in the present species the eyes are nearer together than in his figure, and agree indeed even more closely with his representation of those of *Cyphodeirus* (*l. c.* pl. ii. fig. 22), especially as in that genus he makes the eyes pretty uniform in size, whereas in *Smynthurus* he represents the central eye of the quincunx as much smaller than the others, which is not the case in this species.

The antennæ are ·0475″ in length, of which the terminal (so-called) many-jointed portion forms nearly one-half. The basal segment is cylindrical and quite short, being ·004″ in breadth, and only ·005″ in length. The two following segments are of nearly equal size, being each about ·012″ in length and ·002″ in breadth. On the whole they are cylindrical; but their outline, and especially that of the third, is somewhat knobby. They bear a few scattered bristles, resembling those on the head and body, and also a few smaller hairs near their apices. The terminal portion of the antenna resembles a necklace of beads welded together, and gradually diminishes in size at the tip, though, for the greater part of its length, it has a diameter across the beads of ·0015″. At each projection is a whorl of small hairs, and at the apex are a few rod-like hairs, resembling those found on the antennæ of so many Insects and Crustacea, and which are doubtless organs of sensation, though I was unable, from their minute size, to ascertain their structure in a satisfactory manner.

The descriptions given by different naturalists of the mouth-parts of these animals have been very dissimilar. Fabricius mentions mandibles and maxillæ, labium and two pairs of palpi, consisting respectively of five and three segments. Latreille does not hesitate to characterize this description as being "absolument fictive." Assuredly it is absolutely incorrect; but is it not more probable that Fabricius should have mistaken the species he examined, than that this great naturalist should have voluntarily committed a fault so certain of detection?

The account given by Latreille himself is little more satisfactory. "La lèvre inférieure," he says, "se compose de deux petites lames longitudinales, parallèles, avec trois ou quatre divisions setacées, au bord supérieur de chaque, et dont l'une est peut-être un palpe. Quelques autres pièces, et qui, à en juger par la couleur brune, ou tirant sur celle de la corne, de leur extrémité, sont probablement les mandibules et les mâchoires, remplissent les cotés. J'ai aperçu, à chacun d'eux, un petit corps arrondi, portant une soie, et que je présume être un palpe maxillaire. Le centre de la bouche est mou, vésiculeux, et cintré supérieurement par le labre. J'ai souvent examiné, avec une grande attention, la bouche de ces insectes étant encore en vie : je n'en ai vu saillir aucune partie, et il m'a été impossible d'en déterminer, avec certitude, l'organisation. J'ai consulté anciennement sur cet objet mon ami Savigny, et je me rappelle qu'il me répondit qu'il n'avait pas été plus heureux que moi."

This description is vague as well as inaccurate, and was evidently written in haste, as Latreille could not have intended to attribute to mandibles the possession of *maxillary* palpi. I quote the passage, however, because, if I have myself fallen into error, I may well be excused for having misunderstood a structure which baffled Latreille and even the illustrious Savigny himself.

However this may be, the mandibles and maxillæ are easy enough to identify, and this has been correctly done by Nicolet and Bourlet. The latter, whose second memoir I have as yet been unfortunately unable to obtain, distinguishes (according to M. Gervais, Suites à Buffon, Aptères, vol. iii. p. 382), 1°, Un épistome paraissant arrondi; 2°, un labre membraneux, en carré long, entier et caché; 3°, des mandibules; 4°, des mâchoires; 5°, un menton ovale; 6°, une languette large, saillante, ciliée, à deux divisions, chacune de ces divisions quadrifide; 7°, des palpes maxillaires et des palpes labiaux, mais seulement rudimentaires."

This description is not altogether correct as regards the Smynthuridæ, nor does M. Gervais state which species was examined by M. Bourlet, or how far the description is considered by that author as applicable to all the Poduridæ.

M. Nicolet's description of the mouth in the Poduridæ is as follows:—"Bouche incomplète, composée d'un labre, de deux mandibules, deux mâchoires et d'une lèvre; point de palpes." I do not quite understand what M. Nicolet means when he calls the mouth "incomplète," nor is he correct as to the absence of palpi. He has, however, been followed by most succeeding writers. (See, for instance, v. Siebold's 'Anatomy of the Invertebrata.')

The true composition of the mouth-parts appears to me to be the following:—1st, an upper lip; 2nd, a pair of mandibles; 3rd, a pair of maxillæ; 4th, a pair of small palpi; 5th, a pair of organs probably homologous with the second maxillæ; 6th, a central organ, corresponding to the so-called "langue vésiculeuse" in the Lepismidæ; 7th, the lower lip.

The labrum is a simple, entire, quadrate, horny lobe, somewhat broader at the base than at the apex, with a few scattered hairs, and a row of teeth at a little distance from the free border, those on each side being parallel and opposite, so that they all point inwards.

The mandibles are rather small, and differ somewhat from one another (Pl. XLV.

figs. 1, 2, 3, 4), though they agree in general outline. The basal part is long and somewhat cylindrical, with a large gaping orifice, through which the muscles pass into the head. The whole organ is about ·03″ in length; at a distance of about ·02″ from the base is a raised molar surface, which is covered with minute, rather blunt teeth, and, in conjunction with the corresponding portion of the opposite mandible, evidently serves the function of mastication. The terminal incisive portion is dissimilar in the two mandibles: the one has six teeth; the other only three, which fit into the intervals of the first. This part of the mandible diminishes rapidly in thickness towards the tip; the dorsal line, however, is continued throughout in the same direction, though with three gentle curves resembling in direction, though less abrupt than, those of a bow or a reversed S. The front line of the mandible, on the contrary, makes a sudden change of direction at the beginning of the molar portion, so that the terminal part of the mandible seems to lie in a different plane from that of its basal part.

The maxillæ (Pl. XLV. figs. 5, 6) are a little shorter than the mandibles. The width varies, being smallest towards the upper end, and greatest towards the middle. The upper extremity is terminated by a somewhat complicated system of teeth. First, there are three strong curved teeth, the outer one being the largest, and the inner one the smallest. In addition to these are two lamellæ, whose inner edges are beset with a row of minute, sharp projections. Lastly, there is a large central, somewhat fan-shaped lobe, the central part of which bears some fine hairs on the margin. All these parts appear to have some power of independent movement. The body of the maxillæ is strengthened by a chitinous framework; down each side runs a strong rib, while the two are connected at the centre by a transverse piece, which is also continued on the inner side a little way beyond the rib, and curves at the same time so as partly to surround the softer parts. The two lateral ribs converge to meet one another at the base as at the apex. At the former, however, they enclose a space which has the form of an acute triangle, while at the basal end they curve round to meet one another. At the base the chitine is rounded off on the outer side, but is produced into a sharp point on the inner edge.

The palpi (Pl. XLV. fig. 8) are short, one-jointed, rounded but not tapering at the free end, and with two longish setæ and one or two minute hairs, none of them, however, attached at the apex.

The second pair of maxillæ are membranous and delicate. Their form (Pl. XLV. fig. 9) is somewhat difficult to describe. At the extremity are two teeth of unequal size; on the basal side of these are three more or less projecting lobes; and then follow a number of small teeth, which end at a point where the two maxillæ converge towards the middle line so as to touch one another.

The under lip is stronger, and consists of two more or less quadrate lobes.

The feet of *Smynthurus* are very peculiar, and differ in the different species. Nicolet has given two figures of a foot, seen from different sides; but neither of them agrees altogether with any of those examined by me. In my specimens the tarsus was very short, and bore two peculiar appendages. On the outer side was an elliptic, elongated claw, transparent above, terminating in a spine, and bearing also one large tooth and three smaller ones on its underside. On the underside of the tarsus is a second claw, smaller and more slender than the first (Pl. XLV. fig. 11). At its free end it is produced into two processes and a small spine. The shorter process reaches about as far as the free end of the other organ, and is like a spine in form, though apparently not so stiff; the second process is somewhat longer, and whip-like.

The anterior legs are the shortest, and the posterior the longest, the middle pair being intermediate in size as well as in position. The relative proportions of the segments, as well as the structure of the foot, are the same in all three pairs. The tarsus is very short; the tibia is much the longest segment. The coxa, trochanter, and femur diminish in diameter, and increase in length. At the attachment of the leg are one or two deep folds, which, however, are not, I think, to be considered as indicating true segments; and we may therefore consider the segments as being five in number. The legs are regularly, but not very densely, clothed with hairs.

Anterior abdominal appendage.—This organ, which is attached to the sternum of the anterior abdominal segment, did not escape the attention of M. Nicolet, who, however, describes it as "une petite pièce blanche, saillante, multiarticulée," while in the present species, as well as in the other two observed by me, it has at most two segments, and is of a dark colour. In *Smynthurus Buskii* it consists of a large quadrate basal piece, which is somewhat widest at its proximal end, and bears at the side two small appendages, of which the one nearest to the apex is bilobed. The terminal segment is swollen at the base, and rounded at the extremity, where are four small setæ.

M. Nicolet considers that this organ serves to retain the spring in its place. It is generally turned backwards, and lies in such a position as to lap over the basal part of the spring, between the two lamellæ, which perhaps are in part covered by the small lateral appendages; and, by the pressure which it thus affords to the tension of the muscles, he supposes that it adds force to the spring. However this may be, it seems to me to be homologous with the anterior abdominal appendage of Lepismidæ, the basal portion being, however, very much developed, and the lamellæ only represented by the small lobes at the apex.

The spring is attached, according to Nicolet, to the penultimate abdominal segment; this, however, is apparently an oversight, since in pl. 3. f. 6, he figures it on the underside of the great antepenultimate segment.

Excepting in one case (*S. ornatus*), M. Nicolet does not allude to the form of this organ as affording any specific characters; but, as will be seen by comparing our Pl. XLV. figs. 12, 13, and Pl. XLVI. fig. 24, the structure is by no means the same in all species.

The organ consists, as usual in the Smynthuridæ, of a basal portion and a pair of two-jointed appendages.

If we take a specimen in which the basal portion is about ·01″ in length, the breadth will be about ·014″; the first segment of the appendage will be ·0225″ in length, and gradually taper from a width of ·0065″ at the base to ·003″ at the apex. It bears many scattered hairs, most of which are simple and about ·005″ in length. On the inner margin, however, are three hairs of very different structure. They have a length of ·014″, and gradually taper from the base to the apex, where, however, they suddenly swell up into a delicate oval structure, something like the button at the end of a foil, or rather perhaps a drop of dew, except that the form is more elliptic. The terminal portion of the organ has no hairs; it has a broad knife-like shape, and is ·009″ in length by ·0025″ in breadth. On its inner margin it has a row of minute teeth; the outer edge is smooth. At the base of the spring are two peculiar, thickened parts of the skin (Pl. XLV. fig. 13). They are constant in form and position: the shaded part seems to be rather thicker than the rest; but the whole structure is transparent, and more refractive than the skin round it. They do not serve as attachments to muscles, and I am at a loss to understand what their function can be. On each side of the anus are two great scimitar-shaped organs (Pl. XLV. fig. 14), which are no doubt gigantic and specially modified hairs. They appear, indeed, to agree with the ordinary ones in their constitution and mode of attachment. They are about ·008″ in length, and ·001″ in breadth. The apical half of the inner margin, and a small part of the outer edge, are roughened by irregular teeth, which, however, are so unsymmetrical as rather to suggest the idea of the border being fretted by use. The two scimitars did not even agree in the extent to which they were thus affected.

Papirius, Lbk.

The characters of this genus have been given above.

Papirius cursor, n. s. Body globular, with scattered hairs; abdomen without a re-entering angle. Colour dull purple. Eyes not situated in a black patch. Ends of spring pale. Antennæ four-jointed; terminal segment short, with about ten distinct whorls of hairs, but without actual joints. Claw with two distinct teeth on the lower margin.

Length ·05″.

Pl. XLVI. fig. 25, represents a form of *Gregarina* frequently found in this species.

This species occurred, with the preceding, under logs of wood. It appeared, however, somewhat later in the autumn; at least, I found the first specimen towards the end of October. It was common through November, but died out again towards the end of the year, reappearing in May.

The structure of the antennæ at once distinguishes this species from all those described by M. Nicolet. In this respect it approaches more nearly to the *Smynthurus viridis* of Templeton, from which, however, its colouring is entirely different; and Mr. Templeton does not, unfortunately, give any anatomical details.

The legs are longer than in the preceding species; the animal is altogether more lively, not indeed so fond of walking as the following species, but more so than *S. Buskii*, which does not very often move except by leaps.

The antennæ are much longer than in the preceding species, the increase being in the two middle segments. The whole organ has a length of ·055″, with the comparatively small thickness of ·002″. The basal segment is ·005″ in length; the second ·0225″; the third is a little longer than the second, and especially towards its apical end, which is slightly swollen, and resembles a knobby stick. The terminal segment is about as long as the basal, and is somewhat conical. The whole organ is covered with scattered hairs, which are particularly numerous on the distal half of the third and on the apical segments.

On the latter they are arranged in whorls, giving the organ an appearance of being jointed, which, however, is not really the case.

The mandibles much resemble those of *S. Buskii*; I found, however, in my specimens six apical teeth on one mandible, and only four on the other.

The maxillæ also resemble those of the preceding species. The arrangement of the teeth is, however, a little different; and they appear to be rather more numerous; or at least the two *e* and *f*, fig. 6, have each a large secondary lobe at the base.

The palpus is simple, short, ·005″ in length by ·002″ in breadth, and rounded at the apex (Pl. XLV. fig. 19); it bears one long and two or three short hairs, not at the apex, but almost in the middle of its length, though rather nearer the free end. The organ is membranous, and in most parts transparent.

The upper lip is about ·00416″ in width, and is quadrate in outline, with the corners rounded off. The free edge is roughened by minute teeth, which are largest towards the centre. On each side there is also a row of larger teeth, parallel with the anterior margin, and with the teeth pointing inwards. The organ is also provided with scattered hairs.

The organ which I have suggested to be the representative of the second pair of maxillæ is represented in Pl. XLV. fig. 20. In my specimens it differed slightly from that of *P. Saundersii* in outline, as well as in the possession of two minute teeth. Whether these differences are constant must be decided by the examination of other individuals.

The under lip resembles that of *P. Saundersii* (Pl. XLVI. fig. 30).

The legs are longer in proportion, but at the same time thinner, than those of the preceding species. The proportions of the different legs are the same, the anterior being the smallest, and the second pair intermediate in size between that and the third pair. In the relative sizes of the different segments also this species agrees very closely with *Smynthurus Buskii*—the coxa being short, and the three following segments increasing in size almost in a geometrical ratio. The whole organ, except the tarsus, is clothed with scattered hairs, which, however, are most numerous on the tibia. The tarsus itself is short and bare. The appendages of the tarsus are manifestly (Pl. XLV. figs. 22, 23) arranged on the same type as in *S. Buskii*, though the details so far differ as to offer good specific characters. The outer spine (*a*) is not elliptic, but resembles in outline the blade of a clasp knife, and has two strong teeth on the under edge. The second inner appendage (*b*) also presents well-marked differences. The basal portion bears a small, curved spine, and in the first foot (fig. 22) gradually contracts, while in those of the third pair (fig. 23) there is a sudden diminution immediately beyond the basal spine. The tip of the filament (Pl. XLV. fig. 23 *c*) appeared to me to be slightly swollen. In this character it presents much analogy with the so-called "tenent hairs" described by Mr. Tuffen West in the twenty-third Volume of the 'Transactions of the Linnean Society;' see, for example, his figures of these hairs on the tarsus of *Ocypus olens* (Pl. XLII. fig. 24 *i*), or those from *Mylabris cichoriæ* (Pl. XLII. fig. 29). In both those cases, however, the hairs are very numerous, and their combined action is no doubt sufficiently efficacious; but in this case, where we have only a single hair on each foot, its action must be very slight.

The spring in this species is rather longer and slenderer than that of the preceding.

The basal part gradually tapers to the extremity, which is sparingly clothed with short hairs, but has no trace of the three long, button-bearing hairs which occur in *Smynthurus Buskii*. The terminal segment is, as usual, free from hairs; it scarcely tapers, but is simply rounded off at the end. On the inner side are from 25 to 35 small teeth, of uniform size; between the two last is a rounded knob, which occupies the space of about three teeth, but does not project beyond the general outline.

The ventral tentacles are very similar to those of *S. Buskii*. They are provided with the same gland-like papillæ, and fulfil doubtless the same functions.

Papirius Saundersii, n. s. Body globular, without a re-entering angle. The great abdominal segment is produced backwards, so that the two terminal segments are not seen when the animal is in its natural position. The penultimate segment is small, and only distinguishable on the ventral side.

Variety a.—Head yellowish, with a tinge of green on the posterior part, more or less distinct brownish markings on the central line, and a curved patch of the same colour behind the antennæ; eye-disk black. Back greenish, mottled with brown: the size as well as the darkness of the markings varies in different specimens; but the fundamental pattern is generally the same, though the proportions of the parts may differ considerably. On each side of the median line on the anterior half of the abdomen is a more or less interrupted band; about the middle of the back (that is to say, at their lower extremity) these are joined on the outer side by a diagonal band, and the two on each side unite, then separate and pass outwards and backwards, soon however returning again to the middle line, and thus enclose a more or less quadrate, or circular, space of the paler colour. In the middle line, and at the posterior end of the great abdominal segment or segments, is a marking which is very characteristic. There is first of all a small dark square, immediately behind which are three oblongs of the same colour, and at the posterior end a dark band passing backwards. The pale spaces between the oblongs vary in width, and sometimes are almost obliterated. The oblongs also vary in length, sometimes increasing gradually in length from the front one, like the steps of a pyramid, while at others the two last, or all three, are of equal length.

In different specimens I found every shade between brown and dirty olive-green, while in some the light ground preponderated over the darker markings, and in others the reverse was the case. Sometimes the darker parts were of a beautiful purple.

The sides of the body, and the two basal segments of the antennæ, are of the dark hue, whatever that may be, with, however, a few spots of lighter colour.

The two apical segments of the antennæ were purple in all my specimens, which struck me as a very curious fact, since I should have expected that the antennæ would have followed the law of colouring which prevailed on the other parts of the body.

The posterior segment of the abdomen, the spring, the whole underside of the body, and the legs are pale, the latter with a tinge of red.

Variety b.—The dark parts more extensive, and very dark brown or purple. This variety is at first sight so different from the former, that, until I compared the nature of the markings and the structure of the different organs, I supposed that it was a different species.

The two varieties occur together.

The body is covered by scattered hairs, which are longest on the posterior part of the back, where they have the appearance of a tuft. The terminal segment of the antenna is short, as in *P. cursor*.

The structure of the antennæ is enough to distinguish this species from any of those described by M. Nicolet; nor can it be confused with the *Smynthurus signatus* of Templeton, which, as already mentioned, is a different species from the *S. signatus* of Fabricius, to which Mr. Templeton, as I consider erroneously, refers it. In many respects it approaches Mr. Templeton's *S. viridis*, which, again, I must consider to be erroneously identified with the *S. viridis* of Fabricius; the antennæ, however, are differently constructed, and the markings are not exactly the same. Rather in front of the antennæ, and close to the middle line, is a double dark spot, which suggests the idea of ocelli.

Length 05″. Found in the latter part of November, December, and January, among leaves and under logs of wood, with the two preceding species. It is not only, however, of livelier colours than either of those, but also of more active habits, running freely, and jumping more lightly and gracefully.

I have given myself the pleasure of naming this pretty little species after my kind friend Mr. W. Wilson Saunders, V.P.L.S., to whom I am under many and great obligations.

The *antennæ* closely resemble those of *P. cursor*, the proportions of the different segments being, indeed, almost exactly the same.

The *upper lip* also (Pl. XLVI. fig. 26) much resembles that of the preceding species. The margin is clothed with short hairs rather than teeth, and those at the middle are no longer than the lateral ones.

The *mandibles* have respectively six and five teeth; in other respects they, as well as the *maxillæ* and *maxillary palpi*, much resemble those of *P. cursor*, as also do

The *second pair of maxillæ*, which, however, have only one minute tooth. The margin is varied somewhat in different individuals, being occasionally almost straight, and in other cases more or less lobulated.

The *tongue* is rounded and bilobed, having a slight notch in the middle.

The *lower lip* is formed of two somewhat quadrate lobes, the outer angles being, if we may so say, rounded off, while the inner apical angle of each lobe is slightly produced. The organ has several tufts of hairs. The margins have no teeth.

The three pairs of legs, and the respective segments of which they are composed, agree closely with those of *P. cursor*; but the foot, though formed on the same type, differs in its details, resembling *S. Buskii* in some respects, and *P. cursor* in others. The outer claw agrees most with that of the former species, while the lower appendage follows that of the latter. Instead of the outer claw tapering to the extremity, it is rounded off, while the lower angle is produced into a small claw (Pl. XLVI. figs. 31, 32). The lower appendage is rather thicker than in *P. cursor*, and the filament *e* is somewhat shorter. There are, moreover, *two* minute spines on the posterior foot, which, however, in different specimens, differ somewhat in size and position. In some cases, indeed, the smaller spine seemed to be absent.

The small appendage attached to the ventral surface of the first abdominal segment is shaped something like a pear, and attached by its larger extremity. It bears four or five short hairs. Attached to it is a second piece, also of a pyriform shape, but with the apex divided into two lobes. When the spring is turned forwards, the base ends close to this organ, exactly as described by M. Nicolet.

The basal part of the spring, that is to say, the part measured from the fold which separates (if my suggestion is correct) the first from the second abdominal segment, is ·0125″ in length; the middle part is ·022″ in length, with a breadth of ·002″ at the base, and ·002″ at the extremity; while the terminal segment is ·0075″ in length, and ·00125″ in width at the base. It tapers a little towards the extremity, and has from 30 to 40 small teeth on its inner margin.

The distribution of the hairs resembles that of the preceding species.

The hairs on the posterior part of the abdomen are of two sorts, some (Pl. XLVI. fig. 34) being short and sword-shaped, while others are longer, and resemble a lady's riding-whip.

The males may be distinguished from the females, so far as my observations went, only by the presence of a small papilla on the ventral surface, just in front of the anus.

On the Anatomy of the Smynthuridæ.

Smynthurus Buskii.

Digestive Organs.—The intestinal canal is a straight tube, and falls into three divisions —the œsophagus, the stomach, and the rectum. The œsophagus is rather long, narrow, and composed, as apparently in most of the Thysanura, of an inner chitinous membrane and an outer layer containing muscular fibres. The stomach extends almost the whole length of the thorax and abdomen. It is a capacious sac, and is lined internally by yellow nucleated cells, resembling the so-called *liver-cells* of some lower Invertebrata. They are about ·005″ in diameter, and tolerably uniform in size. They are themselves colourless, but contain a great number of minute yellow globules, resembling oil-globules. The nuclei, when freed from the surrounding matter, are clear vesicles about ·002″ in diameter, and contain a very few minute granules. The contents of the stomach consisted, in my specimens, altogether of spores and young shoots of Cryptogams. The rectum is quite short, and, like the stomach, is provided with longitudinal and transverse muscles. The former, however, are not easy to distinguish. The digestive organs of the Thysanura are very uniform; at least, in addition to the genus *Smynthurus*, I have examined specimens of *Isotoma*, *Degeeria*, *Lipura*, *Macrotoma*, and *Lepidocyrtus*, without finding any great differences. M. Nicolet also gives one description of the digestive organs as applicable to all the Poduridæ (including *Smynthurus*), but he takes a very different view of the subject.

The digestive organs of the Poduridæ, according to him, are composed of five parts, "l'ésophage, le jabot, le ventricule chylifère, les vaisseaux hépatiques, l'intestin grèle, et le cæcum." He admits, however, that "le jabot paraît n'être qu'une simple dilatation de l'ésophage, dont le diamètre varie selon que l'insecte a plus ou moins mangé;" it has also no different structure from the rest of the œsophagus, and cannot therefore be compared with the true "jabot" of other insects. M. Nicolet mentions the longitudinal muscles on the stomach, and has also noticed the transverse fibres, which, however, he simply calls "rides transversales et irrégulières," though in the specimens examined by me they were more distinct and regular than those of the other series.

I found no posterior division of the stomach sufficiently well marked to justify M. Nicolet's name of "intestine grèle;" and the rectum, which M. Nicolet describes as being "parfaitement lisse," was in my specimens distinctly muscular. He calls it "cæcum," which, however, is no doubt a mere slip of the pen. The most essential difference between us, however, is as to the Malpighian vessels, of which M. Nicolet thinks that there are six, "tubuleux et filiformes ou du même diamètre dans toute leur longueur; ils sont insérés immédiatement au-dessus du rétrécissement pylorique; leur longueur égale à peine la moitié de celle du ventricule chylifère; du reste, leur extrême ténuité et leur peu de consistance ne m'ont pas permis de les étudier en détail."

I can only say that neither in *Smynthurus* nor in any other genus of Poduridæ which I have examined, have I been able to detect any trace of these organs.

The fatty tissue consists of lobular, opaque, white masses, which owe their appearance to the presence of innumerable granules. These vary from a very minute size up to $\frac{1}{6000}$th of an inch, and are probably excretory products. A large band of it lies on each side of the intestinal canal, with which it has numerous connexions, though I could not convince myself that there was any open communication between the two.

Respiratory Organs.—*Smynthurus* breathes by means of tracheæ. There are, however, only two large spiracles; at least I was unable to see any others; and all the larger tracheæ, even some in the posterior part of the body, were traceable up to one or other of these. It is very unusual for an articulate animal to have only two spiracles; and their position is still more extraordinary, for they open on the underside of the head, immediately below the antennæ. No insect is known to have spiracles either in the head or between this and the prothorax; and Burmeister (Handbook of Entomology, p. 165) even goes so far as to state that none are ever so situated. It appears, however (see Pagenstecher, Beiträge zur Anatomie der Milben), that, though in most Mites the tracheal orifices are situated at the base of the legs, yet in *Trombidium holosericeum* the spiracles are two in number, and, as in *Smynthurus*, are situated at the lower side of the head, though not exactly in the same place, since in this species they open on the inner side of the basis of the mandibles.

In the Thysanura, according to Nicolet *, "Les ouvertures trachédennes ou stigmates, dont je n'ai pu découvrir que huit, sont placées par paires sur les arceaux supérieurs des quatre premiers segments de l'abdomen. La couleur de leur péritrême, qui est la même que celle du corps de l'insecte, les rend très-difficiles à apercevoir; leur forme est lunulaire; ils occupent le milieu de chaque bord latéral des segments ci-dessus mentionnés, mais à une distance de ce bord égale au septième environ du diamètre transversal de l'insecte."

M. Nicolet apparently gives this description as applicable to all the Podurelles (a term in which he includes the present genus); and it has been so understood by succeeding writers (see, for instance, Gervais's 'Insectes Aptères,' vol. iii. p. 385, and Von Siebold's 'Anatomy of the Invertebrata,' translated by Burnett, p. 438). It is, however, altogether incorrect as regards *Smynthurus*; nor does it apply to many of the true Po-

* Nouv. Mém. de la Soc. Helvétique, vol. vi. p. 38.

duridæ, among which I have examined species belonging to most of the genera, though I have not yet been able to obtain any specimens of the true *Podura*, to which genus the species examined by Nicolet belonged. Close to the spiracles, the tracheæ break up into a great number of thin branches, which supply the head without much more subdivision. There is also a very large trunk, which almost immediately divides into two branches, the smaller one of which soon divides again, and supplies the anterior region of the thorax, while the other gives off branches to the posterior legs and the abdominal organs. In the manner of subdivision, the tracheæ of *Smynthurus* differ from those of the true Insects, and agree more closely with the Myriapoda and tracheal Arachnida, in the fact that they do not often give off branches nor form tufts, but generally divide dichotomously, and run considerable distances without a separation.

I have noticed no respiratory movements; and the supply of oxygen is probably due therefore principally to that diffusive power of gases, the laws of which have been so well worked out by Dr. Graham, and even applied to the respiration of insects. "In the law of diffusion of gases," he says, "we have therefore a singular provision for the full and permanent inflation of the ultimate air-cells of the lungs. But it is in the respiration of insects that the operation of the law will be most distinctly perceived. The minute air-tubes accompanying the blood-vessels to every organ, and, like them, ramifying till they cease to be visible under the most powerful microscope, are kept distended during the most lively movements of the little animals, and the necessary gaseous circulation maintained, wholly, we may presume, by the agency of diffusion." Though we must attribute some influence to the respiratory movements exhibited by so many insects, the above explanation seems to me to throw much light on the question, which I have already treated at greater length in the 'Linnean Transactions' for 1860.

I should not have thought it necessary to allude again to the subject, but that Prof. Rathke, in a posthumous memoir "On the Respiratory Process in Insects" (See Ann. and Mag. of Nat. Hist. 3 ser. vol. ix. p. 105), appears to have overlooked these facts, and thereby to have fallen into some errors. Thus he says, "From the absence of all such phenomena, we might conclude that in the pupæ of the above-mentioned insects (Coleoptera and Hymenoptera) the tracheary respiration is entirely interrupted." And further on, "In any case, it is certain that the respiration of pupæ can only be very weak." It has, I think, been sufficiently shown that the mere absence of respiratory movements does not necessarily involve such a conclusion.

While, however, in *Smynthurus Buskii* the mere presence of tracheæ is easily detected, difficult as it may be to ascertain their distribution, I have, to my great astonishment, been unable to detect a trace of them in the genus *Papirius*. Remembering that though the great Treviranus was unable to convince himself of the existence of tracheæ in *Lepisma*, they have since been discovered by Burmeister, and being only too well aware of the difficulties attending the dissection of these minute animals, I long attributed the apparent absence of tracheæ to my own unskilfulness; but this explanation is not, I think, tenable; and even if rudimentary tracheæ be hereafter discovered, I feel at least convinced that their arrangement and distribution will be found to differ altogether from those which characterize *Smynthurus*. It must be remembered that the air in the tracheæ of freshly killed insects glitters like threads of quicksilver; and however absurd it may sound, I consider the inside of an insect, with its beautiful and rich tracery of glittering tubules, to be one of the loveliest objects in nature. In searching, therefore, for tracheæ we are very much assisted by the presence of the air; and while in preserved specimens these organs are not easy to trace, at least towards their extremities, in fresh specimens they are generally very conspicuous.

I have not yet discovered in *Papirius* any other organs of respiration; but, considering how soon these animals dry up if placed in a dry atmosphere, it seems quite possible that they may respire through the general surface of the skin.

Female Generative Organs.—The ovaries of *Smynthurus* are very simple. From the delicacy of their membranous envelope, it is not very easy to extract them entire; but the best way is to make a section of the animal from the back at the anterior part of the cephalothorax, to the base of the spring: in this case, the ovaries will generally be found uninjured, and may be separated from the other organs without very much difficulty. They consist of a single, short and broad egg-tube on each side, and unite posteriorly to form a narrow vagina about ·003125″ in length. Having found it impossible to remove the skin in such a manner as to expose the ovaries *in situ*, and as the method above described destroys, of course, the natural position of the organs, I am unable to say much as to the usual position of the ovaries. They did not appear, however, to pass directly forwards, but seemed rather to curve round from the point of attachment to the vagina so as to lie rather in the posterior part of the body. They were, I think, on the dorsal side of the intestinal canal; but this point I unfortunately forgot to note at the time.

M. Nicolet was unsuccessful in his search for the organs of generation. "Je l'ai déjà dit," he says, "les difficultés que l'extrême petitesse de ces insectes oppose à la dissection, rendant fort difficile l'étude de leur organisation intérieure, qui peut-être restera encore longtemps inconnue; le hasard seul, en rendant un observateur témoin d'un accouplement, pourra faire découvrir leurs organes génitaux, mais un pareil hasard est difficile à prévoir." I quote this sentence as an excuse for the numerous details, in the anatomy of *Smynthurus*, which I have left unascertained; many of which, however, want of time alone has prevented me from making out. I may add that the small size of *Smynthurus* gave me less difficulty than its curious form and the extreme delicacy of its internal organs. By opening the animal, however, as above mentioned, I was able several times to make out the vagina above described, and also to trace it to the vulva, which, with the anus, opens into a common cloaca at the posterior end of the body; this, however, from the great development of the segment bearing the spring, is thrown apparently on to the dorsal surface.

The only accessory organs which I could find were two small, glandular, rounded bodies attached to the vagina close to its orifice. They were ·0055″ in width, and shaped like a kidney, with the convex side in front. On the other side of each, that is to say near the vulva, is a dark-brown rounded mass, about ·003″ in diameter. Beyond their relative position, I did not make out the relation which these organs bore to one another or to the vagina.

My examination of *Smynthurus* began early in October. At this period the ovaries generally contained perfectly clear jelly-like nuclei, of which the largest were about ·001″ in diameter, but many were much smaller; these nuclei were surrounded by a clear, transparent, but less brilliant substance, which sometimes formed a complete spherical envelope to a single nucleus, but generally appeared as a lobulated mass enclosing two or more. In other cases, which I suppose were more advanced, the nuclei were darkened by a deposit of granules. Even, however, early in October the development of the eggs was sometimes much more forward, and the ovary contained a number of yelk-masses at pretty regular intervals. In a transverse section of the ovary there were three, or at the broadest part four rows. The spaces between the yelk-masses were occupied, as before, by the nuclei and their transparent enveloping substance. The yelk-masses having at this period no bounding membrane, when I attempted to isolate them by opening the ovary, they immediately fell to pieces; which made the study of their development somewhat difficult. On the 13th October I found a specimen with eggs apparently ready to be laid; they were yellow, round bodies, ·01″ in diameter, with a single structureless ovarian membrane, and the yelk was composed of oil-globules of various sizes up to ·0015″. I could find no trace of Purkinjean vesicle. On the 22nd I examined another female in a similar condition, and found the eggs to be about forty in number.

Male Generative Organs.—*Smynthurus Buskii*, as I have already observed, became much rarer in the latter part of November, and disappeared altogether early in December. Up to this time I had been occupied in the determination of species and the examination of the other parts; so that my description of the male organs of reproduction must be taken from *Papirius Saundersii*, which made its appearance later in the autumn, and lived longer through the winter. There is, however, no doubt that, if my specimens had lasted, I should have been able to lay before the Society a description of these organs in *Smynthurus Buskii*, which, from its greater size, was the species most favourable for dissection.

In *Papirius Saundersii*, as in many other apterous Articulata, the testis is formed on the same type as the ovary. On each side of the body is a simple tube (Pl. XLVI. fig. 38 *a*), opening into a triangular reservoir with its base in front. The two posterior sides of the triangle are accompanied by a glandular accessory organ, containing a central cavity (Pl. XLVI. fig. 38 *c*), full of minute globules, the largest of which do not exceed ·000083″ in diameter, while the majority were much smaller. From the posterior angle of the reservoir a short and narrow vas deferens runs into the ductus ejaculatorius, which is also short pyriform, and opens, like the vulva, with the anus at the posterior end of the body.

The development of the spermatozoa proceeds as in *Obisium* (Phil. Trans. 1861). The testis contains small cells, about ·00025″ in length, and collected into masses of various sizes, which have probably arisen within mother-cells; their size does not appear to depend in any way on the stage of development of the spermatozoa. The small cells which compose them are at first somewhat oval; gradually one end elongates, and at length they resemble in form the egg of a *Cynips*, consisting of a thread, with a small swelling at one end, and a larger oval body at the other (Pl. XLVI. fig. 39); this, however, is not probably the mature form.

The testis also contained numerous greenish, oval or somewhat quadrate bodies (Pl. XLVI. fig. 41), about ·0002″ in length, and exactly resembling the similar bodies which I found in the testes of *Chelifer* and *Obisium*, and which so curiously resemble the spermatozoa of *Polydesmus*.

There were also a number of larger spherical cells (fig. 42), from ·0005″ to ·001″ in diameter, and transparent or containing only a few granules. These may perhaps be compared with the similar bodies found in the testis of *Oniscus*.

The walls of the triangular reservoir are rather thick, and consist of nucleated cells (Pl. XLVI. fig. 38). It contains the spermatozoa and the green bright bodies, as well as some other globules, which resemble oil-globules.

The walls of the accessory glands are also composed of thick cells. They are completely filled by the minute granules, which form an opaque mass. The ductus ejaculatorius has an apparently chitinous lining, which is strengthened, like the tracheæ and some other chitinous parts of Articulata, by transverse ribs, which, in this case, are very delicate.

The so-called "*gastric tube*," and the two filaments which proceed from it, are not the least curious part of the anatomy of *Smynthurus*. The gastric or, as it may better be called, the ventral tube is situated on the underside of the body, in the middle line, and immediately behind the second pair of legs. From it the animal can project two long, colourless, transparent filaments, which, when extended, are nearly $\frac{1}{10}$th of an inch in length, are somewhat elbowed in the middle, and at the end are covered with small vesicles or "glands," which, according to Nicolet, secrete abundantly a mucous fluid, by which the whole organ is "continuellement invisqué," but which I have not observed on the specimens examined by me. Nicolet gives a figure (pl. 3. fig. 22) of a tentacle, which does not altogether agree with my observations; but, as he does not mention the species from which it was taken, it is impossible to say that the differences may not be partly specific, though I am not disposed to think that they can all be accounted for in this manner. M. Nicolet observes that the tentacles are "doués d'un mouvement rétractile exactement pareil à celui des tentacules oculaires des Limaces;" but he does not figure nor describe the very curious muscles by which the apparatus is worked, nor has the subject been investigated by any other naturalist.

In Pl. XLVI. fig. 35, I give a figure of the whole organ in a state of retraction. At the point *a*, the basal portions of the two tentacles, *b*, *b*, are attached to the wall of the ventral tube; the tentacle itself is, of course, in this position turned inside out, the outer wall, *b*, being the inner wall in fig. 36, and the small vesicles seen on the outer wall in that figure being here in the central part of the hollow tube. All the letters in this figure represent the same parts as in fig. 35. At the part *f* is attached the muscle *e*, which in fig. 35 lies inside the tube, while here it is necessarily external to it. The point *i* is the terminal part of the filament when extended; the numerous vesicles can be seen, in an inverted position, through the transparent walls, and the muscle *h*, attached in fig. 34 to the inner side of the extreme end, is turned out in the same manner as the muscle *i*. The point *f*, as may be seen in fig. 36, very nearly divides the tentacle into two equal parts, though the basal portion (that is to say, the part *f*, *b*, *a*) is slightly the longer of the two; although, therefore, the part *i*, *c*, *f* is always found bent nearly into a semicircle, still the tentacular ends of the two muscles *e* and *h* are kept about $\frac{1}{60}$th of an inch apart, while their opposite ends are attached, close together, to the wall of the back, immediately above the ventral tube—a position which adds much to the difficulty of dissecting out the whole organ without injuring any of the parts. The terminal muscle *h* is single and cylindrical, while the other one is divided nearly in the middle into two equal branches (fig. 36, *e*, *g*). Although the arrangement and attachments of these different parts are so peculiar and intricate, a comparison of the two figures (Pl. XLVI. figs. 35, 36) will, I think, satisfactorily illustrate the mode in which the organ is extended, directed, and retracted. The whole skin of the animal is kept in a state of considerable tension by the quantity of its contents; so that if an incision is made, part of the entrails are immediately forced out. If, therefore, we imagine the muscle *e* to relax, the tension of the skin acting on the place at which the ventral tube is folded inwards—in fact, on the tube *b*, at the end *a*—will begin to force the tentacle inside out, so that what was the inner wall will become the outer one, and *vice versâ*, and the muscle *e*, as it elongates, from being external to the tube, will gradually become internal. The first effect of this upon the other section of the tentacle, *c*, will be to straighten it, but gradually the muscle *h* also must relax; the continuance of the same pressure will invert also the tube *c*, and, the muscle *h* being carried into it in the same manner as has already happened to *e*, we shall at last have the state represented in fig. 35,—the whole tube being inverted from its former position, the lower half containing the two muscles, the upper half only the one marked *h*.

The protrusion of the organ, however, though probably much assisted by the tension of the skin, is not to be altogether attributed to it, as the muscles are apparently surrounded by a layer of transverse fibres, which must tend to produce the same effect. I was at first inclined to wonder at the presence of two muscles, and to suppose that the object might have been equally well attained by the presence of only the one marked *h*. The two muscles, however, acting on different parts, may enable the organ to be retracted more quickly than might otherwise be the case—an advantage evidently of much importance to a part so delicate. Whatever also may be the function of the tentacles, a muscle attached to the middle part will enable the animal to apply this portion to some parts of its body which perhaps could not otherwise be so conveniently reached. Again, it is evident that a single muscle attached to the part *d* could not have fully retracted the tube, because the distance between *d* and *a* is less than the length of the tentacle; but this difficulty is at once avoided by the presence of a second muscle, which throws the tentacle into a curve; moreover, greatly as the two muscles are extended when the organ is protruded to its full length, if there was only one it would require a still greater power of elongation.

One function at least of the ventral tube is easily visible. If a *Smynthurus* is laid on its back—a position from which it has some difficulty in recovering its feet,—and if, while it is in this attitude, a piece of glass is brought within its reach, the animal will endeavour to seize it with the feet, but at the same time it will project one or both of the ventral tentacles, and apply it or them firmly to the glass, emitting at the same time a drop of fluid, which no doubt gives a better hold. I have, however, known a *Smynthurus* seize hold with one of its tentacles of the needle with which I was turning it over on its back; and the adherence was much firmer than the mere presence of a little fluid would account for. In the parallel case of the Poduridæ, M. l'Abbé Bourlet supposes that the ventral tube acts as follows:—"1°. Qu'il sert à ces insectes à se maintenir sur les surfaces perpendiculaires en y faisant le vide; 2°. Que le liquide excrété par lui sert à humecter la queue et la rainure; 3°. Qu'il supplée à la faiblesse des pattes dans les chutes qui suivent les sauts." I am therefore disposed to agree with him in so far as he denies that the adhesive power depends altogether on the viscous fluid; but, on the other hand, I cannot attach much importance to his two latter suggestions.

De Geer well understood the use of this curious organ. He says, "quand la Podure (under which name he includes the present genus *Smynthurus*) marchait contre les parois du poudrier, il lui arrivait souvent de glisser; c'était comme si les pieds lui manquaient, de façon qu'elle était sur le point de tomber; dans l'instant même, les deux filets parurent et furent lancés avec rapidité hors de leur étui, s'attachant dans le moment au verre par la matière gluante dont ils sont enduits, en sorte qu'alors la Podure se trouvait comme suspendue à ces deux filets." Nicolet gives a similar explanation of their function, and, like De Geer, attributes the adhesiveness to the glutinous matter which they secrete. Upon this point, however, I feel compelled, as already mentioned, partly to disagree with these two high authorities.

The Nervous System.—M. Nicolet describes the nervous system of *Smynthurus* as consisting of four ganglia, with a double connecting-cord. Two of these ganglia occupy the head, and form the œsophageal collar. The 1st subœsophageal ganglion (Nicolet, *l. c.* pl. 4. fig. 1 *c*) gives off two small nerves on each side. The 2nd, which is situated nearly midway between the 1st and 3rd, has a third nerve on each side; and the posterior ganglion, besides three pairs of nerves corresponding apparently to those of the preceding ganglion, has at its hinder extremity three other much larger nerves, which supply the posterior part of the body.

I found much difficulty in making out the nervous system at all, but hoped that Dr. Hicks's bleaching process might facilitate the matter. In this, however, I was disappointed, nor was Dr. Hicks himself more successful: he writes me word, "I have been as unsuccessful as you in the bleaching process. The thickness of the body, and the want of thickness of the chitine layer allowing shrivelling, are obstacles which I am afraid will not be overcome. It does well for the legs, wings, and antennæ; but for the thick bodies it seldom, I think, will suit, unless the integument is very firm." Dr. Hicks, however, satisfied himself that there were "three thoracic ganglia, with a posterior cord extending into the abdomen in the median line."

Since that time I have been unable to obtain any specimens of *S. Buskii*, which, being a large species, is a favourable subject for examination. I had, however, already satisfied myself of the presence of two large ganglia in the anterior part of the body; but the nerves proceeding from them seemed to me to be larger than those figured by Nicolet.

EXPLANATION OF THE PLATES.

Plate XLV.

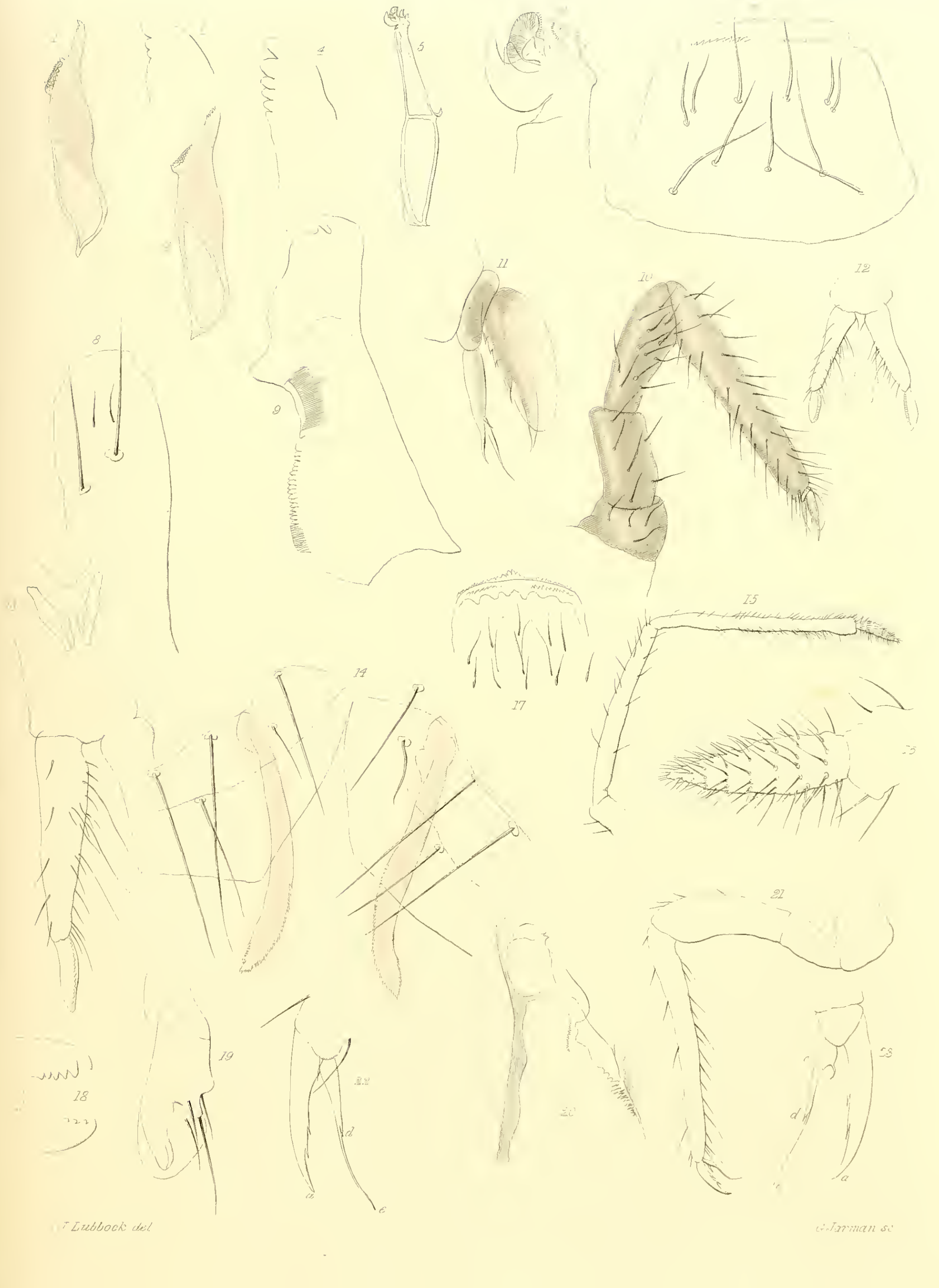
Fig. 1. *Smynthurus Buskii.* Mandible, × 60.
Fig. 2. " " Tip of the same, × 250.
Fig. 3. " " Mandible of other side, × 60.
Fig. 4. " " Tip of the same, × 250.
Fig. 5. " " Maxilla, × 60.
Fig. 6. " " Tip of the same, × 250.
Fig. 7. " " Labrum, × 250.
Fig. 8. " " Palpus, × 250.
Fig. 9. " " Second maxilla, × 250.
Fig. 10. " " Leg of third pair, × 60.
Fig. 11. " " Foot, × 250.
Fig. 12. " " Spring, × 60.
Fig. 13. " " Part of the same, × 250.
Fig. 14. " " Anal appendages, × 250.
Fig. 15. *Papirius cursor.* Antenna, × 60.
Fig. 16. " " Tip of the same, × 250.
Fig. 17. " " Upper lip, × 250.
Fig. 18. " " Tips of the two mandibles, × 250.
Fig. 19. " " Palpus, × 250.
Fig. 20. " " Maxilla of the second pair, × 250.
Fig. 21. " " Leg of the third pair, × 60.
Fig. 22. " " Foot of the first leg, × 250.
Fig. 23. " " Foot of the third leg, × 250.

Plate XLVI.

Fig. 24. " " Spring, × 60.
Fig. 25. *Gregarina* of *P. cursor*.
Fig. 26. *Papirius Saundersii.* Upper lip, × 250.
Fig. 27. " " Tip of first maxilla, × 250.
Fig. 28. " " Tip of second maxilla, × 250.
Fig. 29. " " Palpus, × 250.
Fig. 30. " " Lower lip, × 250.
Fig. 31. " " Foot of anterior leg, × 250.
Fig. 32. " " Foot of posterior leg, × 250.
Fig. 33. " " Anterior abdominal appendage, × 250.
Fig. 34. " " Anal hairs, × 250.
Fig. 35. Ventral tentacles retracted, *Smynthurus Buskii,* × 60.

a. Orifice of tube.
b. Basal part of tentacle.
c. Apical part of tentacle.
d. Point of attachment to dorsal surface.
e. Basal muscle.
f. Point of attachment of basal muscle.
g. Branch of basal muscle.
h. Apical muscle.
i. Papillæ turned outside in.

Fig. 36. Ventral tentacles, *Papirius purpureus,* partially extended, × 60
Fig. 37. Female generative organs, *Smynthurus Buskii.*
Fig. 38. Male generative organs, *Papirius Saundersii,* × 60.
Fig. 39. Spermatozoa, × 250.
Fig. 40. Earlier stages of spermatozoa, × 250.
Fig. 41. Greenish cellules occurring in considerable numbers in the male generative organs, × 250.
Fig. 42. Large transparent cells occurring in considerable numbers in the male generative organs, × 250.
Fig. 43. *Papirius Saundersii.*



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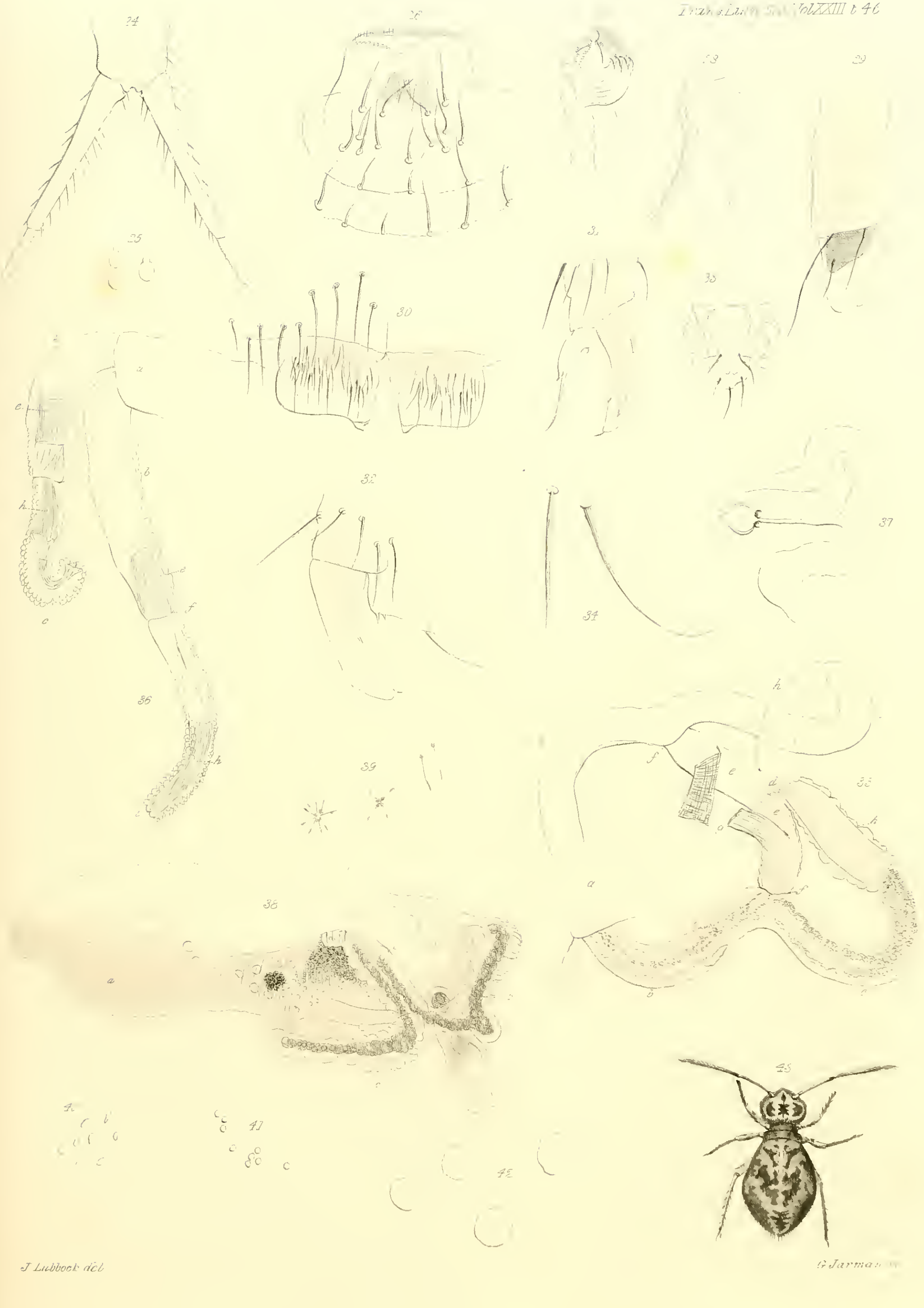


J. Lubbock del. G. Jarman sc.

XXVIII. *On the Geographical Relations of the* Coleoptera *of Old Calabar.*

By Andrew Murray, *Esq., F.L.S., Assist. Sec. Roy. Hort. Soc.*

Read February 6th, 1862.

The late Prof. Edward Forbes's speculation or theory that the South-American continent was at one time united or in close proximity to Western Africa, in the direction of the Sargasso Sea, has met with very general favour and acceptance; but the paper on the Orchidaceæ of Fernando Po, lately read to this Society by Dr. Lindley, and other recent observations show that much evidence is still needed before it can be said to be established. As a small contribution to the determination of this question and its collateral issues (such as the former points of junction or of greatest proximity of the two continents, and the lines by which the allied faunæ and floræ have been dispersed), I shall lay before the Society a few memoranda relating to the geographical affinities of the Coleoptera of Old Calabar, a part of West Africa of which comparatively little is known, and which I have had favourable opportunities of studying through the kindness of the Scottish missionaries who have established themselves there.

I shall not attempt here to enter into an examination or description of the entire Coleopteran fauna of Old Calabar. That task I have already commenced in a work partially published, and which, although for the present interrupted by more engrossing duties, I trust ere long to resume. On the present occasion I shall limit my notice to a few illustrations of the more remarkable affinities which I have observed between the Coleoptera of Old Calabar and those of other countries, and, in doing so, shall refrain from noticing many species to which I could have referred as allied, when their form or genus could also be said to be generally distributed over the whole world.

1. As to America, and more especially South America.

The first I shall particularly notice is *Galerita*—an American genus comprising upwards of forty species, of which nine-tenths are found in America, most of them in the United States, some in California, some in the West Indies, others in Brazil, &c., and so southward to Monte Video. The northern species have a red thorax and black or dark-blue elytra. As we go southwards, species are found with the colour of the thorax darker or black, and its shape narrower. In Caraccas and the West India Islands, the species *G. unicolor* found there has a black, narrow thorax, with blue elytra; and *G. Lacordairei*, found at Monte Video, is wholly black. I have four species of this genus from Old Calabar, all black, and all having the elongated thorax, &c., of the South-American species; one of these species is found also in Senegal. The American species *Galerita unicolor* is contrasted with my Old-Calabar species *Galerita femoralis* in Pl. XLVII. figs. 1 and 1 *a*. There are only two Asiatic species; so that the inference to be drawn is, that there is a little overflowing, on the one hand, from America into Asia, and a somewhat greater overflowing, on the other, into Africa.

The *Pheropsophi*, or larger *Brachini*, furnish an instance the converse of what we see in *Galerita*. Their metropolis is in tropical Asia and West Africa; but a few and rare New-World species are found in Eastern South America. Three or four species only are to be found in America, to balance the fifteen or sixteen of Africa.

I do not take into account the genera *Calleida* and *Lebia*, which, as at present constituted, are to be found all over the world. But there is one genus or subgenus of the family established by Eschscholtz, viz. *Lia*, confined to South America, of a peculiar facies, very smooth, very convex, and of a pale colour, which has a congener in Old Calabar, so like in form and general appearance, though of a finer colour (being, when alive, of a lovely delicate flesh-colour), that no one can doubt its affinity, although some of the characters given for *Lia* are not exactly found in it. This is a very marked instance of a purely American form, found nowhere else on the face of the globe (so far as we yet know), reappearing on the West Coast of Africa. The reader will find a South-American species *Lia affinis* contrasted with my *Lia clavicornis* in Pl. XLVII. figs. 2 and 2 *a*.

Another, similar instance occurs in the genus *Goniotropis*. The whole of the species of that genus are American, with the exception of three African, of which one is a new species, described by me, from Old Calabar. The other two are not recognizable from the descriptions (Brullé's and Hope's), and may or may not really belong to the genus; but there is no doubt as to my Old Calabar species being as close as can well be to *G. castanea* of New Granada. Compare figs. 3 and 3 *a* of Pl. XLVII., being respectively *Goniotropis castanea* and my *G. Wylei*. Lacordaire erroneously unites with this genus *Pseudozæna orientalis* of Klug, and equally erroneously, as I think, keeps distinct from it Solier's genus *Tropopsis* from Chili.

Dejean's genus *Hypolithus*, notwithstanding the difficulty of finding appreciable characters to distinguish it from *Harpalus*, has a sufficiently marked facies to make it readily recognized by the eye, the upper surface having a peculiar granulated texture. West Africa and South America are the sole countries where they have been found. Old Calabar produces two species.

America possesses a peculiar form of *Orectochilus* (of which the most readily seizable character is the want of a scutellum); no species of this has hitherto been found out of America. Old Calabar has now produced one.

In the Histeridæ, a peculiar rounded form distinguishes the genus *Omalodes*. No species exactly of that genus has been found elsewhere; but species of an allied genus, *Contipus*, forming the transition between it and the ordinary form of *Hister*, have been found in Yucatan, Senegal, and Old Calabar.

In the Nitidulidæ, two species of the American form *Prometopia* have been found in Africa; and the genus *Platychora* is represented by Thomson's *Pherocopis*, species of which have been found on both sides of the continent. *Lobiopa senegalensis* is scarcely distinguishable from the South-American *L. contaminata*.

Among the Trogositidæ, species of *Alindria* are found in both countries.

In the Buprestidæ I may specially refer to the genera *Actenodes* and *Belionota* as of the closest affinity. They are confined, the one (*Actenodes*) to America, and the other (*Belionota*) to Africa and the Old World. *Actenodes chalibeitarsis* from Mexico may be contrasted with my *Belionota Championi** from Old Calabar in Pl. XLVII. figs. 5 and 5 *a*.

Lampetis, or *Psiloptera*, is found all over the tropics; but the Old-Calabar species is closer to some of the South-American species than to the East-African or Indian species. *Psiloptera equestris* from Brazil is figured in Pl. XLVII. fig. 6, alongside my *Lampetis piperata* † from Old Calabar, fig. 6 *a*.

The Lamellicornes in like manner present similar affinities. Among the Cetoniadæ, perhaps the most striking is the almost exclusive possession respectively taken of America by the Gymnetidæ, of Africa by the Pachnodæ, and of the Indian district by the Protætiæ. This is not the place to discuss the value of the different characters used to distinguish these groups; nor do I at all mean to indicate that I consider the three I have mentioned as of equal value. They are undoubtedly not so; *Protætia* and *Pachnoda* are greatly nearer to each other than *Gymnetis* to either of the others. But I place them together as alliances in a certain sense. They are examples of a not very uncommon mode in which affinity may be traced,—viz. when a general resemblance remains, while some considerable deviation has taken place in the structure. In *Gymnetis* and *Pachnoda*, for example, the colouring, texture, and peculiar dull velvety appearance are preserved, while the structural characters have deviated. Every systematic naturalist will acknowledge the great assistance he derives in tracing out the true relations of species from some indefinable family resemblance or trick of the visage, which suggests the idea and sets him in the right track, but which he finds it impossible to render into words. Such is the resemblance between *Pachnoda* and *Gymnetis*. At the same time it is a resemblance which, while suggesting a common parentage, according to the Darwinian theory, cannot be cited as indicating more than a very distant relationship.

* Nigro-fusca, capite thorace et subtus chalybeo-cuprea parum purpurata; capite declivi, oculis magnis fere verticem capitis attingentibus, vertice linea lævi striata, antice irregulariter punctato, maculis parvis lævibus, clypeo subbilobo; thorace antice angustiore, angulis antice declivibus, basi recto, ante scutellum utrinque valde sinuato et exciso, magna profunda fovea semilunari transversa utrinque versus latera posita, paulo pone medium fovea et angulis posticis parum aciculatim lineatis; scutello longissimo, thorace longiore (quarta parte elytrorum longitudine); elytris basi utrinque angulato-attenuatis, apice apiculato, ad suturam singulis quinquecostatis, punctatis, punctis a retro formatis, costis, punctis et textura paulo ut in *Necrodi*, costis tertiis et quartis conjunctis paulo pone medium: subtus lateribus punctatis et aciculatim lineatis, medio lævi; prothorace rotundatim et late carinato; segmentis abdominis ad latera apiculatis, medio longa plana haud profunda fovea, utrinque lævi carina metata aciculatim punctata; femoribus aciculatim lineatis.

Long. 12 lin., lat. 4 lin.

† Supra aureo-cuprea, irregulariter profunde impressa vel punctata, nigro vel viridi-nigro maculata, subtus chalybea; clypeo emarginato, labro transverso, mandibulis rotundis crassis molaribus; thorace antice angustiore, lateribus angulatis, basi sinuato, disco irregulariter spatiis lævibus notato, punctis confluentibus et rugosis sæpius latera versus instructo; scutello minuto, rotundato et convexo; elytris apice attenuatis, ad humeros angulatis, lateribus sinuato-angulatis paulo pone humeros, apice attenuato emarginato rugose striato-punctatis, spatiis lævibus nigris disco irregulariter maculatis, lateribus magis rugosis et metallicis: subtus prothorace et mesosterno tricarinato, carina bilineata; pedibus chalybeis, punctatis.

Long. 12 lin., lat. $4\frac{1}{2}$ lin.

On the whole, the amount of affinity in the Lamellicornes is very limited. Some of the tribes show indications of affinity; but, with the exception of a few worldwide-distributed genera, such as *Serica*, *Adoretum*, and *Onthophagus*, I can scarcely point to a genus in which allied species are to be found in both countries. The great *Augosoma Centaurus*, as it belongs to the Dynastidæ, has, of course, relations with the South-American Dynastidæ; but, according to Lacordaire, it has nearer affinities with the Indian Dynastidæ than with those of South America. I have not made a special study of the Dynastidæ myself, and therefore adopt Lacordaire's view in preference to my own empirical inclination rather to place it alongside of the South-American species.

Scarcely a single species of epigeal Tenebrionidæ has been received from Old Calabar; and in like manner they are extremely scarce on the opposite coast of South America. Those which are non-epigeal furnish a few links, and the Taxicornes and *Stenelytra* a few others, as, for example, *Stenochia violacea* from Brazil, and *S. longipennis** from Old Calabar, figs. 4 and 4 *a* of Pl. XLVII.

The Longicornes supply some very interesting and close affinities. For the first time a *Parandra* has been found in the Old World, at Old Calabar. See the figs. of *Parandra brunnea* from North America, and of *P. beninensis*† from Old Calabar, figured in Pl. XLVII. figs. 7 and 7 *a*. *Dorycera spinicornis* from Old Calabar is obviously a near relation of *Polyoza Lacordairei* from Brazil (see Pl. XLVII. figs. 8 *a* and 8). Several species of the American form of *Callichroma* are already known as found in Senegal; but the number has been considerably increased by the Old-Calabar species; at least, seven or eight new species have reached me from thence. A new *Œme* has been found there, and one or two other American forms. But by far the largest proportion of the Longicornes of Old Calabar are new, and of the African facies.

The same remark applies to the Curculionidæ. Very few of these are described; and among them are a number of most interesting and peculiar new forms. There is a form allied to that of *Platyomus* of Brazil, but their affinity is doubtful. *Sphenophorus Phœnicis* is, however, closely allied to the Palm Calandras of South America; and *Rhina barbirostris* is found in both countries. With these exceptions, I do not recall any species showing near relationship.

The Old-Calabar Phytophaga are also mostly new, and peculiar to that country; but

* Nitida, omnino chalybeo-metallica; capite punctato, inter oculos breviter longitudinaliter impresso, ante oculos excavato, oculis partim divisis ut in *Stenochia violacea*, labro lato transverso; thorace subquadrato, brunneo, sparsim fortiter punctato, marginato, lateribus rotundatis, margine laterali reflexo, antice pone caput expanso et glabro; scutello parvo, triangulari; elytris thorace quadruplo longioribus, parallelis, striato-punctatis, interstitiis nitidissimis lævissimis sparsim punctatis, punctis vix sub lente conspicuis: subtus lateribus sparsim fortiter punctata; pedibus longis.

Long. 11 lin., lat. $3\frac{1}{2}$ lin.

† Ferrugineo-fusca, punctata, punctis rugosis, oblongis vel quadratis seu angulatis: ♀ capite fronte trisulcato vel bilobato, antice transversim excavato; clypeo prope oculos utrinque carinato, fere trilobato, lobo mediano obtuse subquadrato prominente; mandibulis crassis, convexis, dentatis: thorace transversim subquadrato, marginato, postice angustiore, fortius et rugosius utrinque antice punctato; utrinque bifoveolato, fovea una medium versus posita, altera deltoidea ad basin; angulis anticis projicientibus et acutis, posticis obtusis; marginibus lateralibus irregulariter sinuatis; scutello glabro, impunctato; elytris sub-tricarinatis: subtus mento rugosa, lateribus metasterni et segmentorum abdominalium lævissime papillosis, prosterni et femoribus punctatis.

Long. 9 lin., lat. 3 lin.

it affords an example of the American family *Œdionychis*. The Erotylidæ present some resemblances between the two countries, as *Dacne grandis* to *Dacne heros*, &c.

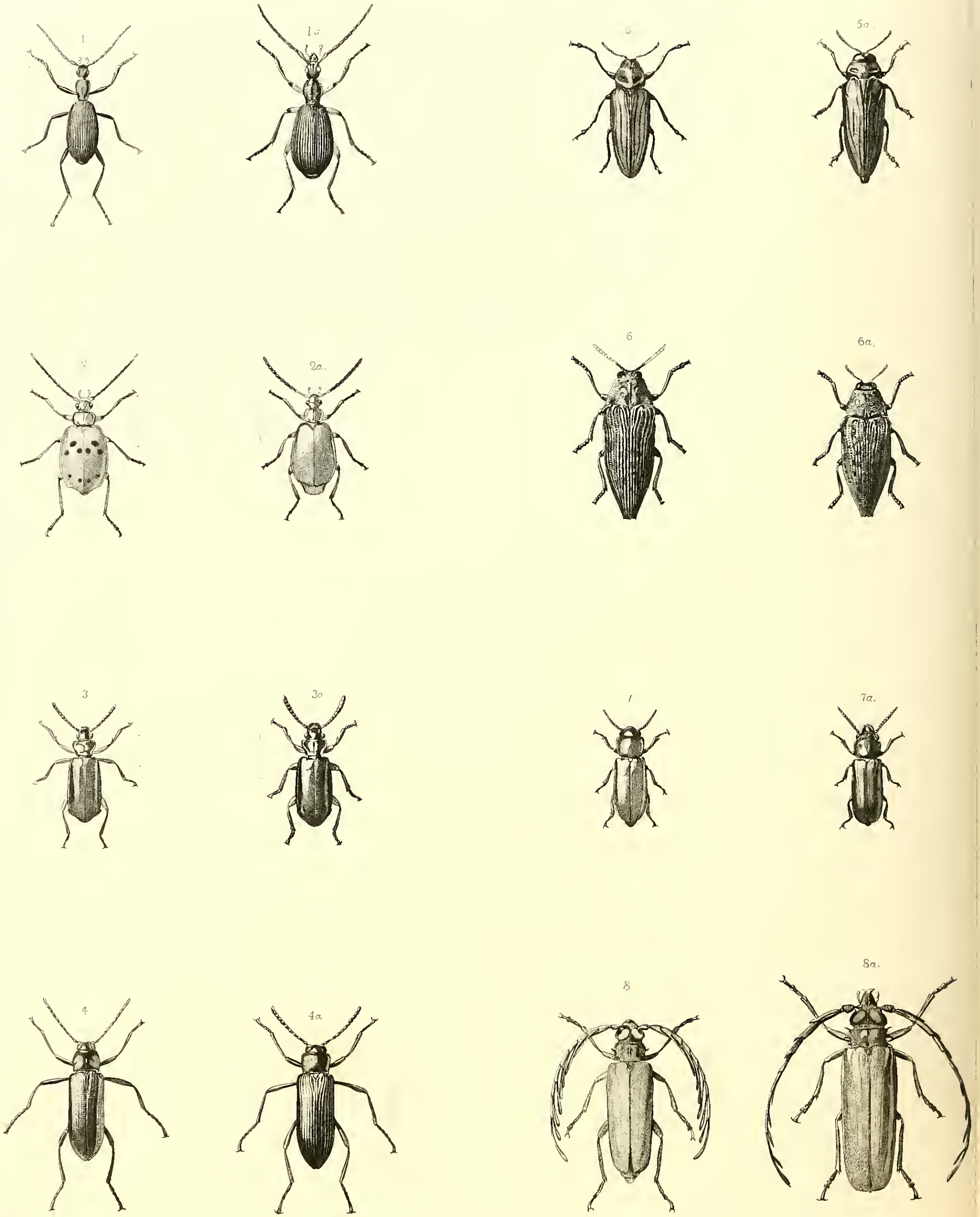
The general result of the whole undoubtedly is, that while by far the greater proportion of the species of Old Calabar have the West-African facies, a small but still perceptible proportion has the South-American facies.

The natural inference from these relations is, that at some period the two continents must have been united or contiguous; but this is not a necessary sequence. For example, no one will maintain that the Kentucky caves have ever been united or contiguous to the Carniolan caves; and yet the relationship and resemblance of the eyeless Coleoptera found in these two localities are greater than in any two species which can be contrasted from Old Calabar and South America. I am willing to assume for the present that Europe and North America have been at some period united, and that the affinity between *Anophthalmus Bilimekii* and *A. Tellkampfii* may be explained, on Mr. Darwin's theory, by assuming them to be the product of the same or of allied *Trechi* which have wandered into the caves, and that the like conditions have impressed a like form on their offspring. This latter assumption is of course not Mr. Darwin's; for he repudiates the idea of physical conditions making much, if any, impress upon life. I confess I am still a believer in that exploded heresy. I can see no other way of explaining the existence of these allied blind insects in caves so widely separated; and if it applies to the caves, it may equally apply to any district with well-marked physical conditions. May not, for instance, a North-American *Prionus*, the same as, or closely allied to, a European species, have wandered southwards to the Brazil districts and produced a *Polyoza*, while its European fellow wandered into Old Calabar and produced a *Dorycera*? that is, supposing the physical condition of Brazil and Calabar to be the same, and that they have some resemblance in climate, moisture, &c., as is, I believe, the case. This is indicated, *inter alia*, by the scarcity of epigeal Tenebrionidæ in both. The distribution of that class of insects is curious; Lacordaire thus states it:—"In the old continent, the whole of Africa, the borders of the Mediterranean, and the regions in the neighbourhood of the Caspian Sea constitute three great centres in which they abound. The East Indies and Australia only possess a small number. In South America, the whole of Patagonia, the Argentine Republic, Chili, Bolivia, and Peru are the only regions of this vast continent where they are greatly multiplied. In North America, they begin to appear in the plains to the east of the Rocky Mountains; and their number goes on increasing in proportion as they advance to the west. California and the still imperfectly explored regions of New Mexico seem to be, in that continent, the special country of these insects. But the most important fact to mention is, that, except a few *Opatri*, not one of these American forms enters into the genera peculiar to the old continent, and *vice versâ*. *More than that, North America and South America do not appear, so far as is yet known, to possess a single genus in common.* The non-epigeal Tenebrionidæ are distributed according to other laws. They are found everywhere, but more than anywhere else in the intertropical regions of South America." So far as regards epigeal species, this is in accordance with what might be expected. Being apterous, their distribution must be less extensive and more defined. A barrier, such as a great river or an arm of the sea, which would be impassable to the one, may be easily crossed by the other. These epigeal Tenebrionidæ, moreover, are specially adapted for desert and sandy, arid districts. In a very leafy or muddy country they would be out of place; and such a country would prove as effectual a barrier to their progress as the sea. Their presence in both countries, more especially when South America seems to be separated by a barrier impassable to them from the north, would have afforded a strong presumption that they had once been united; but their absence from both, or either, when the countries are unfitted for their mode of life, will not prove much either way. So far as it goes, however, its tendency would of course be against continuity.

The number of American forms and alliances, although too distinct and decided and too great to allow us to attempt to explain them away by accidental introduction, as by the Longicornes being floated across the Atlantic in wood in which they may have existed in the chrysalis state, &c., is at the same time too small in proportion to the general preponderance of true West-African forms to allow us to suppose that the continuity or proximity, if it ever existed, was extensive or recent. And although there are certainly some of the allied species which I have specially noticed, such as *Galerita* and *Goniotropis*, whose presence it is very difficult to account for upon any other principle than communication by contiguity, it cannot be said that this is beyond question. Some such machinery as I have above referred to, of parallel descent from common more northern ancestors, may, with the help of a lively imagination, ingeniously explain away exceptional cases, and relieve us from the difficulty of accounting for the facts otherwise than by proximity or junction. And one important fact in favour of this is, that we can point to a good many alliances between Old Calabar and the East Indies of the same nature as those between it and South America, and these not alliances with no interruption but the sea, but interrupted on each hand by wide and distinct faunæ.

Still I am bound to say that, after making every allowance, the impression which remains on my mind is in favour of some sort of communication having existed between West Africa and South America, south of, or nearly on the line of, the equator, interrupted not only by a long breach of time, but probably also by wide spaces of discontinuity.

2. The relations of the Coleoptera of Old Calabar to those of the eastern coast of Africa are scarcely less interesting than they are to those of South America. They are not, however, most developed in the same families. In the latter, the Lamellicornes have occupied a very small place; in Eastern Africa they occupy the chief place. The Goliaths especially attract attention. On the eastern coast we have representative or, rather, closely allied species of the principal forms found on the west coast. The true Goliaths are represented by *Goliathus Fornasinii*. Several distinct species of *Eudicella* are found on each coast. *Diplognatha gagates* and *silicea* are scarcely distinguishable. Some rare Heteromera, *Dinoscelis*, a subgenus of or genus allied to *Pezodontus*, are found both in Mozambique and Old Calabar. The Lycidæ are in some instances identical, and in others very closely allied. The related Longicornes are no less numerous; and, in addition to actual instances of affinity, the Old-Calabar species



T. W. Robinson, Delt et Sc. 1862.

often exhibit a certain family resemblance to those of East Africa, which can be appreciated, but is difficult to express. The affinities with the Cape species are rarer than with those of Mozambique. The connexion with Mozambique is a very interesting problem, which must wait unriddling until Central Equatorial Africa be explored. It would be very interesting to know whether the Goliaths stretch across the whole continent, new species replacing new species until we arrive at Mozambique, or whether there is a total gap; or if we must cast about for other explanations of the occurrence of *G. cacicus* on the one side and *G. Fornasinii* on the other.

3. The East-Indian district has a considerable number of alliances with Old Calabar. Not to speak of the *Pheropsophi*, the occurrence of *Macrocheili*, of *Orthogonii*, and a number of other Carabidæ in both countries is of interest. The Heteromera furnish a number of similar cases. The Lamellicornes give a certain number of identical species; but of those merely allied the number is not so great. Some genera of the Longicornes are represented in both countries; but the affinity is seldom so marked as to prevent a tolerably good entomologist allotting the country to which they belong without being told it. The Curculionidæ, as in South America, are nearly unrepresented.

The relations with Europe are very few, and mostly in cosmopolitan genera, as *Dermestes*; and I know of no species identical with a European one.

I have not met with any species showing relation to a purely Australian genus.

On the whole, I would sum up the character of the Coleoptera of Old Calabar as indicating a distinct fauna, mainly impressed with the West-African character; possessing none, or next to none, of the epigeal species either of Africa or any other country, such as *Anthia*, epigeal Tenebrionidæ, &c.; having very little connexion with the South-African fauna, and still less with that of North Africa and Europe, and, taking its proximity into account, a surprising want of the species common at no great distance in point of latitude along the Gold Coast, but separated from Old Calabar by the mighty floods of the Niger; having considerable affinity with the eastern coast of Equatorial Africa, some examples of affinity with the East-Indian district, and a few but distinct and most interesting relations with South America.

EXPLANATION OF PLATE XLVII.

Fig.	Species from America.	Fig.	Species from Old Calabar.
1.	*Galerita unicolor*, Dej. Spec. gén. des Coléopt.—Trinidad.	1 *a*.	*Galerita femoralis*, Murr. Ann. Nat. Hist.
2.	*Lia affinis*, Lap.—Brazil.	2 *a*.	*Lia clavicornis*, Murr. Ann. Nat. Hist.
3.	*Goniotropis castanea*, Dej. Spec. gén. des Coléopt.—New Granada.	3 *a*.	*Goniotropis Wylei*, Murr. Ann. Nat. Hist.
4.	*Stenochia violacea*, Fab. Syst. Eleuth.—Brazil.	4 *a*.	*Stenochia longipennis*, n. sp.
5.	*Actenodes chalibeitarsis*, Chev.—Mexico.	5 *a*.	*Belionota Championi*, n. sp.
6.	*Psiloptera equestris*, Oliv.—Brazil.	6 *a*.	*Lampetis piperata*, n. sp.
7.	*Parandra brunnea*, Fab. Syst. Eleuth.—North America.	7 *a*.	*Parandra beninensis*, n. sp.
8.	*Polyoza Lacordairei*, Serv. Ann. Soc. Ent.	8 *a*.	*Dorycera spinicornis*, Fab. Syst. Eleuth.

XXIX. *Note on* Hamamelis *and* Loropetalum; *with a Description of a New* Anisophyllea *from Malacca. By* Daniel Oliver, *Esq., F.L.S.*

Read February 20th, 1862.

An examination, some months ago, of the genera of Hamamelideæ, in respect to the relations of a plant which I have since described in the Society's 'Transactions'* (*Sycopsis*), incidentally led me to the comparison of the American and Asiatic species included, provisionally, in the genus *Hamamelis* by the late Robert Brown in his Botanical Appendix to Abel's 'China' †. I have since re-examined both species (*H. virginica* and *H. chinensis*), and feel satisfied that they cannot be regarded as truly congeneric, and that they were rightly separated by Walpers, though without amended generic diagnoses, in his 'Annales' (vol. i. p. 275)—the Chinese plant under the name *Loropetalum*, as suggested by Mr. Brown.

They differ primarily in the structure of the anthers, lobation of the calyx, and foliage. The anthers of the Chinese plant have their cells opening each by two vertical valves, and their connective produced into a curved subulate appendage equalling or slightly exceeding the cells. The calyx is quadrilobate, the scar of the limb being near the summit of the fruit, or about $\frac{3}{4}$ths from the base. The leaves are evergreen, entire, with a few curved and anastomosing secondary lateral veins. In *H. virginica*, on the contrary, the small anther-cells open each by a single, strongly recurved valve; they are destitute of the produced connective; the calyx is divided almost to the base; the deciduous leaves have, on each side the midrib, usually 5 to 7 straight, secondary veins, passing directly to the margin. These differences, I believe, constitute valid grounds for the generic separation of the two species, and the name *Loropetalum*, as suggested by R. Brown, may suitably attach to the Chinese plant. The genus *Hamamelis*, however, is not lost to Asia: a plant growing in Japan (*H. japonica*, Sieb. et Zucc.) is, as remarked by Dr. Asa Gray ‡, extremely near to *H. virginica*, and doubtless referable to the same genus with it. In the Japanese plant the fruit becomes nearly superior, the scar of the calyx-limb being about $\frac{1}{5}$th from the base. The foliage closely corresponds with that of the American species.

Adopting the genus *Loropetalum*, the uniovulate genera of Hamamelideæ may be briefly diagnosed thus:—

* *Flores apetali.*

Parrotia, C. A. M. Stamina 5–7 (antheris breviter mucronatis [*P. persica*], v. muticis [*P. Jacquemontiana*]). Ovarium semiinferum. *Folia decidua.* (Caucasus, Persia, Kashmir.)

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* *Suprà*, p. 83. † Page 375.

‡ Bot. Memoirs, from 'Mem. Am. Acad. Arts and Sciences,' n. s. vol. vi. p. 390.

FOTHERGILLA, L. fil. Stamina circiter 24, antheris obtusis (loculis in valvulas 2 a medio solutas dehiscentibus in *F. alnifolia*). *Folia decidua.* (United States.)

DISTYLIUM, Sieb. et Zucc. Calyx liber, fere ad basin partitus. Stamina 2–8 (antherarum dehiscentia vix valvata in *D. racemoso*), connectivo producto. Ovarium superum. *Flores hermaphroditi* v. *abortu unisexuales. Folia persistentia.* (Japan, Khasia?.)

SYCOPSIS, Oliv. Calyx tubo ovarium arcte cingente, lobis quasi superis. (Stamina in *S. Griffithiana* 8, antheris apice breviter productis.) Ovarium semiinferum. *Flores abortu unisexuales. Folia persistentia.* (Khasia.)

** *Flores corolla vel squamulis calycis lobis alternantibus donati.*

† *Petala elongato-linearia, lanceolata v. spathulata.*

CORYLOPSIS, Sieb. et Zucc. Flores pentameri. Antheræ muticæ (loculis in valvulas 2 a medio solutas dehiscentibus in *C. himalayana* *). *Folia decidua. Flores amentacei.* (Japan, E. Himalaya, and Khasia.)

DICORYPHE, Thouars. Flores tetrameri (v. quandoque pentameri). Stamina 4–5 (antherarum loculis in valvulam unicam ab externo solutam dehiscentibus, antheris acutiusculis, in *D. stipulacea*, fide Tulasne †). Calyx tubo cylindrico. (Madagascar.)

HAMAMELIS, L. Flores tetrameri. Calyx profunde lobatus v. partitus. Antheræ muticæ loculis in valvulam unicam ab externo solutam dehiscentibus. *Folia decidua, venulis secundariis rectis parallelis.* (United States, Japan.)

TRICHOCLADUS, Pers. Flores pentameri. Antheræ mucronatæ loculis in valvulam ab externo solutam dehiscentibus. (South Africa.)

LOROPETALUM, R. Br. Flores tetrameri. Antheræ loculis in valvulas 2 a medio solutas dehiscentibus, connectivo producto. *Folia persistentia, venulis reticulatis.* (China, Khasia.)

†† *Petola squamæformia, calycis lobis alternantia.*

TETRATHYRIUM, Benth. Antheræ loculis in valvulas 2 a medio solutas dehiscentibus, connectivo producto. Stigma subulatum. (Hong Kong.)

EUSTIGMA, Gard. et Champ. Antheræ obtusæ loculis in valvulas 2 vix æquales a medio solutas dehiscentibus. Stigma latum, papilloso-lobatum. (Hong Kong.)

I have not seen a specimen of any *Dicoryphe*. Tulasne, in "Fragmenta Floræ Madagascariensis" ‡, describes several species, one (*D. stipulacea*, J. St.-Hilaire) very fully.

The mode of dehiscence of the anthers has been employed by authors as a sectional character in grouping the genera, but it does not appear sufficiently constant in closely allied forms to be thus prominently applied. I have examined the anthers of a number of species contained in Sir W. J. Hooker's herbarium, and have noted the character which the genera present in this respect in the above conspectus. The transverse separation of the two vertically opening valves above and below from the upper and lower margins of their cell is sometimes inconspicuous, or the valves may separate distinctly below, and scarcely at all above. In *Parrotia Jacquemontiana*, for example, the anthers

* Siebold and Zuccarini describe two other species, *C. pauciflora* and *C. spicata*. The anthers in the latter are said to open "loculis longitudinaliter univalvibus."

† Ann. Soc. Nat. ser. iv. t. viii. p. 143.

‡ Ann. Soc. Nat. *l. c.*

are small, unappendaged, and each loculament opens by a pair of valves parting like folding-doors from the median line. In *P. persica* they are much elongated, shortly mucronate, and dehisce longitudinally without separation at top and bottom. In other respects the plants appear very near each other.

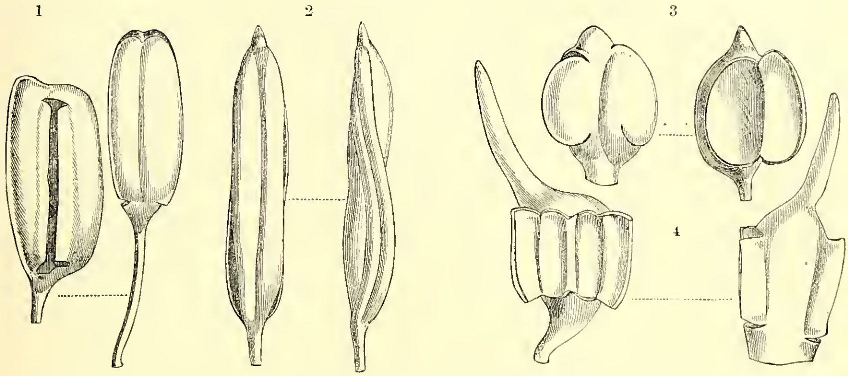


Fig. 1. represents the anthers of *Parrotia Jacquemontiana*, and Fig. 2. those of *P. persica*.
Fig. 3. represents the anthers of *Hamamelis virginica*, and Fig. 4. those of *Loropetalum chinense*.

The genera *Hamamelis* and *Loropetalum* may be briefly described as follows :—

HAMAMELIS, L. *Calyx* profunde 4-lobatus v. partitus, infra ad ovarii basin adnatus. *Petala* 4, linearia. *Stamina* 4, squamulis 4 alternantia ; filamentis brevibus ; antheris muticis, loculis valvatim dehiscentibus, valvula ab externo latere soluta persistente. *Ovarium* biloculare, ovulis solitariis. *Capsula* semisupera v. fere supera, lignosa, apice bivalvis, loculicide dehiscens ; endocarpio soluto.

Arbusculæ in America boreali et Japonia, foliis deciduis subcrenatis v. inæqualiter dentatis, venulis secundariis 5–7 *rectis ad marginem parallelis.*

LOROPETALUM, R. Br. (App. Abel's China, p. 375). *Calyx* quadrifidus, tubo ad ovarium adnato. *Petala* 4, linearia. *Stamina* 4, squamulis 4 parvis alternantia, epigyna ; filamentis brevissimis ; antherarum connectivo in acumen subulatum producto, loculis in valvulas 2 ab medio utrinque solutas verticaliter dehiscentibus. *Ovarium* biloculare, ovulis solitariis. *Capsula* semisupera, lignosa, loculicide dehiscens ; endocarpio corneo, soluto.

Frutex in China et montibus Khasiæ indigena, foliis persistentibus, integerrimis, subtus venulis anastomosantibus reticulatis.

The *Anisophyllea* which I describe was collected by the late W. Griffith at Malacca. In his collections, now in course of distribution at Kew, there is a considerable number of specimens of it, apparently all of one gathering, and none in fruit. A note by Griffith accompanies the specimens, with a brief description, locality and date of collection (1842).

Anisophyllea Griffithii, sp. nova. Foliis alternis petiolatis lanceolatis v. ovali-lanceolatis, sæpe leviter acuminatis, apice acutis, coriaceis, siccitate flavescentibus, unicostatis, subtus nervis 2 a basi utrinque margini arcte parallelis, venulis vix prominentibus reticulatis; floribus in spicis solitariis v. binis axillaribus, singulis arcte sessilibus remotiusculis; calyce limbo 4-lobato, lobis coriaceis triangularibus æstivatione valvatis; petalis calycis lobis alternantibus, iisdem brevioribus, coriaceis, late quadrato-oblongis integris v. vix 3-lobulatis, stamina opposita arcte foventibus et cum iisdem plus minus adnatis; staminibus 8 epigynis, 4 sepalis 4 petalis (longitudine æqualibus) oppositis, filamentis crassiusculis, antheris parvis late rotundatis vel didymis, longitudinaliter dehiscentibus; ovario infero 4-loculari, ovulis solitariis pendulis, stylis 4 liberis subulatis.—*Arbor verisimiliter. Folia* 3–4 *unc. longa,* 1–$1\frac{1}{2}$ *lata, petiolo* $1\frac{1}{2}$–2 *lin. Spicæ* $1\frac{1}{2}$–$2\frac{1}{2}$ *unc.*; *flores circa* 1 *lin. diametro.* Ager Punnus, Malacca, W. Griffith. (Pl. XLVIII.)

I consider this plant clearly congeneric with *Anisophyllea zeylanica*, Benth.*, and with *A. laurina*, Br., of West Africa, the original *Anisophyllea*, of which I have recently had the opportunity of dissecting flowers from specimens forwarded by Mr. Mann from the Gaboon River. The latter I find to have a 4-locular ovary, with a pendulous ovule in each cell and four free styles, as stated by Mr. Bentham in the Addenda to 'Flora Nigritana.' *A. Griffithii* differs from both the above in the absence of the strongly marked lateral costæ of the leaves and the form of the petals, which in *A. laurina* and *A. zeylanica* are laciniate or fimbriate.

Of the remarkable plant described by Jack, in the 'Malayan Miscellanies'†, under the name of *Haloragis disticha*, I have not had the opportunity of dissecting flowers; but from his description, and from the appearance of flowerless specimens, it is very probably a species of *Anisophyllea*, with which genus it is associated in Sir W. J. Hooker's Herbarium.

I cannot but consider that this genus was more correctly disposed of by Mr. Bentham under the order Rhizophoraceæ than it has been since by Drs. Hooker and Thomson in Hamamelideæ‡, or by Mr. Thwaites in Barringtonieæ §.

It has no very close affinity with any described genus that I am aware of; but, excepting in its alternate leaves, it presents much in common with some Rhizophoreous plants, though considerably removed from the true Mangroves. The divided or lobed petals (as in *A. zeylanica*), closely involute around their opposed stamens (as in *A. Griffithii*), point strongly to this relationship, which is not weakened by its inferior 4-celled ovary and tetramerous symmetry, with valvate æstivation of the calyx. Some of these characters, especially the latter-named, remove it from known genera of Hamamelideæ. I have not

* Niger Flora, p. 343. † Reprint in Calc. Journ. iv. p. 336. ‡ Linn. Proc. ii. p. 85. § En. Pl. Zeyl. p. 119.

Anisophyllea Griffithii. D Oliv

W.H.Fitch del. G Jarman sc.

seen fruit or seed; so that I cannot speak to the fact noted by Mr. Thwaites respecting the embryo and its germination, which latter that excellent botanist finds, in *A. zeylanica*, to resemble that of *Careya* and *Barringtonia*. Admitting this to apply to the genus, however, I am far from considering it a sufficient ground for associating *Anisophyllea* with *Barringtonieæ*, from which group it is in other respects abundantly diverse. But the structure and germination of the embryo, as described by Mr. Thwaites, I think not very dissimilar to that of the Mangrove, apart from the singular though comparatively unimportant circumstance of the germination of the embryo while yet suspended in the pericarp from the parent tree.

EXPLANATION OF PLATE XLVIII.

Anisophyllea Griffithii, Oliv.

Fig. 1. Flower.
Fig. 2. The same, with lobes of the calyx removed.
Fig. 3. The same, vertical section.
Fig. 4. Petal and its opposed stamen.
Fig. 5. Petal.
Fig. 6. Stamen.
Fig. 7. Cross section of the ovary.

XXX. *On African* Anonaceæ. *By* George Bentham, *Esq., Pres. L.S.*

Read April 17th, 1862.

Anonaceæ, although evidently numerous in tropical Africa, are amongst the least-known of the plants of that continent. In the 'Niger Flora,' published in 1849, Dr. Hooker indicated twenty species as then more or less known; but that number included three cultivated Anonas, and two or three supposed species since ascertained to be mere synonyms; and very few have since been published. They are generally trees or woody climbers, bearing but few flowers, little attractive to the eye, and having considerable external resemblance to each other. The specimens gathered by collectors are therefore generally few and imperfect, often with only a single flower which cannot be examined without destroying the specimen, and yet the changes in form which the parts of the flower undergo in the course of their development would often require their examination in bud and in the full-grown flower, as well as in fruit, before their generic and specific affinities can be ascertained with precision. At the time of preparing the Order for our 'Genera Plantarum,' our African materials were still very deficient; many valuable additions were, however, received from the late Mr. Barter in time for the revision of our manuscript before going to press: but those more recently transmitted by Mr. Mann from the West Coast, and by Dr. Kirk from the Zambesi, could only be alluded to whilst correcting the last revise; and some have only come to hand since the sheet was printed off. Having now examined them all, it has appeared to me that some were of sufficient interest for figuring in the 'Transactions' of the Society, and I have accordingly accompanied the plates I have had prepared by a synopsis of all the African species contained in the Kew herbaria in so far as the specimens permitted; and I have also enumerated the few published species which I have been unable to identify, as well as such new ones as, from the imperfection of the specimens, must remain as yet of doubtful affinity.

Anonaceæ, with few exceptions, have a very limited geographical range. Their usually arboreous habit, slow growth, tardy maturity, and comparatively few flowers with indehiscent fruits, little attractive to birds and not endowed with any peculiar means of dispersion, give to most of the species but few chances in the general struggle for existence. Of the nearly forty African species now more or less known, all are confined to that continent, with the exception of the American *Anona palustris*, which appears to be really native in the swamps of the western tropical coasts; and none are as yet known to extend across from the West to the East, excepting *Anona senegalensis*, which is, again, a very American form and very closely allied to several American species. In Africa, however, it is described as covering immense tracts of country in the greatest abundance, as well by Leprieur in Senegambia, as by E. Vogel in Bornou and by Kirk on the Zambesi.

Of eleven African genera, three, *Hexalobus*, *Monodora*, and *Clathrospermum*, all very distinct, are confined to Africa, or at furthest extend to Madagascar. Six are common to Asia and Africa: of these, two, *Popowia* and *Oxymitra*, are small genera, of which the African species have a somewhat different character from the Asiatic ones; and the other four, *Uvaria*, *Artabotrys*, *Unona*, and *Melodorum*, are more considerable Asiatic genera, represented in Africa by one, two, or three species. One genus, *Anona*, is a large American one, unknown in Asia, but represented by three species in Africa and two in Madagascar; and, lastly, *Xylopia* is also chiefly American, but with two or three Asiatic as well as African species. *Anaxagorea*, a very distinct genus common to America and Asia, has not yet been found in Africa; nor do we as yet know, from the latter continent, of any Anonaceæ allied to *Phæanthus* or *Heteropetalum*, two small groups, the one Asiatic, the other American, so similar in character that they might well be united in one genus.

Several African Anonaceæ have edible fruits (this quality is particularly attributed by collectors to the Anonas, to *Popowia Kirkii*, and to most of the Uvarias); and many are aromatic, which is especially noted of the *Xylopia æthiopica* or Malaghatta pepper and *Monodora myristica* or Calabash nutmeg; and the woods of the arboreous ones are said to be hard and good. The climbing species, which bear in Asia so large a proportion to the whole, are but very few in Africa.

1. Uvaria, Linn.; Benth. et Hook. f. Gen. Pl. 23.

This genus, after having been variously extended and reduced by different botanists, has been limited by Hooker and Thomson to those species in which the petals of each series, and more especially the inner ones, are imbricate in the bud as in the true American Guatterias, which the majority of Asiatic species much resemble in habit and in the shape of the flowers, differing only in their pluriovulate carpels. Three of the African species are quite conformable to the ordinary Asiatic type; but in *U. connivens* and *U. fusca* the petals are much thicker and less spreading, and the outer ones valvate, thus approaching *Melodorum*, to which genus I should have been inclined to refer it, were it not that the inner petals are nearly as large as the outer ones, one of them very much overlapping the two others in the bud, and all are much more open than in any *Melodora* I know.

1. U. Chamæ, P. de Beauv. Fl. Ow. et Ben. ii. 42, t. 83; ramulis junioribus foliisque ferrugineo-tomentosis glabratisve, foliis ovalibus ellipticisve obtusis subacuminatisve breviter petiolatis subtus pilis stellatis minutis conspersis, pedunculis 2–5-nis extra-axillaribus brevibus, sepalis basi v. ad medium coalitis ferrugineo-tomentosis, petalis obovatis patentibus, antherarum connectivo apice truncato, baccis stipitatis oblongis ferrugineo-tomentosis.—Arbor parva. Folia majora 5 poll. longa, $2\frac{1}{2}$ poll. lata, nonnulla tamen multo minora. Baccæ 6 ad 18, $\frac{1}{2}$–1 poll. longæ, stipitibus 3–4-linearibus. Semina 2–6, septis horizontalibus separata, oblique oblonga, compressa, testa nitida, hilo incrassato umbilicato.

Unona Chamæ, Guill. et Perr. Fl. Seneg. 7, t. 3. f. 2. *U. macrocarpa*, DC. Syst. Veg. i. 489.

Senegambia (*Leprieur*, *Heudelot*); on the Santiago in Oware (*P. de Beauvois*); at Nupe on the Niger (*Barter*).

These are fruiting specimens with the leaves at first sight glabrous, but the minute stellate hairs scattered on the under surface can generally be detected with a lens.

2. U. GLOBOSA, Hook. f. Fl. Nig. 210; ramis gracilibus novellis ferrugineo-tomentosis, foliis (parvis) oblongo-ellipticis sublanceolatisve obtusis supra nitidis subtus pilosulis, floribus subsessilibus solitariis geminisve ferrugineo-sericeis, petalis patentibus valde imbricatis, antheris apice truncatis, baccis subglobosis brevissime stipitatis ferrugineo-velutinis.—Frutex ?, *U. micranthæ* Hook. f. et Thoms. affinis. Folia 2–3-pollicaria, nervis præter costam parum conspicuis. Bracteæ orbiculatæ, concavæ, deciduæ. Flores parvi. Sepala lata, basi breviter connata, dense ferrugineo-sericea. Petala majora patentia extus tomentosa subsericea, in alabastro cujusve seriei valde imbricata, in speciminibus nostris vix perfecte evoluta. Stamina numerosa connectivo apice truncato-dilatato. Baccæ 3–4 lin. diametro, 4–7-spermæ.

At Accra, in west tropical Africa (*Vogel*).

3. U. LUCIDA, Benth.; foliis ovali-oblongis acuminatis, basi late rotundatis, utrinque ramulisque glaberrimis nitidis, pedunculis terminalibus subternis brevibus floribusque tomento tenui rufo-canescentibus, petalis liberis obovato-orbiculatis obtusissimis.—Species *U. luridæ* Hook. f. et Thoms. et *U. Narum*, Wall. affinis. Folia pleraque 3 poll. longa, $1\frac{1}{2}$ poll. lata, petiolo 2-lineari, tenuiter coriacea, costa subtus prominente, nervis tenuibus. Pedicelli in specimine 3, intermedius flore evoluto 4 lin. longus. Bracteæ obovatæ, 2 lin. longæ. Sepala orbiculata, vix 3 lin., petala fere 5 lin. longa et lata, omnia extus cano-tomentosa. Torus planus. Stamina numerosa, connectivo ultra loculos obovato truncato. Gynæcii carpella numerosa, linearia, arcte conferta, glabra. Styli crassi, angulati, truncati. Ovula 6–8.

Guatteria lucida, Boj. Hort. Maurit. 6.

Island of Mombase, off the east coast of Africa (*Bojer*), according to the label of a specimen from a generally well-named collection of Bojer's plants formerly in the herbarium of the late Dr. Graham. The same label is affixed in the Hookerian herbarium, but in a less authentic manner, to a specimen of *Polyalthia* (*Guatteria*) *Korinti*. Both are probably from the Mauritius Botanic Garden, where Bojer states his *G. lucida* to have been raised from seeds brought from Mombase.

4. U. CONNIVENS, sp. n.; foliis amplis elongato-oblongis acuminatis infra medium angustatis glabris, petiolo brevissimo, pedunculis axillaribus brevibus 1-floris bracteatis floribusque minute tomentellis, petalis conniventibus crassis latis concavis exterioribus subvalvatis, interiorum uno exteriore, toro convexo, antheris apice capitatis, carpellis glabris, stigmatibus oblongis.—Arbor 30-pedalis. Folia fere pedalia, supra medium 3 poll. lata, infra medium longe angustata, ima basi obtusa, petiolo crasso 3–4 lin. longo, rigide membranacea v. vix coriacea, nervis primariis arcuatis distantibus costaque subtus prominentibus. Pedunculi $\frac{1}{2}$–$\frac{3}{4}$-pollicares, basi bibracteati et supra medium unibracteati. Sepala 4 lin. longa, orbiculata, concava, cito decidua. Petala purpurea, exteriora fere pollicem longa et lata, crassa concava acutiuscula, parum aperta, marginibus leviter imbricatis v. fere valvatis, interiora paullo minora, uno obtusissimo, cetera acutiora margine latiusculo obtegente.

Torus crassus, fere hemisphæricus, sub carpellis tamen planus v. leviter excavatus. Stamina numerosissima angusta, connectivo apice capitulo parvo appendiculato. Carpella numerosa, glabra, ovulis 12–15 biseriatis, stylis oblongo-clavatis ovario ipso paullo brevioribus. Fructus non visus.

Ambas Bay and Fernando Po (*G. Mann*).

Some large, ovoid, thick glabrous carpels, full 4 inches long, containing each three or four seeds, separately gathered by Mr. Mann, may possibly belong to this species.

5. U.? FUSCA, sp. n.; foliis amplis elongato-oblongis acuminatis infra medium angustatis glabris, petiolo brevissimo, floribus subsessilibus bracteis imbricatis sepalisque ferrugineo-sericeis, petalis latis concavis leviter imbricatis subvalvatisque, antheris apice truncatis, carpellis villosis.—Arbor 25-pedalis. Folia iis *U. conniventis* simillima, fere pedalia. Flores gemini, subglobosi, pollicem diametro. Bracteæ plures, arcte imbricatæ, interiores sepalis paullo minores, exteriores parvæ. Sepala lata, basi breviter connata. Petala iis *U. conniventis* subsimilia sed minus crassa et vix imbricata. Stamina ultra 2000, arctissime conferta. Carpella fere 100, villosa, 3–4-ovulata, stigmate crasso brevi truncato, post anthesin jam paullo aucta sessilia, falcato-oblonga.

Fernando Po (*G. Mann*).

The flowers of our specimen are scarcely sufficient to determine the affinities with precision; but I believe it to be a *Uvaria*, near the last. Mr. Mann describes the flowers as brown.

Doubtful Species.

U. ovata, DC.

U. ovata, Schum. et Thonn. Beskr. Pl. Guin. 255.

U. cylindrica, Schum. et Thonn. *l. c.* 256.

I am unable to identify either of the above three species amongst our specimens. *U. cylindrica*, with narrow lanceolate petals, may perhaps be a *Unona*.

U.? gracilis, Hook. f. Fl. Nig. 210. We have no specimen; but from the description it is possibly a *Clathrospermum*.

U.? sp. with rather large sessile flowers, more imbricate, and without the bracts of *U. fusca*, and shorter leaves, nearer those of *U. Chamæ*. Fernando Po (*G. Mann*). A single specimen with one imperfect flower.

U.? sp., named *Kookaree* in Sierra Leone. Fruits and one leaf only in the Kew Museum. Not unlike *U. Chamæ*; but the carpels are more villous, shorter and thicker, on longer stalks.

2. ARTABOTRYS, R. Br.; Benth. et Hook. f. Gen. Pl. 24.

This is chiefly an Asiatic genus, represented in Africa by two species, having both of them the climbing habit and remarkable hooked peduncles of the Asiatic ones; and one of them, the W. African *A. macrophylla*, has the same petals, thick, concave, and closely connivent at the base, with more or less spreading oblong or narrow laminæ;

but the other, the eastern *A. brachypetala*, is somewhat anomalous in the petals being almost reduced to the concave lower portion, thus bringing the plant technically near *Melodorum* or *Popowia*. The habit, however, and other characters do not admit of its removal from *Artabotrys*, and the petals do occasionally appear to be produced into a short acumen at the top.

1. A. MACROPHYLLA, Hook. f. Fl. Nig. 207; glabra, foliis (amplis) late ovatis ellipticisve utrinque rotundatis et apice abrupte acuminatis tenuiter coriaceis supra nitidis, pedunculis multifloris, pedicellis brevissimis crassis, sepalis latis acuminatis, petalorum lamina oblongo-lanceolata calyce duplo longiore.—Folia 8–10-pollicaria, petiolo brevissimo.

Fernando Po (*Vogel*).

2. A. BRACHYPETALA, sp. n.; foliis (parvis) ovali-ellipticis oblongisve obtusis novellis puberulis adultis glabratis, pedunculis bi–pluri-floris, petalis inter se æqualibus vix ultra partem concavam acuminatis, baccis obovoideis obtusissimis glaucis.—Frutex scandens ramulis tenuibus foliisque novellis ferrugineo-puberulis. Folia $1\frac{1}{2}$–$2\frac{1}{2}$ poll. longa, $\frac{3}{4}$–$1\frac{1}{2}$ poll. lata, apice rotundata, basi obtusa v. rarius acutiuscula, petiolo raro lineam superante, membranacea v. chartacea. Pedunculi communes more generis breves, bifurcati, demum hamato-recurvi; pedicelli 6–9 lin. longi, tomentosi. Sepala ovata, demum 3–4 lin. longa, extus tomentosa. Petala paullo breviora, lata, crassiuscula, concava, circa genitalia conniventia, glabra, apice obtusiuscula v. in acumen brevissimum producta. Torus convexus, hispidus. Stamina generis, antherarum connectivo ultra loculos truncato-dilatato. Gynæcii carpella plurima, glaberrima, 2-ovulata; styli lineares, superne patentes, decidui. Baccæ $\frac{1}{2}$–$\frac{3}{4}$-pollicares, stipite 2–3-lineari fultæ, nunc late obovoideæ, 2-spermæ, utrinque sulco longitudinali notatæ, nunc angustiores, 1-spermæ. Semina erecta.

At Tété on the Zambesi (*Kirk*). The fruit is said to be pleasant eating.

Doubtful Species.

A. sp.? A small tree, apparently without hooks. Inflorescence in other respects and shape of the flowers as in some species of *Artabotrys*; but in our specimens they are all males.

From the Gaboon River (*G. Mann*).

3. HEXALOBUS, A. DC.; Benth. et Hook. f. Gen. Pl. 24.

This small genus has two African and one Madagascar species, the third African species mentioned in our 'Genera' proving to be a variety only of *H. senegalensis*. The African ones are both remarkable for the transverse undulations and folds of the petals (or lobes of the corolla), especially when the bud is near opening, which is not alluded to in the description of the Mascarene plant, and which was therefore omitted in the generic characters, drawn up before our *H. grandiflorus* was received; but as it occurs in both these species, it is probably characteristic of the genus. These petals have been described by several authors as imbricate, with one outside; but in the only young bud I have been able to examine with care they were certainly valvate in each series, this arrangement being somewhat disguised, when the bud is ready to open, by the increased folds of the petals.

1. H. SENEGALENSIS, A. DC. Mem. Anon. 37; foliis ovali-ellipticis oblongisve supra glabris subtus puberulis, floribus sessilibus, petalis lineari-lanceolatis acutiusculis undulatis extus incano-puberulis.

Uvaria monopetala, Guill. et Perr. Fl. Seneg. 8, t. 2.

Senegambia (*Leprieur* and *Perrottet*; *Heudelot*, n. 360). On the Gambia (*Whitfield*). At Nupe on the Niger (*Barter*).

I had at first considered Barter's specimens as belonging to a different species from the Senegambian ones, with longer, narrower and less obtuse leaves and narrower petals; but a further comparison of all our specimens convinces me that they all belong to one species. The leaves are, in Perrottet's specimen, not 2 in. long and $\frac{3}{4}$ in. broad; in Heudelot's, 4 in. long and $1\frac{1}{2}$ in. broad; in Barter's, 4 to 5 in. long and only $\frac{3}{4}$ to $1\frac{1}{4}$ in. broad; but these agree the best in general form with the figure in the 'Flora Senegambiæ'; and the petals alter very much in shape as they grow out.

2. H. GRANDIFLORUS, sp. n.; foliis petiolatis elliptico-oblongis acuminatis glabris, floribus pedicellatis, pedicellis sepalisque ferrugineo-sericeis, petalis longe lanceolatis.—Arbor 60-pedalis, inflorescentia excepta glaber. Folia 4–8 poll. longa, circiter 2 poll. lata, acumine longo, basi obtusiuscula petiolo 3–4-lineari fulta, chartacea v. tenuiter coriacea, glaberrima, costa subtus prominula, nervis primariis utrinque circiter 15. Pedunculi axillares, solitarii v. gemini, semipollicares, 1–2-flori, dense ferrugineo-sericei. Bractea ad basin pedicelli 3 lin. longa, angusta, basi convoluta, caducissima. Bracteolæ in pedicello 2 oppositæ, basi connatæ, ferrugineo-sericeæ. Sepala ovata, concava, crassiuscula, 4–5 lin. longa. Petala perfecte evoluta ultra $1\frac{1}{2}$ poll. longa, alba, transverse undulata, extus pube minute canescentia, basi in tubum densius pubescentem 2 lin. longum connata. Antheræ numerosæ, connectivo more generis ultra loculos truncato-dilatato. Carpella 10–12, villosa, 2-seriatim pluriovulata; styli breves, reflexi, profunde bilobi, lobis dilatatis apice subtus stigmatosis. Baccæ 3–4, fere lignosæ, dense ferrugineo-tomentosæ, sessiles, 3 poll. longæ, $1\frac{1}{2}$ poll. crassæ. Semina transversa, in quoque loculo ultra 12, singula ultra pollicem longa, septis spuriis transversis (pulpa exsiccata?) separata.

Ambas Bay, West Africa (*G. Mann*). On the Niger River (*Barter*).

The flowers are described from Mann's specimens; the fruit from a single specimen of Barter's without flower, but which, from a comparison of the bark, foliage, and inflorescence, evidently belongs to the same species.

PLATE XLIX. Fig. 1. Corolla. Fig. 2. Stamens and gynæcium. Fig. 3. Torus bearing the gynæcium, with the bracts; the sepals, corolla, and stamens removed. Fig. 4. Stamen, back view. Fig. 5. Carpel of the gynæcium, vertical section. Fig. 6. The same, transverse section. Fig. 7. Fruiting torus, with one carpel attached. Fig. 8. Ripe carpel, vertical section.

4. UNONA, Linn. f.; Benth. et Hook. f. Gen. Pl. 24.

The genuine species of this genus hitherto described are all Asiatic or Australian: the two following African ones have been seen in flower only, but in that respect they agree well with some of the Asiatic ones in all essential points. The North American Asiminas might also be well considered as a section of *Unona*, but more nearly allied to several of the Asiatic than to the African species.

1. U. HIRSUTA, sp. n.; foliis breviter petiolatis ovali-oblongis obovatisve obtusis basi cordatis subtus ramulisque ferrugineo-hirsutis, pedunculis supra medium anguste bracteatis, sepalis lato-lanceolatis, petalis tomentosis exterioribus ovato-lanceolatis 9–11-costatis interioribus minoribus.—Frutex 20-pedalis. Folia 4–6 poll. longa, 2–3½ poll. lata, petiolo 2–3-lineari hispido fulta, supra glabra, subtus elevato-penninervia et transverse reticulato-venosa, pilis ferrugineis præsertim ad costas hispida. Pedunculi laterales v. subterminales, irregulariter fasciculati, floridi subpollicares, rigidi, 1-flori, bractea lanceolata amplectente tomentosa 4–5-lineari. Sepala in floribus suppetentibus 5 lin. longa, vix basi connata, patentia. Petala exteriora 9–10 lin. longa, prope basin fere 6 lin. lata; interiora multo minora, sed verisimiliter nondum perfecte evoluta. Torus fere planus. Stamina numerosissima, connectivo ultra loculos crasso planiusculo. Gynæcii carpella plurima, hispida, pauciovulata; styli elongati, recurvi, intus sulcati. Fructus ignotus.

Fernando Po (*G. Mann*).

2. U. OBOVATA, sp. n.; foliis obovatis v. obovato-oblongis membranaceis utrinque ramulisque molliter pubescentibus, pedunculis unifloris prope basin bractea orbiculato-cordata stipatis, petalis latis demum obtusissimis tomentosis.—Frutex ramulis gracilibus, novellis pilis crispulis tomentosis, annotinis glabratis. Folia obtusa, majora 3–3½ poll. longa, supra medium fere 2 poll. lata, infra medium angustiora, basi obtusissima v. cordata, membranacea, in sicco utrinque pallide virentia, penninervia, petiolo 2–3-lineari. Pedunculi laterales v. terminales, solitarii, 1-flori, graciles, per anthesin subpollicares. Bractea basin pedunculi amplectens, tomentella, 5–6 lin. diametro. Sepala lata, obtusissima, 2 lin. lata, tomentella, basi brevissime connata. Petala tomentosa, in alabastro acutiuscula et biseriatim valvata, in flore magis evoluto patentia, exteriora 5–6 lin. longa, fere orbiculata, obtusissima, extus subsericeo-pubescentia, tenuissime pluricostata, interiora multo minora. Torus fere planus, hirsutus. Stamina numerosa, connectivo ultra loculos crasso, truncato. Gynæcii carpella plurima, villosa, ovulis 6–8 subbiseriatis; styli breves, recurvi, glabri. Fructus ignotus.

Hot-springs at the foot of Moramballa on the Zambesi (*Kirk*).

Amongst Asiatic *Unonæ* this comes nearest to *U. dumosa* in the orbicular bracts and obtuse petals; but the much smaller flowers give it a very different aspect. The fruit is unknown; and the ovules, more evidently arranged in two rows than in most species, indicate that the berries are most probably not moniliform but continuous as in *U. pannosa*, Dalz., and as in the closely allied genus *Asimina*.

Polyalthia, Blume; Benth. et Hook. f. Gen. Pl. 25.

An Asiatic genus, in which we include the Asiatic Guatterias as limited in Hooker and Thomson's 'Flora Indica,' and probably, as far as hitherto known, unrepresented in Africa. I only mention it here because in the Hookerian herbarium there is a specimen of *P.* (*Guatteria*) *Korinti*, with the label "*Guatteria lucida*, Boj. ex ins. Mombase oris Africæ orientalis, Bojer." There has been, however, probably some misplacement of labels—perhaps in the Mauritius Garden; for the Kew herbarium has another specimen, derived from the late Dr. Graham's collection, also as from Bojer, with a similar label, which is the *Uvaria lucida* described above.

5. Popowia, Endl.; Benth. et Hook. f. Gen. Pl. 25.

A small genus, not yet sufficiently well known to be accurately characterized, containing two African, two Asiatic, and one Australian species; differing from *Polyalthia* in the more connivent petals, from *Melodorum* in the small flowers rather more open, and in the carpels with one or two ovules erect from the base of the cavity, not ventral, and from *Clathrospermum* in the more numerous stamens with the cells lateral, below the summit of the connectivum, not bordering the top of the connectivum. In the *P. caffra*, however, the anthers are not so closely packed, nor the cells so much concealed by the flattened top, as in the Asiatic and Australian species.

1. P. caffra, Hook. f. et Thoms.; foliis breviter petiolatis oblongis obtusis acuminatis acutisve basi obtusis membranaceis subtus pilosulis, costis petiolis ramulisque ferrugineo-pubescentibus, pedunculis lateralibus bifidis plurifloris, baccis stipitatis globosis subovoideisve glabris.—Rami graciles. Folia 2–4-pollicaria. Flores parvi, depresso-subglobosi, tomentelli. Sepala lata, alte connata. Petala exteriora calyce duplo longiora, lata, crassiuscula, concava, valvata, in floribus suppetentibus arcte conniventia, sed forte demum subpatentia; interiora similia, paullo minora. Stamina vix ultra 20, brevia, connectivo crasso apice parum dilatato loculos oblongos laterales verticales vix occultante. Torus convexus, puberulus. Gynæcii carpella glabra, 1-ovulata, stylo breviter oblongo.

Guatteria caffra, Sond. in Harv. et Sond. Fl. Cap. i. 9.
Woods at Omsamwubo and Port Natal (*Drège*, *Guienzius*).

2. P.? Kirkii, sp. n.; glabra, foliis breviter petiolatis anguste v. obovato-oblongis utrinque obtusis membranaceis, pedunculis lateralibus brevibus paucifloris, baccis stipitatis oblongis glabris.—Habitu *P. caffræ* similis sed ex omni parte glaberrima. Ramuli tenues. Folia superiora cujusve ramuli 2–2½ poll. longa, ½–¾ poll. lata, inferiora breviora et sæpius latiora, omnia penninervia, nervis tenuibus arcuatim anastomosantibus, petiolo 1–2-lineari. Flores nobis desunt. Pedicelli fructiferi ad ramulos breves foliatos brevissimi, uniflori, v. in pedunculo communi seu ramulo brevi aphyllo plures. Baccæ 2–6, stipite 2–3 lin. longo fultæ, ½–¾ poll. longæ, obtusissimæ v. vix mucronulatæ, monospermæ.

On the Zambesi at the foot of Moramballa and opposite Senna (*Kirk*, who reports the fruit to be pleasant eating)

The flowers being unknown, the position of this species in *Popowia* or *Clathrospermum* is somewhat doubtful; but the habit is entirely that of *P. caffra*.

6. Oxymitra, Blume; Benth. et Hook. f. Gen. Pl. 26.

An Asiatic genus of seven species, of which the characters had to be slightly enlarged to comprehend the three or four African ones described below. It differs from *Goniothalamus* chiefly in the inner petals sessile not contracted into a claw, and from almost all the remaining *Mitrephoreæ* either in the 1- or 2-ovulate carpels, or in the outer open or spreading petals being much longer instead of shorter than the inner connivent ones. *Richella* has, however, the flowers of some of the African Oxymitras; and we should have united it with that genus, but that the seeds are said to be 3-winged, a character otherwise unknown in Anonaceæ. *Marenteria*, Nor., from the incomplete character given by Dupetit-Thouars, Nov. Gen. Madag. p. 18, has been usually referred to *Uvaria* or *Unona*; but as he expressly says that the outer petals are spreading and the inner ones erect, it is very probably an *Oxymitra*; and if this should prove correct, Thouars's name should in strictness be preferred.

1. O. hamata, sp. n.; foliis oblongo-ellipticis acuminatis supra glabris subtus puberulis, costis petiolis ramulisque ferrugineo-tomentosis, pedicellis solitariis superne incrassatis, sepalis minimis, petalis exterioribus longe lineari-lanceolatis apice recurvis.—Arbor parva, ramulis gracilibus novellis pube densa ferruginea vestitis. Folia pleraque circiter 4 poll. longa, 1½ poll. lata, supra lævia, subtus penninervia, nervis arcuatis parallelis prominulis costaque ferrugineo-tomentosis, inter nervos pube tenui conspersa. Pedicelli laterales, 1–1½-pollicares. Sepala vix linea longiora, reflexa. Petala crassiuscula exteriora basi breviter concava, dein planiuscula, primum breviter linearia apice valde revoluta, et utrinque tomentosa, demum fere recta v. apice tantum recurva, usque ad 2½ poll. longa, 2–2½ lin. lata, supra glabrata; interiora crassa, lata, vix ½ poll. longa, circa genitalia arcte conniventia. Torus convexus. Stamina numerosa, connectivo supra loculos incrassato. Gynæcii carpella numerosa, villosa, uniovulata, funiculo brevi; styli lineari-clavati glabri. Fructus ignotus.

On the River Bagroo, West Africa (*G. Mann*).

Plate L. Fig. 1. Flower with the outer petals cut short. Fig. 2. One of the inner petals. Fig. 3. Flower with all the petals removed. Fig. 4. The same with the anthers removed. Fig. 5. Anther, back view. Fig. 6. The same, inner view. Fig. 7. The same, side view. Fig. 8. Carpel and style. Fig. 9. Carpel, vertical section. Fig. 10. Carpel, transverse section. Fig. 11. Ovule.

2. O. gracilipes, sp. n.; glaberrima, foliis ellipticis obtuse acuminatis nitidulis, pedicellis solitariis gracilibus, petalis exterioribus ovato-lanceolatis acutiusculis patentibus.—Folia pleraque 3 poll. longa, 1½ poll. lata, pallide virentia, tenuiter venosa, petiolo 2-lineari. Pedicelli ultrapollicares, glaberrimi. Sepala brevia, lata, recurva. Petala exteriora in specimine suppetente semipollicaria, sed forte nondum perfecte evoluta, interiora dimidio minora, supra genitalia arcte conniventia. Torus leviter

convexus. Stamina numerosa, connectivo ultra loculos crasse capitato. Gynæcii carpella plurima, glabra, ovulis 2 ventralibus superpositis. Styli breviter lineares.

On the beach at Fernando Po (*G. Mann,* who describes it as a shrub of 25 feet, with greenish-white flowers).

3. O.? PLATYPETALA, sp. n.; ramulis novellis petiolis pedunculisque tenuissime puberulis, ceterum glabra, foliis obovali-ellipticis oblongisve breviter acuminatis submembranaceis, pedicellis solitariis gracilibus, petalis exterioribus late ovatis patentibus.—Præcedenti primo intuitu similis, sed non omnino glabra, nec glaucescit, folia tenuiora, sepala majora ovata obtusa, et petala exteriora multo latiora, 6–7 lin. longa.

A small tree on the Bagroo River (*G. Mann*).

I have some hesitation in giving a name and diagnosis to this plant, the specimen being insufficient to enable me to examine the internal structure of the carpels. It is, however, so very similar in many respects to *O. gracilipes* that I cannot but feel convinced that it is a congener, although the form of the petals does not admit of uniting it in the same species.

4. O. PATENS, sp. n.; glaberrima, foliis elliptico-oblongis lanceolatisve acuminatis basi acutis, pedicellis fasciculatis, petalis exterioribus oblongis patentissimis.—Arbor elata, ramis horizontalibus. Ramuli etiam juniores uti tota planta glaberrimi. Folia majora 6–7 poll. longa, $1\frac{1}{2}$ poll. lata, inferiora cujusve ramuli breviora et latiora, v. rarius omnia latiuscule oblonga, demum subcoriacea et nitidula tenuiter penninervia et reticulato-venulosa, basi in petiolum 2–3-linearem canaliculatum angustata. Pedicelli $\frac{3}{4}$–1-pollicares, graciles, 2–6-ni, axillares v. laterales, ramulis floridis interdum brevissimis 1–2-foliatis v. subaphyllis pedunculos communes simulantibus. Bracteæ nullæ v. caducissimæ. Sepala vix lineam longa. Petala exteriora demum 6 lin. longa, 2 lin. lata, obtusiuscula, prope basin parum angustata, interiora $1\frac{1}{2}$ lin. longa, circa genitalia arcte conniventia. Stamina ad 30, connectivo supra loculos crasso dilatato. Torus fere planus, glaber. Gynæcii carpella circiter 10, glabra, stigmate depresso-capitato. Ovula 2, e basi erecta, septo verticali separata. Baccæ in specimine nondum maturæ oblique subglobosæ, 3 lin. diametro, stipite brevi crasso, intus 2-loculares, loculis collateralibus 1-spermis.

Forests at Eppah on the Niger (*Barter*). On the banks of the Bagroo River (*G. Mann*).

The vertical septum separating the ovules and seeds is an anomaly we have not observed in other Anonaceæ, but which both Mr. Fitch and myself have found at the time of flowering as well as when the fruit is further advanced.

PLATE LI. Fig. 1. Flower, magnified. Fig. 2. The same with the six petals removed, the sepals remaining. Fig. 3. One of the inner petals. Fig. 4. Anther, inner view. Fig. 5. The same, side view. Fig. 6. Torus and gynæcium. Fig. 7. Carpel of the gynæcium, back view. Fig. 8. The same, side view. Fig. 9. The same, vertical section. Fig. 10. The same, transverse section. Fig. 11. Half-ripe carpel. Fig. 12. The same, vertical section. Fig. 13. The same, transverse section.

7. Monodora, Dun.; Benth. et Hook. f. Gen. Pl. 26.

The genus *Monodora*, entirely African, is one of the most marked among Anonaceæ; for although placed in the tribe *Mitrephoreæ*, as having the outer petals spreading, with the inner ones connivent over the genitalia, and contracted at the base as in *Mitrephora* itself, with the normal anthers of the three first tribes of Anonaceæ, yet it is at once known by the large undulating and variegated outer petals, united at the base with the inner ones in a short ring as in *Hexalobus*; and the structure of the ovary is so peculiar, that it has been often added only at the end of the order as an anomalous genus. In my former notes on the Order (Journ. Linn. Soc. v. 72), I showed that the old idea of the ovary being monocarpellary, with the whole inner surface lined with ovules, as in the carpels of some Nymphæaceæ, was erroneous, and that the ovary consisted, in fact, of a large number of carpels united into a single unilocular ovary with parietal placentas as in some Papaveraceæ and in several regularly parietal Orders, but that these placentas are so numerous as to be absolutely contiguous and as it were blended with each other. This view has been disputed by Mr. B. Clarke, who, from the fact of the stigma of *M. myristica* being frequently oblique and even split down on one side, argues that it is evidently not a compound one, but the ordinary oblique stigma of a single carpel. Its really compound nature, however, which had been already ascertained without doubt by Dr. Hooker and myself in the *M. tenuifolia*, has been fully confirmed by the examination of the species since discovered by our intrepid African collectors, in which the stigma is still more distinctly lobed. The fruit also of *M. grandiflora* often shows a number of external longitudinal ridges and furrows, indicating the backs and sutures of the carpels; and in a small-fruited species from the Zambesi, of which we have unfortunately neither leaves nor flowers, the sutures of the carpels are distinctly marked by prominent costæ.

We have now flowering specimens and fruits of four apparently perfectly distinct species, and fruits only of two more, which, with the *M. angolensis*, Welw., which is unknown to us, carry the number of species to seven. But there is considerable difficulty in framing diagnoses so as to make it easy to recognize them. All are perfectly glabrous, except a few tufts of hairs or partial pubescence on the inner petals; most of them shed their old leaves before the flowering-season, so that the flowers are accompanied usually by young membranous half-grown leaves, which it is difficult to compare with the full-grown more or less coriaceous and shining ones of the fruiting specimens; and in the case of two species, fruits alone were found on trees which had lost all their leaves. The flowers also, as in many other Anonaceæ, are very different in size and shape when they first expand and when they are fully developed. The most tangible characters appear to be derivable from the shape of the inner petals, from the position of the bract, and from the inflorescence on the old wood or on the young shoots. Each species has likewise its own peculiar foliage, but variable within limits very difficult to define. The fruits are also in most cases readily distinguishable from each other in size, shape, or consistence.

The arrangement of the seeds in the ripe fruit is very singular. In most of the species, especially in *M. grandiflora*, the cavity is entirely filled by a large number of seeds fitted into each other, and imbedded in the pulp in every direction without any apparent order.

1. M. MYRISTICA, Dun. Anon. p. 80; foliis oblongis subcuneatisve vix acuminatis basi obtusis, pedunculis in ramulis hornotinis apice bracteatis, sepalis undulatis acuminatis, petalis interioribus late ovatis basi brevissime abrupteque contractis margine dorsoque pubescentibus vix foveolatis, stigmate subintegro, fructu magno globoso.—Arbor. Folia 4–5 poll. longa, 1–2 poll. lata, rigidula. Pedunculi in ramulis brevibus laterales oppositifolii v. terminales, in speciminibus suppetentibus 2–3-pollicares, sed ex Bancroftio interdum longiores.

According to Welwitsch, Journ. Linn. Soc. iii. 151, the true *M. myristica* is a native of the primæval forests of the district from the Quizembo river, north of Ambriz, to the mouth of the Coanza. I only know it from specimens cultivated in Jamaica under the name of Calabash Nutmeg, as figured in the Botanical Magazine, t. 3059.

2. M. GRANDIFLORA, sp. n.; foliis obovali- v. elliptico-oblongis brevissime acuminatis basi obtusis, pedunculis in ramulis hornotinis supra medium bracteatis, sepalis undulatis acuminatis, petalis interioribus late ovato-triangularibus subcordatis, auriculis hispidis inflexis intus foveolatis basi brevissime abrupteque contractis, stigmate lobulato, fructu magno globoso.—Folia ramulorum floralium 4–6 poll. longa, $1\frac{1}{2}$–$2\frac{1}{2}$ poll. lata, tenuiora quam in *M. myristica*; caulina interdum pedalia, 4–5 poll. lata. Inflorescentia *M. myristicæ*, sed pedunculi longiores graciliores, bractea foliacea acuminata longe infra florem sita. Petala exteriora usque ad 4 poll. longa, ut in *M. myristica* undulata et variegata; interiora pollicaria, obtusa, concava, conniventia. Fructus usque ad 6 poll. diametro, extus longitudinaliter plus minus conspicue striatus, pericarpio crasso lignoso. Semina numerosissima, absque ordine in pulpa immersa.

Xylopia undulata, P. de Beauv. Fl. Ow. et Ben. i. 27, t. 16. excl. fr.
Ambas Bay, Princes Island and St. Thomas's Island, West Africa (*G. Mann*).

Observing a note to Dr. Bancroft's specimens of the *M. myristica*, that the flowers are often very much larger than they are there shown, I had some doubts whether the *M. grandiflora* might not be the same species, as they certainly agree in many points; but the leaves are very much larger, instead of being smaller as one would expect in the wild type, the peduncles much longer and more slender; the bract is always from a half to two-thirds way up the peduncle, instead of close under the flower; the shape of the inner petals, as well as can be judged in the dried state, is different, and the stigma is very decidedly many-lobed. Whether the two forms may or not be connected by Dr. Welwitsch's specimens remains to be seen.

PLATE LII. (The open flower has the inner petals probably forced open in drying.) Fig. 1. Stamens and ovary. Fig. 2. The same, with a portion of the stamens removed, showing the torus. Fig. 3. Stamen, back view. Fig. 4. Stamen, side view. Fig. 5. Pollen. Fig. 6. Ovary, transverse section.

PLATE LIII. Fig. 1. Fruit, natural size. Fig. 2. The same, transverse section. Fig. 3. Vertical section of a smaller specimen. Figs. 4, 5, 6. Seed, natural size. Fig. 7. The same, vertical section. Fig. 8. The same, transverse section. Fig. 9. Seed, magnified. Fig. 10. The same, with half the testa removed and placed on one side, showing the horizontal plates of the albumen. Fig. 11. Albumen with the whole testa removed. Fig. 12. Seed, transverse section. Fig. 13. Seed, vertical section, showing the embryo. Fig. 14. Embryo, back view. Fig. 15. Embryo, side view.

3. M. TENUIFOLIA, Benth. in Journ. Linn. Soc. v. 72; foliis anguste oblongis acuminatis basi angustatis sæpiusque acutis, pedunculis in ramulis hornotinis medio bracteatis, sepalis undulatis acuminatis, petalis interioribus longiuscule unguiculatis ovatis concavis apice angustatis, margine dente villoso utrinque appendiculatis, stigmate crenulato, fructu ovoideo.—Frutex 7-pedalis. Folia in speciminibus floridis 3–4-pollicaria, sed verisimiliter nondum perfecte evoluta. Pedunculi quam in *M. grandiflora* breviores. Petala exteriora 2-pollicaria, interiora basi in unguem latum 5–6 lin. longum contracta, medio 5–6 lin. lata, uno v. sæpius utroque margine appendice dentiformi oblonga villosa aucta, acumine apicis obtuso 3–4 lin. longo. Flores nonnulli minores, verisimiliter nondum perfecte accreti, petalis exterioribus minus undulatis. Fructus ovoidei, maximi 4 poll. longi, diametro transversali circiter 3 poll., omnino ecostati, pericarpio duro sublignoso crassiusculo. Semina nitida, quam in *M. grandiflora* paullo minora, in pulpa nucis immersa, horizontalia et ad parietes arcte congesta sed cavitatem ovarii non omnino implentia.

At Eppah and Aghamia, on the Niger (*Barter*); Ambas Bay and Fernando Po (*G. Mann*).

4. M. BREVIPES, sp. n.; foliis obovati-oblongis ellipticisve breviter acuminatis basi obtusis coriaceis nitidis, pedunculis in ramulis annotinis brevibus medio bracteatis, sepalis orbiculatis, petalis interioribus latis concavis margine dense villosis, fructu globoso.—Arbor 30–40-pedalis. Folia $\frac{1}{2}$–1-pedalia, rigidiora et nitidiora quam in præcedentibus, petiolo brevissimo crasso. Pedunculi e nodis vetustis 1–$1\frac{1}{2}$-pollicares, 1–2-flori. Bractea orbiculata, concava, obtusissima. Sepala 4 lin. longa, concava, obtusissima et vix undulata. Petala exteriora in flore ut videtur perfecte evoluto vix pollice longiora, ovata, undulato-crispa, basi cuneata; interiora triente breviora, in unguem brevissimum abrupte contracta. Fructus globosus, vix 3 poll. diametro, ecostatus v. costis paucis obscure percursus, pericarpio crasso coriaceo-sublignoso, pedunculo $1\frac{1}{2}$-pollicari. Semina cavitatem omnino implentia ut in *M. grandiflora*.

Fernando Po and Princes Island (*G. Mann*).

Species insufficiently known.

5. *M. angolensis*, Welw. in Journ. Linn. Soc. iii. 151, from Pungo Andongo; the name only given without any indication of its characters.

6. *M.* sp. from the Niger (*Barter*). Fruits only known, which are globular, about 2 inches diameter, without longitudinal ribs or striæ, and the pericarp very much thinner than in any of the preceding ones, and apparently succulent.

7. *M.* sp. from Shiramba, on the Zambesi (*Kirk*). Fruits only known, which are globular, about 1 inch diameter, and with a thin pericarp as in the last, but marked outside by 8 to 10 longitudinal raised costæ. Dr. Kirk describes it as a bush which, at the time he gathered the fruits (July 1859), had neither leaves nor flowers.

8. Anona, Linn.; Benth. et Hook. f. Gen. Pl. 27.

This is a large genus widely spread over the warmer regions of America, and represented in Africa by three species, all belonging to Martius's section Guanabani, one of them identical with an American one and the two others nearly allied to corresponding American ones, and in Madagascar by two species of a peculiar type; but none are known in a wild state in Asia. Besides the above, four species (*A. muricata* of the section Guanabani and *A. squamosa*, *A. reticulata*, and *A. Cherimolia* of the section Atta) are more or less abundantly cultivated for their fruits in Africa as well as in Asia; and specimens are not unfrequently transmitted by collectors without indication of their cultivated origin, so as to have given the idea that one or other of them are indigenous to the Old World. The union of the carpels into a single fruit with numerous one-seeded cells radiating from a central fleshy torus readily distinguishes the genus from all other African or Asiatic ones.

1. A. senegalensis, Pers. Syn. ii. 95; ramulis ferrugineo-tomentosis, foliis ovatis ellipticisve obtusissimis subtus pube tenuissima canescentibus rufescentibusve (v. rarius glaucis subglabris?), petalis crassis, exterioribus late ovatis, interioribus oblongo-triquetris, fructibus demum lævigatis areolis inconspicuis.—Frutex 2–8-pedalis v. rarius altior. Folia sæpius 2–3-pollicaria. Fructus edulis, flavus v. aurantiacus, magnitudine pomi.

A. arenaria, Schum. et Thonn. Beskr. Pl. Guin. 257.

Widely spread over tropical Africa; described as growing in great abundance over vast tracts of country in Senegambia and Sierra Leone by *Leprieur*, *Barter*, and others, in Bornou by *Edward Vogel*, and on the Zambesi by *Kirk*.

2. ? A. glauca, Schum. et Thonn. Beskr. Pl. Guin. 259.

This is a somewhat doubtful species. A specimen of Heudelot's, which Guillemin thought he could identify with Thonning's plant, appears to me to be a nearly glabrous variety of *A. senegalensis*; but Thonning describes the leaves as narrower and acute at the base, which I have never seen in *A. senegalensis*,—besides that one would infer from the expression he uses that the inner petals are broad. His plant may therefore be a distinct species as yet unknown to us.

3. A. palustris, Linn. Spec. 757; glabra, foliis ovatis ellipticisve breviter acuminatis, petalis ovatis coriaceis, interioribus paullo minoribus, fructibus ovoideis demum lævigatis areolis inconspicuis.—Arbor 30–40-pedalis. Folia 4–5-pollicaria, coriacea v. chartacea, reticulato-venosa, petiolo sæpius pollicari. Pedunculi sæpius pollicares.

A. chrysocarpa, Guill. et Perr. Fl. Seneg. 6, ex charactere dato.

In swamps at Grand Bassa Cove (*E. Vogel*), and, if the synonym of *A. chrysocarpa* be correct, in the marshes of Cape Verd and Cape Mboro in Cayor (*Leprieur*, his description agreeing in every respect with our plant).

Dr. Hooker in the 'Niger Flora' suggests that it may be cultivated; but Vogel was always very exact in noting on his labels all cultivated specimens; and in the present instance he certainly regarded this *Anona* as indigenous, as he refers it to the *A. chrysocarpa*, Lepr.

4. A. Barteri, sp. n.; glabra, foliis brevissime petiolatis oblongo-ellipticis acuminatis acutisve basi angustatis coriaceis nitidis, fructibus globosis areolis prominentibus umbonatis obtusissimis.—Arbor 50-pedalis. Folia 6–9 poll. longa, 2–2½ poll. lata. Flores nobis desunt. Pedunculus fructifer ½–¾-pollicaris. Fructus 1½–2 poll. diametro, carpellorum apicibus distinctis depresso-hemisphæricis in sicco canescentibus 4 lin. latis, et sæpius costis 4–6 a stigmatis cicatrice radiantibus percursis. Dissepimenta inter semina tenuia, et torus centralis parum incrassatus.

Onitoka, on the Niger (*Barter*).

5. *A*. sp.? A single specimen apparently near *A. Barteri*, with narrow more acuminate leaves and a single flower as yet very young.

A small tree on the Gaboon River (*G. Mann*).

9. Melodorum, Dun.; Benth. et Hook. f. Gen. Pl. 28.

An Asiatic genus, differing from *Anona* in its free carpels, and from *Xylopia* in the shape of the petals and the want of the peculiar hollow deciduous anther-bearing portion of the torus. The first of the two following African species does not enter precisely into either of the sections established by Hooker and Thomson, but would constitute a third with glabrous fruits and smooth arillate seeds; the second is still further removed by the want of inner petals and the narrower outer ones, but still may well be included in the genus as far as it is hitherto known.

1. M. africanum, sp. n.; glabrum, foliis ovali-ellipticis coriaceis nitidis subtus rubidis reticulato-venosis, pedicellis brevissimis axillaribus, carpellis 2-ovulatis, alabastris subglobosis, baccis glabris elongatis inter semina constrictis, seminibus arillatis.—Arbor 30–40-pedalis. Folia 4–5 poll. longa, 2–3 poll. lata, brevissime acuminata, basi cuneata et in petiolum brevissimum contracta, nervis primariis vix magis quam rete venularum conspicuis. Pedicelli crassi, 2–4 lin. longi, bractea basilari lanceolata incurva crassiuscula caducissima, bracteolis in pedicello 1–2 brevibus. Sepala in calycem trifidum connata, lobis late triangularibus, 2 lin. longa. Alabastrum globosum leviter 3-angulatum, extus sericeo-incanum v. rubiginosum. Petala exteriora lata, concava, crassa, valvata, 4–5 lin. longa; interiora minora, carinata, acute acuminata, glabra, pariter valvata. Stamina numerosa, connectivo ultra loculos truncato-dilatato. Gynæcii carpella plurima, linearia, villosa, in stylum linearem attenuata. Ovula 2, superposita. Baccæ 2-pollicares, medio leviter constrictæ, 2-spermæ v. abortu 1-pollicares 1-spermæ, oblongæ, stipite semipollicare fultæ. Semina erecta, nitida, arillo cupulato ad medium seminis attingente in lobulos numerosissimos lineares densissime imbricatos diviso.

Island of S. Thomas off the West Coast, and Cameroon Mountain, at 4000 feet (*G. Mann*).

2. M.? polycarpum, Benth.; foliis ovatis v. elliptico-oblongis subacuminatis coriaceis

nitidis subtus ramulisque molliter pubescentibus v. demum glabratis, pedicellis brevibus axillaribus, alabastris oblongo-triquetris, petalis interioribus nullis, carpellis numerosis breviter oblongis glabris longe stipitatis.—Folia 4–6-pollicaria, brevissime petiolata. Pedicelli solitarii v. gemini, crassi, ferrugineo-tomentosi. Sepala lanceolata, patentia, crassiuscula, 4–5 lin. longa. Alabastrum crassum, acute triquetrum. Petala exteriora pollicaria, crassissime triquetra, sibi invicem arcte appressa, dorso tomentosa, faciebus interioribus glabris, basi circa genitalia excavata; interiora omnino desunt. Torus convexus? denudatum tamen non vidi. Stamina numerosa, connectivo ultra loculos depresso-capitato. Gynæcii carpella numerosa, villosa. Baccæ ultra 30, glabræ, oblongæ, $\frac{3}{4}$ poll. longæ, stipitibus 1–1$\frac{1}{2}$-pollicaribus.

Anona? polycarpa, DC. Syst. Veg. i. 499. *Cœlocline polycarpa*, A. DC. Mem. Anon. 32.

Sierra Leone (*Afzelius*); on the Sugar-loaf Mountain, at an elevation of 2000 feet (*Dr. Daniell*). From specimens in the British Museum.

10. Xylopia, Linn.; Benth. et Hook. f. Gen. Pl. 28.

A considerable American genus, with a few Asiatic species besides the subjoined African ones. The floral characters are nearly those of *Anona* and *Melodorum*, differing chiefly in the very narrow long or tapering petals and in the remarkable concave almost cup-shaped torus, the outer portion, which bears the stamens outside and encloses the gynæcium, falling off as soon as the flowering is over, leaving the carpels on an apparently convex torus. The fruit is nearly that of *Unona*. In *X. acutiflora* and *parviflora* the seeds have no arillus, which occasioned their generic separation by A. DeCandolle under the name of *Cœlocline*; but in *X. æthiopica* that arillus is very small; and in no Anonaceæ does its presence or absence appear to be of generic value.

1. X. æthiopica, A. Rich. Fl. Cub. 53, in adnot.; foliis ovali-ellipticis oblongisve coriaceis nitidis subtus pilis minutis appressis puberulis, alabastris elongatis obtusis supra basin contractis, calyce tomentoso vix dentato, carpellis elongatis torulosis glaucis, seminum arillo brevissimo.—Folia 4–6 poll. longa, 1$\frac{1}{2}$–2 poll. lata. Flores 1$\frac{1}{2}$-pollicares, extus dense sericeo-tomentosi. Baccæ numerosæ, sub-2-pollicares, vix 3 lin. crassæ. Semina quam in sequentibus multo minora.

Unona æthiopica, Dun. Anon. 113. *Uvaria æthiopica*, Guill. et Perr. Fl. Seneg. 9. *Xylopiæ undulatæ* fructus in P. de Beauv. Fl. Ow. et Ben. i. t. 16, excl. fl. et fol. *Habzelia æthiopica*, A. DC. Mem. Anon. 31.

Common in the palm-woods of Senegambia (*Leprieur* and *Perrottet*); in forests at Eppah on the Niger (*Barter*); in Prince's Island and on the Nun River (*G. Mann*).

2. X. acutiflora, A. Rich. l. c.; foliis ovato-oblongis ellipticisve obtuse subacuminatis tenuiter coriaceis subtus glaucis adpresse pilosis, alabastris acuminatis, calyce acuto trilobo, petalis longe lineari-lanceolatis, baccis crassis oblongis vix torulosis, seminibus exarillatis.—Folia 2 v. rarius 3 poll. longa, $\frac{3}{4}$–1 poll. lata. Pedicelli calyce longiores. Flores perfecti pollicares, petalis demum ut videtur apertis v. revolutis. Baccæ paucæ, 1–1$\frac{1}{2}$ poll. longæ, $\frac{1}{2}$ poll. crassæ.

Unona acutiflora, Dun. Anon. 116, t. 22. *Cœlocline acutiflora*, A. DC. Mem. Anon. 32.

At the confluence of the Quorra and Chadda (*Barter*); Congo (*Chr. Smith*).

3. X. PARVIFLORA, A. Rich. l. c.; omnia *X. acutifloræ*, exceptis petalis brevioribus crassioribus, in speciminibus nostris lanceolatis semipollicaribus.

Uvaria parviflora, Guill. et Perr. Fl. Seneg. 9, t. 3. *Cælocline parviflora*, A. DC. Mem. Anon. 33.
On the Niger (*Vogel, Barter*); on the Bagroo River (*G. Mann*).

I do not feel at all confident in the real distinction between the above two species and the *Unona oxypetala*, Dun. Anon. 114, t. 23, or *Cælocline oxypetala*, A. DC. *l. c.*, which must also be a *Xylopia*, nor in my having correctly identified our specimens; for the foliage and fruit seem to be the same in all, the differences consisting in the comparative length of the pedicels, and especially in the length of the petals; but that is known to change so much in Anonaceæ as the flowering advances, that, until we have good specimens in all the different stages of growth from the young bud to the fading flower, the question can scarcely be decided.

11. CLATHROSPERMUM, Planch.; Benth. et Hook. f. Gen. Pl. 29.

A genus hitherto confined to Africa, but consisting only of one well-ascertained species, with one or two others differing in some points, but which are as yet only known from very incomplete specimens; its position and limits, therefore, cannot be considered as settled. The size and shape of the flowers and the fruits are nearly those of *Popowia*; but the small number of stamens, either in a single row or so loosely arranged as to show the cells on the margin of their flat tops, places our plant in the tribe of *Miliusieæ*, where it approaches nearest to *Alphonsea*, but differs apparently both in the shape of the anthers and in the fruit. Possibly it may hereafter be united with the Asiatic *Alphonsea* and two or three South-American little-known species that have been described as *Bocageas* but have truly valvate petals, forming a genus, like *Xylopia*, common to the three continents.

1. C. VOGELII, Planch. in Herb. Hook.; ramulis foliisque novellis ferrugineo-sericeis, foliis obovali- v. elliptico-oblongis subacuminatis adultis glabris, pedicellis ad axillas 1–3-nis, staminibus 6–9.—Frutex v. arbor parva, ramis debilibus nunc sarmentosis. Folia nunc omnia 2–3-pollicaria, nunc pleraque 4–5-pollicaria, membranacea v. tenuiter coriacea, subtus glaucescentia v. rubescentia. Pedicelli 3–4 lin. longi, bracteis minutis. Alabastra depresso-globosa, ferrugineo-sericea. Petala demum aperta v. subpatentia, late ovata, exteriora 3 lin. longa, interiora paullo minora. Antherarum vertex planus, horizontalis, fere triangularis, ad marginem exteriorem loculos 2 parvos ostendens; filamenta erecta, leviter complanata. Gynæcii carpella 5–8, villosa, stylo breviter filiformi. Ovula sæpius 2–3 superposita, sed interdum solitaria videntur. Carpella matura nunc omnia monosperma, in aliis speciminibus breviter oblonga 3 lin. longa et breviter stipitata, in aliis duplo longiora et longius stipitata, nunc pleraque duplo triplove longiora 2–3-sperma, inter semina plus minus contracta.

Uvaria? Vogelii, Hook. f. Fl. Nig. 208, t. 17.
On the Quorra (*Vogel*); in Sierra Leone and on the Niger (*Barter*); on the Bagroo (*G. Mann*).

Doubtful Species.

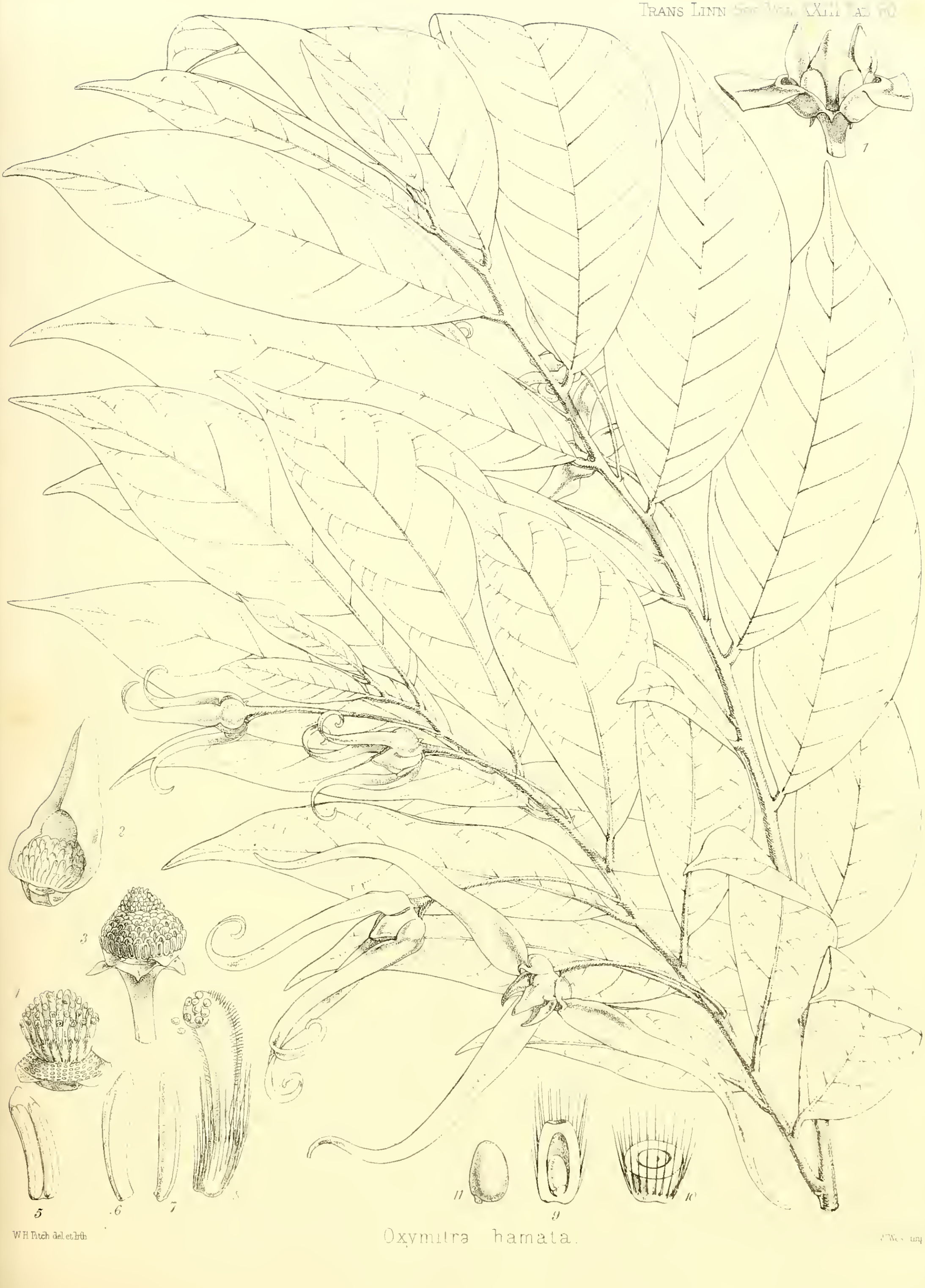
2. *Uvaria? gracilis*, Hook. f. Fl. Nig. 210; pedicellus pollicaris, gracilis; sepala patentia, ovata; obtusa, 2–3 lin. longa.

3. *C.* sp.? A specimen from the Gaboon River (*G. Mann*), with much larger leaves than the *C. Vogelii*, rusty pubescent underneath, the flowers more numerous, of the same size and shape, but all males; and besides the seven or eight radiating perfect stamens with marginal anther-cells as in *C. Vogelii*, there are round them a considerable number of small glandlike staminodia, and the centre of the flower is occupied by a hairy disk without any ovary.

W.H. Fitch del et lith.

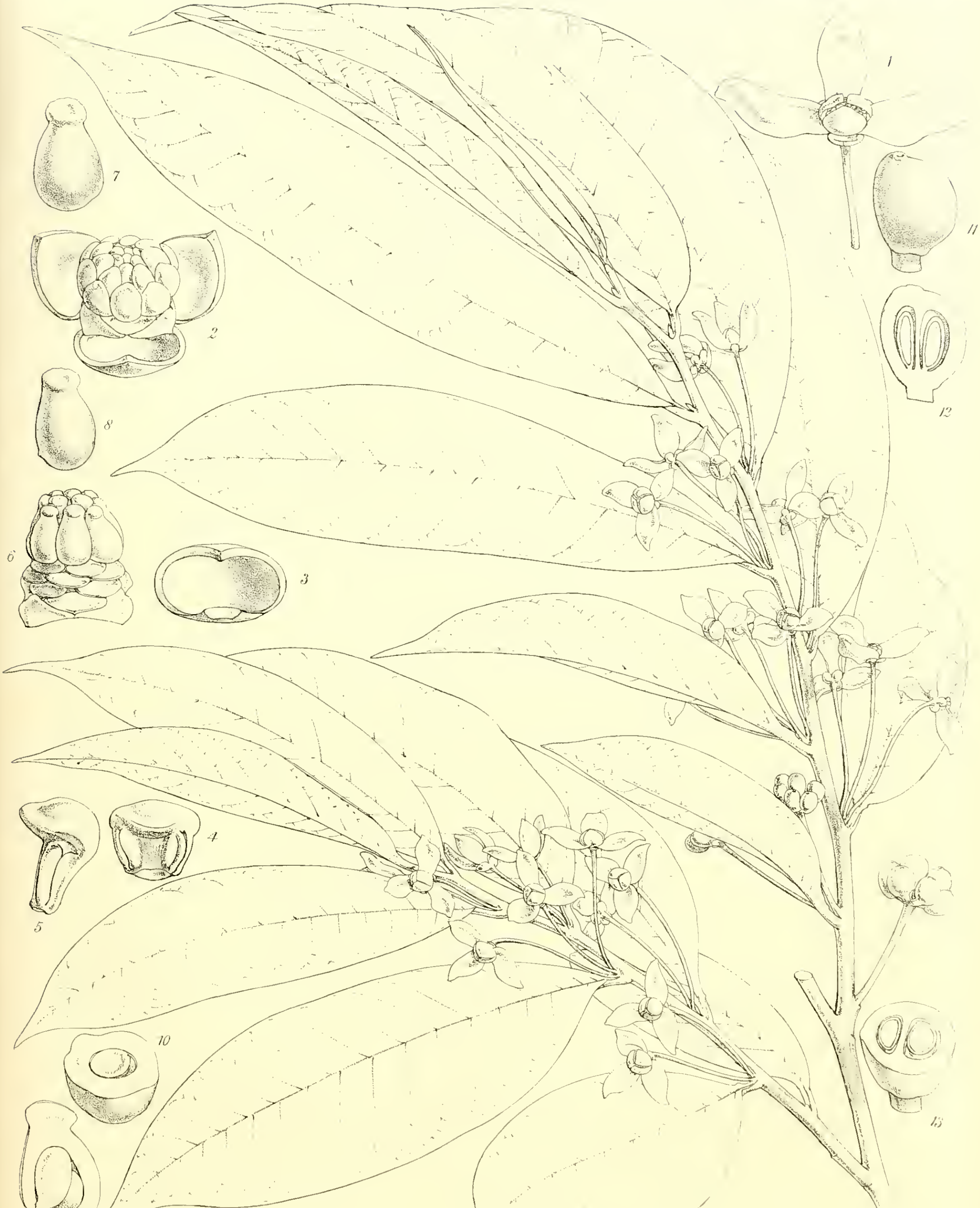
Hexalobus senegalensis

V.



W H Fitch del et lith

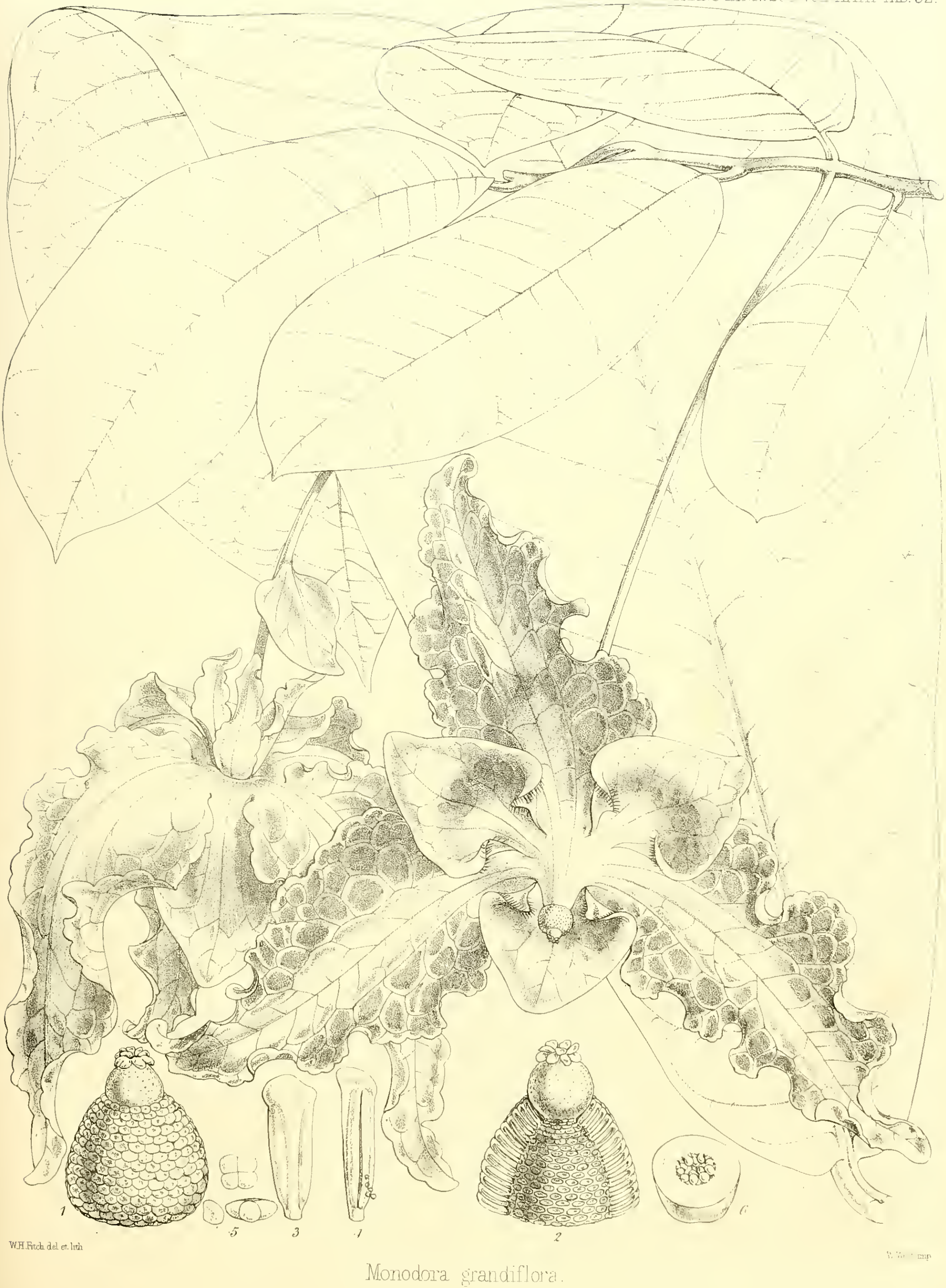
Oxymitra hamata.



W.H. Fitch del et lith

Oxymitra patens.

V. West imp.



W.H. Fitch del. et lith. W. [illegible] imp

Monodora grandiflora.

W.H. Fitch del. et lith.

Monodora grandiflora.

XXXI. *On Prolification in Flowers, and especially on that kind termed Axillary Prolification.* *By* Maxwell T. Masters, *Esq.*, *F.L.S.*, *Lecturer on Botany at St. George's Hospital.*

Read February 20th, 1862.

In a paper which is inserted in the last Part of the 'Transactions,' I had the honour of laying before the Society the results of my inquiries into the subject of median prolification. I propose now to treat especially of axillary prolification in flowers. My materials have been derived from the same sources that are mentioned in my previous paper; and from them I have drawn up a list of genera in which this deviation from the ordinary rule has been observed. The list is, I believe, comprehensive enough to afford a sufficient basis for the opinions and remarks which follow, although I have no doubt many additions might be made to it by a more thorough search through the periodical botanical publications (especially those in the German language) than I have been enabled to make. Anything like a statistical record, showing the frequency with which this form of prolification has been observed in certain genera and species as compared with others, would be very difficult, if not impossible, to draw up. The approximate estimates which I have formed are, I believe, sufficiently correct for the purposes of this paper.

Among the many points of interest presented by the subject, the following are particularly treated of in this memoir,—viz., the nature, number, and position of the adventitious buds, the genera in which the change is most frequently to be met with, and the inferences to be derived therefrom, the changes that occur in the flowers so affected, conjointly with the prolification, &c. There are also certain flowers whose construction is such as to render them particularly interesting at all times, and yet more so when the subjects of any deviation which illustrates their normal mode of formation; these are, of course, not overlooked in this paper. Other flowers, that have been erroneously said to be the subjects of this malformation, also demand notice at our hands. A comparison of the two forms of prolification, axillary and median, leads to such interesting results that I have devoted some space to it. This affords me the opportunity of showing how the morphology of certain of the large families of plants may be elucidated by cases of prolification; and at the same time it enables me to insert certain particulars relating to median prolification, which have presented themselves to me since the publication of my paper on that subject.

Axillary prolification is the term applied to those cases wherein one or more adventitious buds spring from the axils of one or more of the parts of the flower. Engelmann makes use of the word "ecblastesis" to denote the same condition. Both terms are open to the objection that they do not clearly enable us to distinguish prolification occurring within the flower from a similar state originating outside the flower, within the bracts of the inflorescence. This latter condition, called by Moquin-Tandon lateral prolification, is as truly axillary as that to which the name is restricted. In consequence of certain peculiarities in the structure of some flowers, to be hereafter alluded to, it is not in all cases easy to decide whether the new growth springs from the interior of the flower, or from the inflorescence beneath the flower.

The accessory bud presents itself as a leaf-bud, a branch, a flower-bud, or a miniature inflorescence; it may be sessile, but is far more frequently stalked, and in more than half the number of cases is a flower-bud or an inflorescence. There may be one or more of these buds; if two only, then they are usually placed directly opposite one to the other, on the opposite sides of the flower.

It will be seen, from the appended list, that the orders and genera in which this description of adventitious growth occurs most frequently are the following:—*Cruciferæ*, especially the genus *Brassica; Caryophyllaceæ*, e.g., *Dianthus; Resedaceæ; Leguminosæ*, e.g., *Melilotus, Trifolium, &c.; Rosaceæ*, e.g., *Rosa, Potentilla, &c.; Umbelliferæ*, and *Campanulaceæ*. For the most part, these are groups also peculiarly liable to central prolification.

All the parts of the flower may be thus affected; but, as might have been anticipated from the foliaceous nature of the sepals, the new bud usually arises from within the axil of one of those organs. Next in frequency to the calyx, the pistil is subjected to this change—the carpels, however, in such a case being disunited and leaf-like. The petals rank next, and lastly the stamens; these latter, indeed, are usually, but not invariably, absent in these instances, the new growth even occupying their position. Hence it may well be that, when such is the case, there is no real axillary prolification, but rather the substitution of a bud for a stamen. Generally, however, the position of the accessory bud is such that it may properly be referred to the axil of an undeveloped stamen.

The largest number of instances of this malformation, not merely generically, but also individually, occurs in plants the members of whose floral whorls are not united one to the other: thus, it is far more common in polypetalous flowers than in gamopetalous ones. In the prolified flowers belonging to the latter group, the sepals, if not actually uncombined, are only united for a short distance. The same relationship, but in a much less degree, exists in the case of median prolification, as that aberration is likewise most commonly met with in polypetalous flowers. Another feature of interest is the rarity with which axillary prolification is met with in irregular gamopetalous flowers. It may be that the irregular and comparatively excessive growth in some parts of these flowers, as compared with others, may operate in checking any luxuriant tendency in other directions.

As in the case of median prolification, plants having an indefinite inflorescence are more liable to be affected with ecblastesis than those having a definite one. The degree of branching of the inflorescence may be noticed, as this deformity is far more common in branched inflorescences than in those where there is either a solitary flower or a spicate inflorescence. More than two-thirds of the entire number of genera cited as the subjects of this malformation have a branched inflorescence of some form or other; and about two-thirds of the cases occur in genera having indefinite inflorescences. If individual instances could be accurately computed, the proportion would be even higher.

Fully three-fourths of the entire number of genera recorded as occasionally the subjects of this irregularity possess in their usual state some peculiarity of the thalamus; for instance, in about a third of the whole number of genera, the thalamus is more or less prolonged between some or other of the floral whorls, e. g., *Caryophyllaceæ, Potentilla, Anemone, Dictamnus, Umbelliferæ,* &c. About one-fourth of the genera have numerous stamens or numerous carpels, or both, springing naturally from the thalamus. In others (about one-sixth) the thalamus is enlarged into a disk, or else presents one or more glandular swellings, e. g., *Reseda, Nymphæa, Cruciferæ.* In the last-named family, as has been already remarked, prolification is very common. It would be interesting to ascertain precisely what part of an inflorescence is most liable to this affection; but as information on this point is but rarely given in the records of these cases, I can only give the results of my own observations, which go to show that, in a many-flowered inflorescence, those flowers at the outside, or at the lower portion, seem to be more frequently the subjects of this change than those situated elsewhere. This may probably be accounted for by the fact that the malformation is met with most generally in plants with an indefinite form of inflorescence, and therefore the lowermost or outermost flowers are most fully developed; the upper flowers being in a less advanced condition, the change is more likely to be overlooked in them; or it may be that, from the unusual luxuriance in the lower flowers, the upper ones may be either present in their ordinary condition, or may be (as indeed frequently happens) stunted in the size and proportion of their several parts.

Various changes in the form or arrangement of the several floral whorls accompany this malformation; some of these affect the particular organ or organs implicated, and these only, while in other cases some other parts of the flower likewise undergo modification. The changes most commonly met with are such as may be classed under Goethe's theory of retrograde metamorphosis: for instance, if a supplementary bud be developed in the axil of a sepal, that sepal is likely to be more than ordinarily leaf-like in appearance. The dislocation of the affected sepal from its fellows is a very frequent occurrence; in cases of this kind the detached sepal is placed below the others, thus approximating, in position as well as in function, to the bracts. In some of the instances of proliferous pears, on which I shall have occasion to comment, the sepals are described as sharing in the succulent character of the fruit.

The petals, under such circumstances, often exist in the guise of sepals or of small leaves; and instances are recorded wherein the place of the calyx and corolla was supplied by a succession of overlapping green scales, from the axils of which the new buds arose. Such instances seem to afford an extreme degree of a more common change, viz., the diminished size and contracted appearance of the sepals and petals when affected with axillary prolification. They have also a close relationship to such developments as we see in the Wheat-ear Carnation, in certain species of the genus *Mæsa* and others, wherein the calyx is repeated over and again, to the partial or complete suppression of the other parts of the flower. All these cases may be in part explained by the operation of the principle of compensation.

When the andrœcium is affected, the stamen either remains unaltered, or is present in a more or less petal-like condition; but it far more frequently happens that the stamen is entirely suppressed, the adventitious bud supplying its place; thus was it in the *Dianthus*, a figure of which accompanies this paper (Pl. LIV. fig. 1)*.

The pistil, too, is necessarily subjected to very grave alterations when affected with this malformation. It is separated into its constituent carpels; and these assume a leaf-like aspect, and are in the great majority of instances destitute of ovules. Indeed, virescence or chloranthy is very intimately connected with this aberration, as might have been anticipated; for if the parts of the flower assume more or less of the condition of stem-leaves or bracts, it is quite natural to expect that they will partake likewise of the attributes of leaves, even at the expense of their own peculiar functions.

It occasionally happens that an adventitious bud arises from the axil of a monocarpellary pistil. This takes place sometimes in *Leguminosæ*, and seems to have been more frequently met with in *Trifolium repens* than in other plants. The species named is, as is well known, particularly subject to a reversion of the outer whorls of the flower to leaves, and even to a leaf-like condition of the pistil. There are on record instances wherein a leaf-bud has been placed in the axil of a more or less leaf-like carpel; while at other times a second imperfect carpel has been met with in the axil of the first †. I have myself seen numerous imperfectly developed cases of this kind.

It may be asked whether such cases are not more properly referable to central prolification—whether the axis is not in such flowers terminated by two, rather than by one carpel? It is, however, generally admitted by morphologists that the solitary carpel of *Leguminosæ* is not terminal, but is the sole existing member of a whorl of carpels, all the other members of which are suppressed as a general rule, though exceptional instances of the presence of two and even of five carpels have been described ‡.

Again, the adventitious bud or carpel is placed, not laterally to the primary one, or opposite to it, on the same level, but slightly higher up—in fact, in the axil of the primary carpellary leaf. Griffith figures and describes § an instance of the kind in a species of *Melilotus*. The stalk of the ovary is mentioned as having a sheathing base, bearing in its axil a prolongation of the axis of inflorescence, in the form of a short spike with hairy bracts and imperfect flowers, the latter having a well-formed calyx and rudimentary petals and stamens. Griffith infers, from this specimen, that the legume is not to be considered as a terminal leaf.

I have, in my paper on median prolification, adduced reasons for discarding the term "prolification of the fruit;" and the instances now to be commented on supply additional force to those reasons. A very frequent malformation in pears is one wherein a second pear proceeds from the centre of the first, and even a third from the centre of

* This *Dianthus* has the more interest from its similarity to the one described by Goethe, Metam. der Pflanzen. cap. 16. sect. 105; but in that instance median prolification also existed. For my specimens I am indebted to Mr. T. Moore, F.L.S.

† Linnæa, vol. xv. p. 266. *c. ic.* Caspary, Schriften d. Physik.-Oek. Gesell. zu Königsberg, Bd. ii. p. 5, tab. 3. fig. 39, &c.

‡ Lindley, Veg. King. p. 545; also Clarke on the Position of Carpels, Linn. Soc., December, 1850.

§ Notulæ, vol. i. Dicot. p. 126. Atlas, pl. xliii.

the second *. Pears are occasionally also observed arising either from the axils of the sepals of the primary pear or from the axil of leaves originating on the outer surface of the fruits—using the term fruit in its popular sense. These cases afford strong confirmation of the view, that the outer portion of the so-called fruit in these plants is rather to be considered as an expansion and hollowing-out of the flower-stalk, than as formed from the calyx-tube. It is noteworthy that the true carpels and seeds are frequently entirely absent in these cases †. M. Trécul has described and figured an instance in a species of *Prismatocarpus*, in which a second flower proceeded from the axil of a bract attached to the side of the fruit of the first flower ‡. I have in my previous paper alluded to the occasional presence of leaves on the calyx-tube, so-called, of the Rose, Pear, and Apple, to which I may now add, on that of *Cratægus tanacetifolia*.

The unripe fruits of some species of *Lecythis* were stated by Von Martius, at the Meeting of the German Naturalists at Carlsruhe, to produce buds when placed in the earth. The fruit of these plants is probably of the same nature as that of the *Pomaceæ*.

The fruits of *Opuntia Salmiana* and *O. fragilis* § have been observed to form small fruit-like branches around their summits. M. Napoléon Doumet describes the fruit as ripening as usual, but as being destitute of seeds in the interior; after a little while, the fruit begins to wither, and then a circle of small buds, like those of the stem, may be seen at the top of the fruit, each bud springing from the axil of a little tuft of wool and spines found on the fruit. These little buds elongate into long shoots, produce flowers the following year, which flowers exhibit the same peculiarity. Gasparini and Tenore are said to have recorded the same fact as long since as 1832. The specimen from which my figure was taken produced its fruits in the Royal Gardens at Kew, and is now preserved in the museum of that establishment (Pl. LIV. fig. 2). The adventitious growth in these cases appears to arise from the tufts of spines, which, it has been suggested, are the homologues of the sepals. There can be little doubt that the outer and lower portion of the fruit of *Opuntia* and its allies is a dilatation of the flower-stalk. This is borne out by the fruits of *Pereskia*, which bear leaves on their surface arranged spirally.

The fruits of *Pereskia Bleo* are mentioned as producing buds from their summits, in the same way as the *Opuntia* just cited. *P. Bleo* is said, by M. Delavaud ‖, to present this anomaly as a constant occurrence. On the summit of the primary fruit, arising apparently from the axils of the sepals, or of small leafy bracts in that situation, are a series of fruit-like branches, which, in their turn, are surmounted by others, even to the fourth generation. I have not seen an instance of this myself; but a figure is given in the work below cited. Tenore also has recorded "the transformation of the fruits of *Nymphæa alba* and *N. Lotus* into true tubercles, after the seeds had returned to the condition of elementary mucilage ¶." I have not seen the paper wherein this extra-

* Cf. Moq.-Tandon, p. 384; also Lindl. Elements of Botany, p. 65, fig. 130; "Theor. Hortic." Gard. Chron. 1851, p. 67; Irmish, Flora, 1858, &c.

† Caspary, Bull. Soc. Bot. Fr. vol. vi. 1859; also Payer in vol. i. 1854.

‡ Trécul, Ann. Sc. Nat. 2 sér. vol. xx. p. 339.

§ Bull. Soc. Bot. Fr. vol. i. p. 306, vol. v. p. 115.

‖ Bull. Soc. Bot. Fr. 1858, p. 685.

¶ Atti della Reale Accademia delle Scienze di Napoli, t. iv. 1839, pp. 41–45.

ordinary phenomenon is described; but, in reference to it, I may cite the opinion of Prof. Alex. Braun, of Berlin, who states that he has read the memoir of Sig. Tenore with astonishment and incredulity: "His idea of the transformation of a ripe fruit, provided with seeds, seems quite inadmissible; and the application which he makes of it to *N. Lotus*, which has stolons like the Strawberry, is surely inexact: he may have confounded with *N. alba*, a different species which bore stolons, or he may have seen a chloranthy of *N. alba*, with metamorphosis of the pistil into a foliar bud; but then the flower would not be normal, still less would the metamorphosis have been preceded by the formation of a ripe fruit" *.

Tetragonia expansa has been mentioned frequently as the subject of a similar adventitious development. M. Clos has, however, shown that there is no real prolification in this plant, or, at least, no axillary prolification, strictly speaking †.

The specimens that I have examined in Sir W. Hooker's herbarium differ in some measure from those described by M. Clos; and hence, as considerable interest is attached to this plant, I have deemed it advisable to speak of it here at some length.

Prof. Oliver has directed my attention to the earliest notice of this plant, and of its peculiar growth, in a catalogue of plants published by Pallas ‡. The eminent Russian naturalist has figured and described the plant under the name of *Demidovia tetragonoides*, and seems to have had juster notions of the structure of this flower than other more recent botanists. I shall extract such portions of his description as are necessary for the elucidation of the nature of the fruit, and of the adventitious growth attached to it; and intercalate the observations of other botanists, as well as the results of my own examination. Pallas correctly describes the flowers as being placed on short stalks, while other authors describe them as sessile. In truth, the length and thickness of the flower-stalk are subject to considerable variation in different specimens. M. Clos says that the flower-stalk becomes gradually blended with the base of the fruit; and this is usually, though by no means universally, the case. Moreover, in some allied species, particularly in *T. implexicoma*, the flowers are borne on long slender stalks, which do not pass by such insensible gradations into the base of the fruit. Pallas likewise mentions the fact that there are sometimes two flowers in the axil of one leaf, especially towards the upper part of the stem; and I have seen instances where there were three flowers in this situation. In such cases, it is the uppermost flower that is affected in the manner hereinafter mentioned. In speaking of the flower, Pallas thus proceeds:—"Receptaculum cartilagineum, inverse conicum, compressiusculum, coronatum spinis quatuor vel quinque patentibus, et versus pedunculum, ramentis duo oppositis, minimis, sub-barbatis, notatum." Omitting such portions of the description as are not relevant to our present purpose, we come to the following passage:—"E superioribus pericarpiis (non omnibus), ad ramenta, prodeunt flores secundarii minores, &c." Here, then, we

* Bull. Soc. Bot. Fr. vol. v., and 'Ueber Polyembryonie und Keimung von *Cœlobogyne*.' For a figure and description of indubitable axillary prolification in the flower of a cultivated sp. of *Nymphæa*, see Gard. Chron. August 18, 1855.

† Bull. Soc. Bot. Fr. 1855.

‡ Pallas, Enum. Plant. Hort. Demidof., Appendix, Petrop. 1781, *c. ic.*

have the four or five horn-like processes referred to the receptacle of the flower, instead of to the calyx or to the calyx-tube, as is done by DeCandolle, Endlicher, and others. M. Clos considers them to be processes of the upper portion of the flower-stalk,—a view which he supports by citing the fact that the supplementary flower, with its bract, is occasionally found on the top of one of the horn-like processes; and I have myself seen a small leaf in that situation. The figure given by MM. Seringe and Heyland * shows the secondary flower as springing directly from the summit of one of the horn-like processes; and DeCandolle says, "cornua calycina interdum flores accessarios gerunt" †. Reverting to Pallas's description, we find mention made of the ramenta, or small scales which are occasionally found on the fruits of this plant; and the supernumerary flowers are stated to take their origin from them (their axils?). The figures given by Pallas show that the adventitious growths have nothing to do with the true sepals.

Seringe and Heyland ‡ seem to consider the ramenta or scales to be calycine lobes, as they say, "Des aisselles de quelques lobes du calice naissent, pendant la maturation, des fleurs bien conformées."

Misled by these assertions, Moquin-Tandon § and others have considered the plant to afford an instance of true axillary prolification. It is evident, however, from what has been stated, that the calyx is not affected with prolification, but that the supplemental bud arises either from the extremity of one of the horn-like processes of the flower-stalk or from the axil of a small bract attached to its side (Pl. LIV. fig. 3). There are a few flowers, however, in which the pedicel supporting the additional flower is united to the side of the primary fruit for a considerable distance; in these flowers, I have not been able to ascertain precisely whether the supernumerary flower-stalk arises from the base of the primary one, or is distinct from it, in the axil of the same bract. If it originates from the stalk of the primary fruit, it affords an instance of lateral prolification, or prolification affecting the inflorescence. I have only to add on this point, that the pedicel of the primary fruit is sometimes provided with two rather large-stalked leaves near its base—a circumstance which would lead us to expect that the supplementary flower takes its origin from the axil of one or other of them, and thus constitutes, as just remarked, a case of lateral prolification (Pl. LIV. fig. 3, *b*).

Similar conclusions apply to the fruit of *Philadelphus*, in one species of which, *P. speciosus*, M. A. Gris has observed that the so-called calyx-tube was provided with two small bracts, from the axil of one of which proceeded a small flower-bud ‖.

As to the nature of the adventitious growth itself, but little need be said beyond what has been already stated at the beginning of this paper,—the conditions presented being, with few exceptions, of such a nature, as not to demand special comment in this place, albeit some of them are curious as illustrations of morphological doctrines—such, for instance, as the occurrence of tubers in the axils of the sepals of the Potato, mentioned by Knight ¶. Here the leaf-bud shows itself in the form of a tuber; and the true nature of the latter organ is thereby elucidated.

* Bull. Bot. No. 1, p. 18. † Prodromus, vol. iii. p. 452. ‡ Op. cit.

§ Terat. Veget. p. 373. ‖ Bull. Soc. Bot. Fr. 1858, p. 331. ¶ Proc. Hort. Soc. vol. i. p. 39, fig. 2.

In the *Dianthus* (Pl. LIV. fig. 1), the adventitious growth occurred in the form of a circle of flower-stalks bearing alternate, strap-shaped, petal-like scales and one or two imperfect flower-buds, which were made up externally of leafy or petal-like scales, within which was a gamosepalous calyx enclosing rudimentary petals, stamens, and carpels. In other cases, the outer scales were like carpellary leaves destitute of ovules, their margins widely separated one from the other, and their summits surmounted each by a style nearly as long as the leaf itself.

A comparison of the two forms of prolification, axillary and median, leads to some interesting results, and enables me to mention a few circumstances that have occurred to me since my former paper, on median prolification, was published, or that were omitted or overlooked during its compilation. Axillary prolification is a much less frequent malformation than the central form. If only the number of orders and genera be reckoned, the truth of this statement will be scarcely recognized; but if individual cases could be estimated, the difference in this respect between the two would be very much more obvious. This may perhaps be explained on the following grounds:—

It is now almost universally admitted that the flower is homologous with the branch; that, up to a certain time, the branch-bud or leaf-bud and the flower-bud do not essentially differ *. At a later stage, the difference between the two is manifested, not only in the altered form of the lateral organs in the flower-bud, but in the tendency to an arrest of growth in the length of the central axial portion. Now, in prolified flowers, the functions and to a considerable extent the appearance of a leaf-bud or of a branch are assumed, and with them the tendency to grow in length. Median prolification, therefore, in this sense, is a further step in retrograde metamorphosis than is the axillary form. To grow in length, and to produce axillary buds, are alike attributes of the branch; but the former is much more frequently called into play than the latter; for the same reason, median prolification is more common than the axillary form.

The frequency with which "apostasis," or the separation of the floral whorls one from another, to a greater degree than usual, is met with in prolified flowers has been before alluded to.

In both forms, the adventitious growth is much more frequently a flower-bud or an inflorescence than a leaf-bud or a branch. How this is to be accounted for I can only conjecture. Perhaps it may be due to the position of the flowers on a portion of the stem of the plant especially devoted to the formation of flower-buds to the more or less complete exclusion of leaf-buds, *i. e.* the inflorescence. This is borne out by the comparative rarity with which prolification has been observed in flowers that are solitary in the axils of the ordinary leaves of the plant. If the lists of genera be perused, it will be seen that nearly all the cases occur in genera where the inflorescence is distinctly separated from the other branches of the stem. In direct proportion, then, to the degree in which one region of the stem or branches of a plant is devoted to the formation of flower-buds to the exclusion of leaf-buds, is the frequency with which those flower-buds may become affected with floral prolification.

* Linn. Prolepsis Plant. § vii.; Goethe, op. cit. §§ 103–106.

Flowers borne upon indefinite inflorescences are liable to be affected with either form of prolification more frequently than those borne upon definite inflorescences. Prolification in both varieties is also more frequently met with in branched inflorescences than in those in which the flowers are sessile; but the degree of branching seems less material, inasmuch as this malformation is more commonly recorded as occurring in racemes than in the more branched forms of inflorescence. From the similar arrest of growth in length in the case of the flower, to that which occurs in the stem in the case of definite inflorescence, it might have been expected that axillary prolification would be more frequent in plants having a cymose inflorescence than in those whose inflorescence is indefinite; such, however, is not the case. The reason for this may be sought for in the lengthening of the floral axis, so common in prolified flowers—a condition the reverse of that which happens in the case of definite inflorescence.

Median prolification occurs frequently in double flowers; the axillary variety, on the other hand, is most common in flowers whose lateral organs have assumed more or less of the condition of leaves. The other coincident changes have either been already sufficiently alluded to, or do not present useful points of comparison, and may therefore be passed over.

The investigation of these two kinds of aberration from the usual floral arrangement brings to light many interesting facts bearing on the structural peculiarities of certain natural orders. On some of these I propose now to speak, premising, however, that the conclusions drawn from teratological researches, should be checked by the results of a keen scrutiny into the mode of origin and progressive growth of the various flowers, and by the analogies derived from a minute and cautious comparison of one natural form with another.

In the genus *Anemone*, the supernumerary bud has been often seen to spring from the axil of one of the leaves of the involucre, as it is generally called. If so, the prolification must be classed as lateral, and not axillary. This view is borne out by the analogies presented by *Eranthis*, *Nigella*, and other genera. On the other hand, there are grounds for considering the so-called involucre as a calyx removed to a long distance from the corolla. *Hepatica*, and some species of *Hamadryas*, in which the petals show a tendency to become tubular, may be compared with *Anemone* in support of this latter notion.

The *Cruciferæ* seem peculiarly liable to prolification in one or other of its varieties. When median, it usually happens that the pistil is separated into two leaves,—never into four, as might be expected were the fruit made up normally of four carpels as has been suggested *. Another common change is one which is suggestive of the relationship between this order and *Capparidaceæ*, inasmuch as the pistil is placed on the end of a lengthened thalamus or gynophore. When cruciferous flowers are affected with axillary prolification from the region of the stamens, it almost always happens that the adventitious buds are placed on a level with the two short stamens. This may perhaps be cited in support of the hypothesis that there are normally in this family eight stamens, the two that are usually suppressed being represented in the prolified flowers by the

* Cfr. Lindl. Veg. Kingd. 3rd ed. p. 355 *a*.

two adventitious buds. It may be here stated that there are usually (always?) two such buds, and two only, in this family. I have been disappointed in not having been able to discover anything in the cruciferous flowers I have examined that throws light upon the morphology of the hypogynous glands, so common in this family. Either these bodies have been unchanged in the prolified flowers, or they have been entirely absent.

The order *Caryophyllaceæ* is very liable to these malformations. This has been before alluded to, in speaking of the elongation of the thalamus, and the displacement of the members of the floral whorl.

Since the publication of my paper on median prolification, I have been informed of the presence of that malformation in the flowers of a *Geranium*—a genus of an order in which such an occurrence was to have been expected, from the nature of the thalamus.

Prolification among the *Umbelliferæ* is interesting, from the fact that frequently the calyx is completely detached from the pistil, and is separated into its constituent leaves; at other times the structure of the calyx is less extensively interfered with. The pistil is frequently present in the guise of two disunited lance-shaped leaves. The most remarkable instance that has fallen under my notice is a specimen of *Daucus Carola*, gathered by myself in Switzerland in July 1858 (Pl. LIV. fig. 4). In this specimen the calyx was tubular, its limb divided into five small teeth. The carpels were leaf-like, disjoined, and unprovided with ovules; between them rose a central prolongation of the axis, which almost immediately divided into two branches, each terminated by a small umbel of perfect flowers, surrounded by minute bracts. The petals and stamens were little changed; but the calyx and the leafy carpels demand a more explicit description. The lower part of the carpellary leaves was inseparably united to the interior of the calyx-tube. This latter organ was traversed by ten ribs, apparently corresponding to the primary ridges of the normal fruit; these ribs were destitute of spines, and the bristly secondary ridges were entirely absent. Those portions of the carpels which were detached from the calyx had each three ribs, a central and two lateral ones, which appeared to be continuous with the ribs of the calyx below,—although in the case of the calyx there were ten, in the case of the carpels six ribs, three to each. This diversity in number is thus explained:—A circle of vascular tissue ran round the interior of the calyx-tube, at its junction with the limb, and at the point of insertion of the petals and stamens. This vascular circle seemed to be formed from the confluence of the ten ribs from below. Of the five ribs in each half of the calyx, the three central ones were joined together just at the point of confluence with the vascular circle, above which they formed but a single rib—that traversing the centre of the carpellary leaf; the two lateral ribs of each half of the calyx seemed to be continuous, above the vascular rim, with the lateral ribs of the carpel; these lateral ribs were connected on either side with the central one by short branches of communication. The disposition of the ten ribs may be thus represented:—

```
1   1   1       1   1   1
3 2 3 2 3       3 2 3 2 3
1 1 1 1 1       1 1 1 1 1
```

The lower line of figures represents the calycine ribs, the middle row shows how each of these ribs is divided at the vascular rim, and the uppermost row shows their distribution above the rim. From this it will be seen that six of the calycine ribs divide into three branches, one prolonged upwards as a lateral or median rib into the carpellary leaf, the other running horizontally to join with similar branches sent out from the neighbouring rib; the four intermediate calycine ribs divide into two branches only, which join the side branches of the first mentioned, but have no direct upward prolongation into the carpel. The ten ridges are placed opposite to the sepals and petals (Pl. LIV. fig. 5). The nature of the carpophore and of the placenta in *Umbelliferæ* are also illustrated by prolified flowers: thus, in some specimens described by Mr. Townsend*, the ovules were seen hanging from the margin of a leafy carpel. The carpophore, moreover, in place of being, as Dr. Lindley describes it, a forked placenta, which has become in process of development exterior to the carpels†, is in reality, as Mr. Townsend has suggested‡, "a continuation of the axis, serving at first to solder the parts together, and ultimately separating to suspend the freed mericarps." That such a prolongation of the axis should in some cases bear flowers (as in my specimen) is only a further proof of the real nature of the organ.

It will also be obvious, from what has been before said as to the calyx in prolified flowers of this family, that there is in this group a real calyx-tube.

The proliferous flowers in *Rosaceæ* and *Pomaceæ* have already been alluded to as throwing light on the nature of the fruit of these plants, and on the share which the expanded flower-stalk takes in their production; and similar conclusions may be drawn as to the fruit of some other orders, wherein the ovary is said to be inferior, e. g. *Cactaceæ*, *Philadelphaceæ*, *Myrtaceæ*, *Tetragoniaceæ*, *Campanulaceæ*, and probably also of many other families not here alluded to. The conclusions tally well with the organogenic researches of Payer, Trécul, and others.

Furthermore, the accessory buds which are occasionally found on these fruits are rather to be referred to lateral than to axillary prolification, strictly so called. They have been mentioned in this place inasmuch as they are usually recorded as cases of axillary prolification, and are to be found under that head in the works treating on such matters. Other important changes affecting the characters of certain natural orders, such as the change from an adherent to a free ovary, from perigynous to hypogynous stamens, &c., have been already mentioned, and need no further comment in this place §.

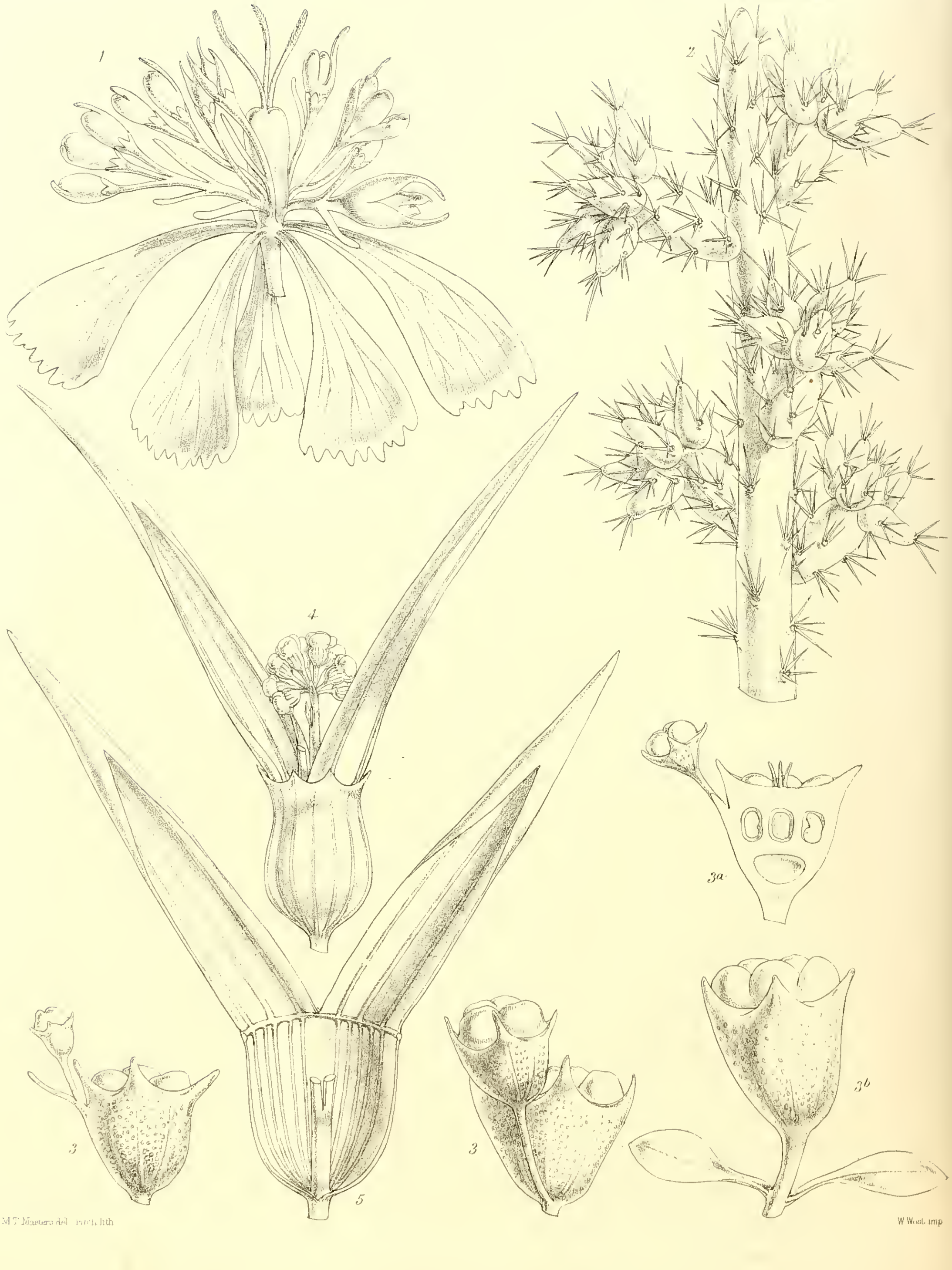
* Bot. Gazette, vol. iii. p. 52. † Veg. Kingd. p. 774. ‡ Loc. cit.

§ For figures and descriptions of flowers affected with prolification, which are not specially referred to in these papers, the reader is referred to the oft-cited treatises of Moquin-Tandon and Engelmann, where numerous references are given; also to Dr. Lindley's 'Theory of Horticulture,' and to a memoir of Prof. C. O. Weber, in Verhandl. des Nat.-Hist. Vereins des Preuss. Rheinlandes und Westphalens, vol. vi. 1858, &c. &c.

List of Genera in which Axillary Prolification has been observed.

Order.	Genus.	Leaf-bud or Branch.	Flower-bud or Inflorescence.	From what organ.
Ranunculaceæ	Clematis	......	Flower-bud	Sepals.
	Caltha	......	Ditto	Ditto.
	Aconitum	......	....	Ditto.
	Delphinium	......	Ditto	Ditto.
	Anemone	......	Ditto	Involucre?
Nymphæaceæ	Nymphæa	......	....	Fruit?
	Nymphæa	......	Flower-stalked	Petal.
Cruciferæ	*Brassica	Leaf-bud	Flower-bud	Sepals and petals †.
	Brassica	Ditto	....	Stamens.
	Brassica	Ditto	Ditto	Pistil.
	Cardamine	......	Ditto	Sepals.
	Cheiranthus	......	Ditto	Ditto.
	Erysimum	Ditto	....	Sepals and pistils.
	Lepidium	......	Ditto	Petals and stamens.
	Arabis	......	Ditto	Sepals.
	Diplotaxis	......	Flower, inflorescence	Pistil, calyx and corolla.
Capparidaceæ	Cleome	......	Flower-bud	Sepals.
Resedaceæ	*Reseda	......	Ditto	Ditto.
Caryophyllaceæ	Arenaria	Branch	....	Ditto.
	Agrostemma	Leaf-bud	....	Ditto.
	*Lychnis	Ditto	....	Ditto.
	Stellaria	Ditto	....	Ditto.
	Silene	Ditto	....	Ditto.
	*Gypsophila	Ditto	Ditto	Sepals and stamens.
	*Dianthus	Ditto	Ditto	Sepals.
	Dianthus	Ditto	Inflorescence	Petals and stamens.
Malvaceæ	Alcea	......	Flower-bud	Stamen.
Aurantiaceæ	Citrus	......	Ditto	Ditto.
Rutaceæ	Dictamnus	Ditto	....	Pistil leafy.
Tropæolaceæ	Tropæolum	Ditto	....	Petals.
Celastraceæ	Celastrus	Ditto	....	Ditto.
Leguminosæ	*Melilotus	......	Inflorescence	Sepals and petals.
	Medicago	......	Flower-bud	Sepals.
	Coronilla	......	Ditto	Ditto.
	Trifolium	Ditto	Second carpel axillary to first	Pistil.
	Trifolium	......	Flower-bud	Sepals and petals.
Rosaceæ	Pyrus	......	Fruit?	Fruit?
	Cerasus	......	Flower-bud	Petals and stamens.
	Potentilla	......	Ditto	Leafy carpels.
	Cratægus	......	Ditto	Petals.
	*Rosa	Ditto	Ditto	Sepals, petals, stamens and pistil.
Myrtaceæ	Lecythis	Ditto	....	Fruit?
Tetragoniaceæ	Tetragonia	......	Ditto	Ditto.
Cactaceæ	Opuntia	Fruit-like branch	....	Tufts of spines.
	Pereskia	Fruit-like branch	....	Sepals?
Philadelphaceæ	Philadelphus	......	Ditto	Sepals?
Umbelliferæ	*Athamanta	......	Ditto	Calyx.
	Daucus	......	Ditto	Calyx and pistil.
	Bupleurum	......	Ditto	Ditto ditto.
	Torilis	......	Ditto	Ditto ditto.
	Apium	......	Ditto	Ditto ditto.

† A mark * is attached to those genera that are the most frequently affected with axillary prolification.



M. T. Masters del. Fitch lith.

W. West imp.

Order.	Genus.	Leaf-bud or Branch.	Flower-bud or Inflorescence.	From what organ.
Umbelliferæ . .	Pastinaca . . .	. . . . . .	Flower-bud	Calyx and pistil.
	Heracleum . .	. . . . . .	Ditto	Ditto ditto.
	Angelica . . .	. . . . . .	Umbel	Ditto ditto.
Campanulaceæ .	*Campanula . .	Branch	. . . .	Sepals.
	Prismatocarpus	Ditto	Fruit.	Sepals, &c.?
Gentianaceæ . .	Gentiana . . .	. . . . . .	Flower-bud	Sepals.
Convolvulaceæ .	*Convolvulus .	. . . . . .	Ditto	Outer calyx.
Solanaceæ. . . .	Solanum . . .	. . . . . .	Ditto	Sepals.
	Solanum . . .	Tubers	. . . .	Sepals and petals.
Scrophulariaceæ	Digitalis . . .	. . . . . .	Ditto	Petals, &c.
	Veronica . . .	. . . . . .	Raceme	Calyx.
Primulaceæ . . .	Anagallis . . .	Branch	Ditto	Petals.
Polygonaceæ . .	Rumex	. . . . . .	Ditto	Sepals.
Santalaceæ . . .	Thesium . . .	Leaf-bud	. . . .	In place of stamens and pistils, both absent.
Euphorbiaceæ? .	Euphorbia? .	Ditto	?	Outer bracts?
Liliaceæ	Herreria . . .	Ditto	. . . .	Sepals.
	Hyacinthus. .	. . . . . .	Flower and raceme	Perianth.
	Convallaria . .	. . . . . .	Flower-bud	Ditto.
	Leucoium . .	. . . . . .	Ditto.	Ditto.
Cyperaceæ. . . .	Carex	. . . . . .	Inflorescence . . .	Utricle.

Note.—The following genera must be added to the list of those occasionally affected with median prolification (*vide* p. 368 hujus voluminis):—

	Leafy.	Floral.
Ranunculaceæ	. . . .	Clematis.
	. . . .	Delphinium.
Cruciferæ	. . . .	Diplotaxis.
Geraniaceæ	. . . .	Geranium.
Rosaceæ	. . . .	Cerasus.
Compositæ	. . . .	Carthamus.
Euphorbiaceæ . . .	. . . .	Euphorbia.
Liliaceæ	. . . .	Leucoium.

EXPLANATION OF PLATE LIV.

Fig. 1. Flower of *Dianthus*, sp.? The calyx is removed; the petals are reflected to show the adventitious flower-buds, &c., occupying the situation of the stamens.

Fig. 2. *Opuntia Salmiana*, showing the accessory buds arising from the tops of the fruits.

Fig. 3. Flowers of *Tetragonia expansa*, showing the position and attachment of the secondary flowers.
a. Vertical section of a flower.
b. Flower with two bracts on the pedicel.

Fig. 4. Flower of *Daucus Carota*. Petals and stamens removed. Calyx without prickles. Carpels prolonged and developed in the form of leaves; between the two rises a flower-bearing axis, one branch of which alone is represented.

Fig. 5. *Daucus Carota*. Diagrammatic sketch of the interior of the calyx and carpels, showing the arrangement of the ribs and the prolonged axis, the upper part of which has been removed.

XXXII. *Contributions to an Insect Fauna of the Amazon Valley.* Lepidoptera: Heliconidæ. *By* Henry Walter Bates, *Esq.* (Communicated by the Secretary.) *

Read November 21st, 1861.

"Die wissenschaftliche Untersuchung der Natur strebt in den Einzelheiten das Allgemeine zu erkennen, um endlich dem Grunde aller Dinge näher zu kommen. Für diese Art Untersuchungen, die immer das Ziel der Naturforschung sein sollte, bietet wohl keine Thierclasse so reichen Stoff als die Insecten."—*Karl Ernst von Baer,* Address on the Opening of the Russian Entomological Society, St. Petersburg, May 1860.

The family *Heliconidæ* was established by Mr. E. Doubleday in 1847, in Doubleday and Hewitson's 'Genera of Diurnal Lepidoptera.' It was founded on a number of Butterflies, remarkable for the elongated shape of their wings, and peculiar (with the exception of one genus, *Hamadryas,* which the author placed provisionally in the family, *op. cit.* p. 98) to the intertropical and subtropical zones of America. Many of them had been described by the older authors under *Heliconia, Mechanitis,* and several other ill-defined genera. They had been previously (in 1836) united in a tribe, *Heliconides,* by Dr. Boisduval in his 'Spécies Général des Lépidoptères;' but this comprehended also the group *Acræidæ,* which Doubleday excluded from the family. Linnæus treated them as a section of the genus *Papilio,* under the name of *Heliconii.* The nearest allies of the *Heliconidæ* are the *Acræidæ* just mentioned and the *Danaidæ*: all are distinguished from the true *Nymphalidæ* by the discoidal cell of the hind wings being always closed by perfect tubular nervules. Mr. Doubleday, placing more reliance on the shape of the antennæ and the abdominal border of the hind wings than on the far more important character above named, was led to exclude the genus *Eueides* from the family: this rendered the definition of the two groups very difficult, if not impossible, *Eueides* having the wing-cells closed in the same way as the *Heliconidæ.* Excepting that I re-admit *Eueides,* and exclude *Hamadryas,* which does not enter into the series of the American *Heliconidæ,* the family will be treated of in the present memoir as defined in the work above quoted.

The position of the *Heliconidæ* in the order Lepidoptera may be understood when I state that in a natural system the group would stand at the head of the whole series of families of which the order is composed. At least, this should be its place according to the view now taken of the order by many systematists, who arrange the families of *Rhopalocera,* or Butterflies, according to their degree of dissimilarity to the *Heterocera,* or Moths—in other words, according as their structure shows a lower or a higher stage in an ascending scale of organization. For, as the lower families of Moths are allied to other orders of insects, the further a group recedes from them in structure, the higher is the grade of perfection of the Lepidopterous type which it exhibits. The families show their degree of affinity to Moths by many characters, the principal of which is the

* The materials on which this memoir is founded were collected by the author during eleven years' research on the banks of the Amazons.

structure of the anterior legs in the adult state of the insects. The *Heterocera* have always six perfect legs: most of the families of *Rhopalocera* have the anterior pair in a more or less rudimentary condition; and as the atrophy seems to have reached its furthest stage in the *Heliconidæ*, this group must be considered as occupying the highest rank in the order. Other characters accompany the one derived from the structure of the legs, which it is unnecessary here to enumerate. It will be seen from these remarks that the order Lepidoptera is one of those groups in the Animal Kingdom which show, beyond the many collateral branches of development that always exist, a clear linear advancement of organization.

The *Heliconidæ*, *Danaidæ*, and *Acræidæ* are related to each other in a different way from that which appears in the received classifications. A few remarks on their mutual affinities are necessary, in order to exhibit the true relations of the *Heliconidæ* to the allied groups of the Old World tropics. It has escaped the notice of all authors, that the *Heliconidæ* are composed of two groups, which differ very considerably in important points of structure; in fact, the majority of the genera of which the family is composed ought to be withdrawn from it, and placed with the *Danaidæ*. The very great superficial resemblance between the two sets of genera has led to their being united by all authors, and prevented inquiry into their real relationship. To avoid innovation, I will retain the family as it stands, and call the group which is allied to the *Danaidæ*, DANAOID HELICONIDÆ, and the other, which approximates somewhat to the *Acræidæ*, ACRÆOID HELICONIDÆ. The Acræoid group comprehends the genera *Heliconius* and *Eueides*; the Danaoid, the whole of the remaining *Heliconidæ*. The following are the distinguishing characters of the two groups:—

Acræoid Heliconidæ. The hind wing-cell is very small, and the nervures are so arranged that the upper and lower radials* (discoidal nervures of Doubleday) appear to be branch and sub-branch of the subcostal nervure, the discocellulars being short and continuous with them; the costal nervure is prolonged to the apex of the wing. The larvæ are similar to those of *Acræa* and *Argynnis* (*Nymphalidæ*), being beset with hispid spines†. The head is broad, the palpi thick.

Danaoid Heliconidæ. The hind wing-cell is very large, and irregular in shape; the two radials never appear as branches of the subcostal, but are very uncertain in position, owing to the very vacillating length and direction of the discocellulars: the costal nervure is short, and terminates on the costa, not reaching the apex of the wing. The larvæ (only one species is known) are smooth, like those of the *Danaidæ*, but are furnished with tubercles, instead of long fleshy threads. Head small, orbicular; palpi slender‡.

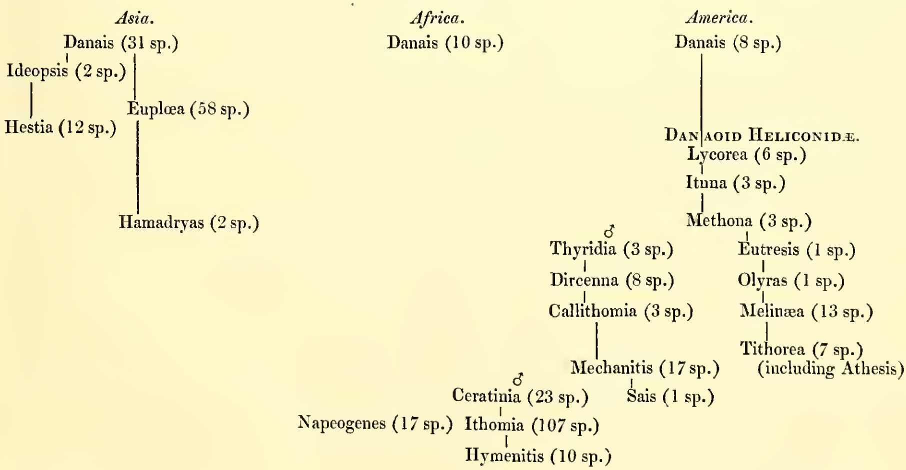
* I have adopted the terminology of Doubleday (Doubl., Hewits., and Westwood's Genera of Diurnal Lepidoptera) with regard to the neuration or veining of the wings, excepting that I call the "nervules" of the subcostal and median nervures "branches," and the "discoidal nervures" "radials," these alterations appearing necessary to prevent the verbal confusion of nervule with nervure, and discoidal with discocellular.

† The early states of these insects were not known to Doubleday. I reared, myself, *Heliconius Erato* (and *Doris*) and *Eueides Lybia*. We are acquainted, through other sources, with the larvæ of *H. Melpomene*, *H. Ricini*, and *Mechanitis Polymnia*.

‡ Since the above memoir was read, Dr. C. Felder of Vienna, in an article entitled, "Specimen Faunæ Lepidopterologicæ riparum Negro superioris in Brasilia septentrionali," 'Wiener Entomologische Monatschrift,' March 1862,

This view of the affinities of the family will make a great difference in the conception of the group as regards the affiliation of the forms. Instead of being a group isolated in its structure, and peculiar to the tropical parts of America, it results that the bulk of the genera have a very close relationship to the *Danaidæ*, which are found in all hot countries of both hemispheres: the *Acræoid Heliconidæ* alone are an isolated set of forms. The American productions, however, show a great superiority in structure and in the diversity of the forms over those of the Old World. In Africa only one genus occurs, namely, *Danais*. In the tropical parts of Asia four genera are found, besides *Danais*; these are *Ideopsis, Hestia, Euplœa,* and *Hamadryas*, which contain together 74 species. In the hot parts of America 16 genera (of *Danaoid Heliconidæ*) have been discovered, comprising 233 described species. Besides this greater diversity of generic and specific forms, the American productions show a much greater advance in organization than those of the Old World; in other words, they recede further from what may be considered as the common type, namely, *Danais*. This is clear from the great and progressive modification in the position of the radial nervures and discocellulars of the hind wings, and the advanced stage of atrophy of the male fore legs reached by most of the genera. In all the Asiatic genera the fore legs are in the same condition as in *Danais* and the *Nymphalidæ*. The following Table will show the relative value of the productions of the two hemispheres in a clearer manner. I have placed the genera in accordance with what seem to be their mutual affinities. The relative length of the lines between them is a rough expression of the degree of relationship. The collateral lines of connexion are also attempted to be expressed.

DANAIDÆ.



has ventured to withdraw the whole of the genera composing the group *Danaoid Heliconidæ*, placing them with the *Danaidæ*, and restricting the family *Heliconidæ* to the two genera *Heliconius* and *Eueides*. He has discovered an excellent and constant character for the *Danaidæ* (in which the *Danaoid Heliconidæ* participate), in addition to those already known, namely, the existence of a small nervule at the base of the fore-wing median nervure which ana-

There is a very wide dissimilarity in minor points and in general appearance between the Asiatic set of forms and the American: the only Old World genus which at all approaches the New World group is *Hamadryas*; but the shape, colours, and neuration of the wings show that it has no close affinity with them. The two sets of forms seem to agree, however, in habits, and apparently occupy the same sphere in the economy of nature in their respective countries. Mr. Wallace, who has had the good fortune to observe both in their native abodes, says, the habits of the South Asian *Euplœæ* (the most numerous genus) are precisely those of the *Heliconidæ*. The Asiatic *Danaidæ* are mostly above the middle size, and include some of the largest Butterflies known; their American equivalents are in general below the middle size. Both are extremely prolific or abundant in individuals, and are amongst the most characteristic productions of their respective countries. Each set, also, are the objects of numerous mimetic resemblances on the part of other Lepidopterous insects of their own region belonging to different families,—the Asiatic mimickers being modelled after the Asiatic *Danaidæ*, and the American after the American members of the same family. The entire dissimilarity of the two sets of forms would seem to teach us that there can have been no land communication east and west between the tropical parts of Asia and America since they first came into existence, and therefore that the great continents must have remained separate in those quarters from a very remote epoch to allow for such an extensive independent development of forms. They are both strictly confined to the hottest parts of their respective hemispheres. In America they are not found beyond the northern tropic, nor much further south than 30° S. lat. They are not known to occur so far from the equator as either tropic in the Old World, but are limited to the south-eastern parts of Asia and the islands of the New Guinea group. The genus *Danais*, with which we have seen both groups are connected, ranges as far north as 41° in Europe, and 45° in North America. It is interesting thus to find that the only genus which is common to the three tropical regions is the sole one of the family that occurs in high latitudes. The only means of communication between the intertropical lands of America and Asia seems to have been a circuitous route by the north (or south); and the essentially tropical forms do not appear to have passed along it. The fact of the peculiar equatorial Asiatic *Danaidæ* not reaching Africa is explicable on the same grounds as their entire distinctness from the American ones, namely, the non-existence of an equatorial connexion of land of a nature suitable for their transit between the two continents since the remote date when the first forms of the group came into being.

The habits of the *Heliconidæ* have been described by various travellers,—Lacordaire having given a complete account of the Cayenne species, and Dyson and Gosse some interesting notes on those of Venezuela and Jamaica. The total number of species described is 284, namely, 233 belonging to the Danaoid, and 51 to the Acræoid group. They are peculiarly creatures of the forests, and, like the Platyrrhine Monkeys, the arboreal

stomoses with the median a short distance from its origin. In the systematic part of the present memoir I shall follow Dr. Felder in this altered classification. The two groups which composed the family *Heliconidæ* are, it must be repeated, completely and widely distinct. Yet the analogical resemblance between them is so great, that some species of the one might easily be confounded (if not closely examined) with species of the other.

Gallinacea (*Penelopidæ* and *Cracidæ*), and other groups of the same region, point to the gradual adaptation of the fauna, during an immense lapse of time, to a forest-clad country.

I found on the banks of the Amazons 94 species (besides many local varieties, considered by some authors as species) of the two groups (67 Danaoid and 27 Acræoid), representing all the genera of the family but three. They are most numerous in those parts of the country where the forests are most extensive and the climate most sultry and humid. I found the number of species to increase in travelling from east to west, from the Lower Amazons towards the eastern slopes of the Andes. They were rare in the somewhat drier tract of country which borders the Lower Amazons about the middle of its course. I found in this large district only 26 species, namely, 10 belonging to the Danaoid and 16 to the Acræoid group. Within an area of about the same dimensions, in the moist region of the Upper Amazons, I collected 64 species, of which 42 were Danaoid and 22 Acræoid *Heliconidæ*. I should judge, from the collections received in England from those parts, that the hot Andean valleys near Bogota, or in Ecuador, contain a still larger number of species than the plains of the Upper Amazons. In the dry forests which clothe a great part of the banks of the Tapajos I found exceedingly few: at one locality, where I collected four months, and which was rich in other families of Lepidoptera, I saw only one species of the Danaoid and four of the Acræoid group. According to Dyson, many species (*Ithomiæ*) of the lowlands in Venezuela have a vertical range of 2000 feet, and some genera (*Hymenitis* [*H. Dercetis*], *Olyras*, *Eutresis*), which do not inhabit the Amazon region, occur at an elevation of 8000 feet. The species are exceedingly abundant in individuals wherever they occur: they show every sign of flourishing existence, although of slow flight, feeble structure, unfurnished with apparent means of defence, and living in places which are incessantly haunted by swarms of insectivorous birds. The pathways in the forest near towns are quite enlivened by the multitudes which fly about amongst the lower trees, in their bright dresses of orange, blue, and yellow, and red and black.

The mode of flight of the members of the two groups is somewhat different. The *Heliconii* and *Eueides* move along in a sailing manner, often circling round for a considerable time, with their wings horizontally extended. The species of the Danaoid group, for the most part, keep near the ground, and have a very slow irregular flight, settling frequently. They are all of social or gregarious habits. Not only do individuals of the same species congregate in masses, but the set of closely allied species which people a district keep together in one or more compact flocks. I noticed in four districts rich in Danaoid *Heliconidæ*, where I collected, that about half the species of *Ithomia* flew together in one circumscribed area of the forest, and the other half in a second similar locality, the rest of the tolerably uniform wooded country, in each case, being nearly untenanted by them. The larger species (*Heliconii*, *Lycoreæ*) frequent flowers, probing the nectaries with their proboscides; but the smaller kinds (*Ithomiæ*), and the members of the Danaoid group generally, are very rarely found thus occupied: I noticed them sometimes imbibing drops of moisture from leaves and twigs. The fine showy *Heliconii* often assemble in small parties, or by twos and threes, apparently to sport together or perform a kind of dance. I believe the parties are composed chiefly of males. The sport begins generally between a single pair: they advance, retire, glide right and left in face of each other, wheel round to a considerable distance, again approach, and so on: a third joins in, then a fourth, or more. They never touch: when too many are congregated, a general flutter takes place, and they all fly off, to fall in again by pairs shortly afterwards. The species which I have seen most frequently employed in this way is the *Heliconius Rhea*, a glossy blue-black species, with bright yellow belts across its wings.

The larvæ of the two or three species whose transformations I observed feed together in clusters on the leaves of trees of moderate elevation, near the places where the adult insects are found.

The majority of the species have very limited ranges. I was surprised, when travelling on the Upper Amazons from east to west, to find the greater part of the species of *Ithomiæ* changed from one locality to another, not further removed than 100 to 200 miles. For instance, there were 11 of these *Ithomiæ* at a place called Fonte Boa, and 9 at St. Paulo, 180 miles distant; but only two of the total number (20) were found in both localities. This is remarkable when we consider that the whole of the country of the Upper Amazons is a nearly level plain, uniformly covered with forest, and offering no perceptible difference in soil or other physical conditions. Five only out of the 20 species have been met with in any other part of South America. The areas of distribution of most of the remaining 15 must be, in each case, a very limited tract of country. The species which inhabit other parts of Tropical America must have similarly contracted ranges, if we may judge from the collections received in England from different districts.

Now, many of these local species have the appearance of being geographical varieties; I could not help suspecting them to be such when I met with them in nature, the differences between the forms of one and those of another locality relating in many cases simply to the colours and colour-patterns of the wings. The marks of distinction, however, are in the majority so well defined, so ordinarily common to all the individuals concerned, and there is so generally an absence of connecting links, that they are held on all hands to be good and true species. Moreover, in those cases already mentioned, where a number of very closely allied species fly together, they keep themselves perfectly distinct; there are no hybrid forms (I am speaking of the *Ithomiæ* and allied genera), and on observing individuals *in copula*, I almost always * found the pair to be precisely the same in colours and markings. In the multiplicity, apparent distinctness, and restricted ranges of the species, this group much resembles the family of Humming-birds of the same regions.

I believe, nevertheless, that the suspicion of many of the species being nothing more than local modifications of other forms has proved to be well founded. Amongst the great number of perfectly distinct and well-marked species, a few occurred which showed great variability: these, I think, afford a key to the explanation of the origin of the rest. The details of variation will be given under the head of each species:

* The exception was in the case of *Mechanitis Polymnia*, which, as will be seen, on referring to the account of it in its place, is a polymorphic species, whose local varieties are in an imperfect state of segregation.

those which supply the most decisive results are *Mechanitis Polymnia*, *Ithomia Orolina* and *Illinissa*, *Ceratinia Ninonia*, and the *Lycoreæ*. The varieties of these present all the different grades between simple individual differences and well-marked local varieties or races, which latter cannot be distinguished from true species, when two or more of them are found coexisting in the same locality without intercrossing, as takes place in *Ithomia Illinissa* and its allies, and probably in *Mechanitis Nesæa* and *Lysimnia*. A striking case of the production of a local variety now spread over a wide area, and undistinguishable from a true species, is afforded in *Heliconius Thelxiope*, to the details of which, given in the systematic part of this memoir, I must refer the reader.

These species, when carefully studied, seem to me conclusively to show that many of the now distinct species of *Heliconidæ* have arisen from local varieties, segregated from the variations of preexisting widely disseminated species; for these distinct forms or species do not essentially differ from the undoubted varieties of the species cited. The genera show different degrees of susceptibility of change under altered local conditions. Thus, many species of *Heliconius* (*H. Rhea*, *Clytia*, *Ricini*, *Vesta*, *Thelxiope*, *Antiocha*, &c.) are unchanged over the whole of the wide country which includes the areas of several successive local races of many *Ithomiæ* and *Napeogenes* *.

The process of the creation of a new species I believe to be accelerated in the *Ithomiæ* and allied genera by the strong tendency of the insects, when pairing, to select none but their exact counterparts: this also enables a number of very closely allied ones to exist together, or the representative forms to live side by side on the confines of their areas, without amalgamating.

The course followed by Nature in the formation of these numerous local species, I think, is clearly exhibited in *Mechanitis Polymnia*, to the details of which, given in its place, I must beg the reader to refer. We see here the manufacture, as it were, in process. The species is widely disseminated and variable. The external conditions in certain localities are more favourable to one or more of the varieties there existing than to the others; those favoured ones, therefore, prevail over the others. We find, in this most instructive case, all the stages of the process, from the commencement of the formation of a local variety (var. *Egaënsis*) to the perfect segregation of one (var. *Lysimnia*, considered by all authors as a true species). In this species, most of the local varieties are connected with their parent form by individuals exhibiting all the shades of variation; and it is on this account only that we know them to be varieties. In the species allied to *Ithomia Flora*, the forms are in a complete state of segregation (with the exception of *I. Illinissa*, which throws light on the rest), and therefore they are considered as species; they are, in fact, perfectly good species, like all other forms considered as such in natural history. It is only by the study of variable species that we can obtain a clue to the explanation of the rest. But such species must be studied in nature, and with

* These are *Ithomia Flora*, an inhabitant of the whole Lower Amazon region (from the Atlantic to the Rio Negro), which is represented by *I. Hippodamia* in Cayenne, and *I. Onega*, *Illinissa*, *Gunilla*, *Priscilla*, *Ilerdina*, in different areas on the Upper Amazon; *Napeogenes Cyrianassa*, which becomes *N. adelphe* on the banks of the Cupari (Tapajos), and *N. Tunantina* on the north bank of the Upper Amazons; *N. Inachia*, which is changed to *N. sulphurina* at Bahia, and to *N. Ercilla*, *N. Corena* and *N. Pharo* in different areas on the Upper Amazon. Other species might be added in confirmation. Most of the species of *Heliconius* quoted are found unchanged over the collective areas of all these forms of *Ithomia* and *Napeogenes*.

strict reference to the *geographical relations* of their varieties. Many closet naturalists, who receive disconnectedly the different varieties in any group, treat them all as independent species: by such a proceeding, it is no wonder that they have faith in the absolute distinctness and immutability of species.

The sexes in the *Heliconidæ* very rarely differ in colours. Secondary sexual characters of another description occur, however, very generally in the Danaoid group. The males, in all the genera but two (*Lycorea* and *Ituna*) of this section, are furnished with a pencil or fringe of long hairs near the costal edge of the hind wings on the upper surface. It sometimes arises from the bottom of a shallow horny cup situated between the costal and subcostal nervures; the hairs are long, soft, and adpressed. I was unable to discover any use in this structure; it seemed not to be under the control of the insect. There is no movement in flight, or position in repose, peculiar to the male sex, which might require an instrument to hold the wings together—a function which the position of the hairs, in the place where the fore wing overlaps the hind wing, suggests to the mind. I believe the appendage must be considered as an outgrowth of the male organization, which is not in this case applied to any especial purpose: it may be taken to be of the same nature as the pencil of hairs on the breast of the male Turkey. Growths of one kind or other, on the surface of the wings, peculiar to the male sex, are frequent in Butterflies: in *Danais* the males have a small horny excrescence on the disk of the hind wings, which, considering the near relationship proved to exist between the two groups, I take to be homologically the same as the pencil of hairs in the *Danaoid Heliconidæ*. In the genus *Pavonia*, belonging to the family *Brassolidæ*, the males in some species have a fringe of hairs near the abdominal border; in others, a long pencil of the same on the disk; and, again, in others, instead of these appendages, a thickened plate on the inner margin of the hind wings.

The most interesting part of the natural history of the *Heliconidæ* is the mimetic analogies of which a great many of the species are the objects. Mimetic analogies, it is scarcely necessary to observe, are resemblances in external appearance, shape, and colours between members of widely distinct families: an idea of what is meant may be formed by supposing a Pigeon to exist with the general figure and plumage of a Hawk. Most modern authors who have written on the group have mentioned the striking instances of this kind of resemblances exhibited with reference to the *Heliconidæ*; but no attempt has been made to describe them fully, nor to explain them. I will give a short account of the leading facts, and then mention some circumstances which seem to throw light on their true nature and origin.

A large number of the species are accompanied in the districts they inhabit by other species which counterfeit them in the way described. The imitators belong to the following groups:—*Papilio*, *Pieris*, *Euterpe*, and *Leptalis* (fam. *Papilionidæ*), *Protogonius* (*Nymphalidæ*), *Ithomeis* (*Erycinidæ*), *Castnia* (*Castniadæ*), *Dioptis*, *Pericopis*, *Hyelosia*, and other genera (*Bombycidæ* Moths)*. I conclude that the *Heliconidæ* are the *objects imitated*, because they all have the same family facies, whilst the analogous species are dissimilar to their nearest allies—perverted, as it were, to produce the resemblance, from

* The accompanying Table, in which a number of the most striking of these are arranged in parallel columns, will give some idea of the extent to which this system of imitation prevails.

Specific Mimetic Analogies in the Lepidoptera of Tropical America, especially between the dominant family Heliconidæ and different other families.

Danaoid Heliconidæ.	Acræoid Heliconidæ.	Acræidæ.	Papilioninæ.	Pierinæ.	Erycinidæ.	Castniadæ.	Bombycidæ.
Lycorea Atergatis	......	......	Papilio Zagreus*	Euterpe Eurytele* ..	......	......	Pericopis angulata.
Methona Psidii { Ituna Phenarete* / I. Ilione*	......	......	......	Leptalis Orise*	......	Castnia Linus*	P. *sp.*
Direenna Epidero	......	......	......	......	......	......	Hyelosia Tiresia.
Tithorea Bonplandii	Heliconius Hecuba.*						
Melinæa Egina	H. Sylvana.						
M. Pardalis	H. Pardalinus*.						
M. Lucifer	H. Aurora.						
M. Messatis	H. Ismenius.						
M. (?) Hezia	H. Zuleika.						
M. Mnasias*—Ceratinia Ninonia.							
M. Mneme	H. Numata.						
Mechanitis Egaënsis	H. Eucoma, var.	......	......	L. Egaëna*.			
M. Nesæa—Napeogenes Xanthone*.	H. Ethra	......	......	L. Astyoche*.			
M. Lysimnia	H. Eucrate.						
Callithomia Alexirhoë* — Ceratinia Ninonia.							
Ithomia Flora { I. Cymo ...... / Napeogenes Ithra*	......	......	......	L. Theonoë*	Ithomeis satellites* ..	......	Dioptis Cyma.
I. Phono	......	......	......	......	......	......	D. diaphana.
I. Illinissa and allies } Napeogenes Ercilla* ..	......	......	......	L. Lysinoë, *var.** ..	I. aurantiaca*	......	D. Æliana.
I. Chrysodonia and allies } N. Corena*	......	......	...... {	L. Erythroë* ...... *var.* of Theonoë.	I. mimica*	......	D. *sp.**
I. Ilerdina	......	......	...... {	L. Leuconoë* ...... *var.* of Theonoë.	}	...... {	Dioptis Ilerdina* } Pericopis, *sp.**
Ceratina Fluonia	......	......	......	......	......	......	Dioptis, *sp.**
Ithomia Onega	......	......	...... {	L. Melanoë* ...... *var.* of Theonoë.	I. Heliconina*	......	Dioptis Onega.
I. Virginia	......	......	...... {	L. Argochloë*. *var.* of Theonoë.			
I. Primula—Napeogenes Pharo.							
I. Euritæa—N. sulphurina.							
I. Eurimedia	......	......	......	L. Eumolia.			
I. Celemia—Napeogenes Tolosa.							
Ceratinia villula—N. Apulia	......	......	......	L. Siloë*.			
	Eueides Lampeto* ..	......	......	......	Stalachtis Calliope	......	Pericopis, *sp.**
	Heliconius Thelxiope	......	......	......	......	......	P. Isse*.
	H. Clytia	......	P. Pausanias*.				
	H. Vesta { Eueides Eanes*. / E. Thales.	Acræa Thalia.	......	L. Acreoides*	......	C. Acreoides*.	
			P. Zacynthus ♀	Euterpe Tereas.			
			P. Æneas and allies } ♀	......	......	......	Pericopis turbida*.
			P. Bolivar ♀	......	......	C. *sp.**	
				Leptalis Lysinoë* *var.* of Theonoë {	Ithomeis stalachtina* } Stalachtis Duvalii.		

* Those species marked * have been ascertained beyond all doubt to be very much fewer in individuals than the species which they mimic.

the normal facies of the genus or family to which they severally belong*. The resemblance is so close, that it is only after long practice that the true can be distinguished from the counterfeit, when on the wing in their native forests. I was never able to distinguish the *Leptalides* from the species they imitated, although they belong to a family totally different in structure and metamorphosis from the *Heliconidæ*, without examining them closely after capture. They fly in the same parts of the forest, and generally in company with the species they mimic.

I have already given an account of the local modifications to which the *Heliconidæ* are subject. It is a most curious circumstance, that corresponding races or species of counterfeiting groups accompany these local forms. In some cases I found proof that such species are modified from place to place to suit the peculiar forms of *Heliconidæ* there stationed. As this is an important point, and one which throws light on the origin of mimetic species, I must ask the reader's careful attention to the details, referring to the plates.

Plate LV. fig. 1 *a* (*Ithomia Flora*) and fig. 1 (*Leptalis Theonöe*) represent a Heliconide and its imitator, both of which inhabit the banks of the Cuparí, a river belonging to the Amazon system, in 55° W. long. Neither of these is found on the Upper Amazons (60° to 70° W. long.), where I made the remaining part of my observations on these insects. At Ega, on this upper river, in 65° W. long., two species of *Ithomia* occurred, which I consider to be local varieties or races of *I. Flora*, namely, *I. Onega* (Pl. LV. fig. 2 *a*) and *I. Illinissa* (Pl. LV. fig. 6 *a*). It is immaterial to the question in hand whether these be considered absolutely distinct species or races; the *Leptalis* which was found in their company was the form called *L. Lysinoë* (Pl. LV. fig. 3), with its admitted varieties (figs. 4, 5, 6, and 8). Only one of these varieties of *Leptalis* mimics an *Ithomia*; this is our fig. 6, which evidently counterfeits *Ithomia Illinissa* (fig. 6 *a*). The prevailing form of *Leptalis*, the *L. Lysinoë* (fig. 3), has no resemblance to any *Ithomia* of Ega, but is, when flying, a wonderful imitation of the *Stalachtis Duvalii* (Pl. LV. fig. 3 *a*), a common insect belonging to a genus (family *Erycinidæ*) equally flourishing and abundant in individuals with the members of the family *Heliconidæ*. I think there will be no doubt in the mind of any one that the Ega *Leptalides* are local varieties of the Cuparí *L. Theonoë* (fig. 1), when all the connecting links between them are studied in the figures given on our two plates. It is highly probable, therefore, that this species has been by some means modified with especial reference to the changed *Ithomiæ*, or other insects, of the locality. The varieties, figs. 4, 5, and 8, were excessively rare: they have the appearance of *sports*, and show how variable the species has been in this district.

The same takes place at St. Paulo, in 69° W. long. Here we find the *Ithomiæ* again changed. Neither the *I. Flora* of the Cuparí and Lower Amazons nor the *I. Illinissa* of Ega occurs; but the second Ega species, *I. Onega*, inhabits the district, and several other species not found in other places, amongst them *I. Ilerdina* (Pl. LVI. fig. 4 *a*), *I. Chrysodonia* (Pl. LVI. fig. 3 *a*), and *I. Virginia* (Pl. LVI. fig. 6 *a*). The prevailing species of

* This may be seen from the figures given of *Leptalis*,—fig. 5, Pl. LVI. being *L. Nehemia*, a species exhibiting the usual form of the family *Pieridæ*, to which the genus *Leptalis* belongs; whilst all the other *Leptalides* figured are mimetic species, totally unlike, as far as facies is concerned, this normal form.

Ithomia of the locality being thus changed, how stands it with the *Leptalides*? They are changed also, and again with close reference to the *Ithomiæ*. I found a number of different varieties, which I could not doubt were local forms of the same species as that found on the Cuparí and at Ega. Thus, there was one (Pl. LV. fig. 2) closely resembling *L. Theonoë* (fig. 1), but modified to produce a nearer imitation of the *Ithomia Onega* (Pl. LV. fig. 2 *a*), which I believe to be a local form of *I. Flora*. Another (Pl. LVI. fig. 3) resembled *Ithomia Chrysodonia* (Pl. LVI. fig. 3 *a*); but the imitation is not fixed or exact in all the specimens taken, as may be seen by comparing figs. 1, 2, 3, of the same Plate. We here detect nature, as it were, *striving* after a correct imitation: the explanation of this will be attempted further on. A third form of *Leptalis* found at St. Paulo is the one figured Pl. LVI. fig. 6, which mimics the *Ithomia Virginia* (Pl. LVI. fig. 6 *a*). Besides these, a few varieties occurred which did not closely counterfeit any *Ithomia*; they were very much rarer than the others. I figure two of these (Pl. LV. figs. 7, 9), to show how they connect the other more strongly modified varieties with the Ega forms.

The *Ithomiæ* concerned in these imitations have the character of true species, being distinct and constant, with the exception of *I. Chrysodonia*, whose varieties are detailed under the head of the species, which is variable, and throws light on the origin of the rest. They are all excessively numerous in individuals, swarms of each kind being found in the localities they inhabit. The *Leptalides* are exceedingly rare; they cannot be more than as 1 to 1000 with regard to the *Ithomiæ*. It may be asked, how can we know they are all varieties (using the term as meaning forms descended from others) of one species? I must refer to the figures given, which, although they do not include all the connecting varieties that were collected, show how nearly all the forms are linked together. The most distinct amongst them are those figured Pl. LVI. figs. 4 and 6. The feature which distinguishes fig. 4 is the white colour of the disk of the hind wings, and the veins which traverse it. This character is shown to be due to variation, from the facts that *Ithomia Oncidia*, an undoubted variety of *I. Chrysodonia* (or *Orolina*), exhibits a commencement of this milky shade of the wings, and that many individuals of *I. Ilerdina* (Pl. LVI. fig. 4 *a*) display steps of modification in the colours of the veins. The variety figured Pl. LVI. fig. 6, appears distinct, from the single pale spot near the tips of the wings; an approximation to this is seen in the variety figured Pl. LV. fig. 9, which is an undoubted modification of *L. Lysinoë* (Pl. LV. fig. 3). The remarkable variety figured Pl. LV. fig. 4 has been described by the only author who has treated on these insects (Mr. Hewitson) as a variety of *L. Lysinoë*. In a polymorphic form, like this *Leptalis*, none of the varieties can be taken from the rest and denominated species, (using the term as meaning forms which cannot have descended from other closely allied ones), without exercising the art of species-making in the most arbitrary manner. For if we allow so great a latitude to variation as that from figs. 3 to 4, 5, 6, 7, 8, and 9, Pl. LV., how can we venture to say that natural modification, having gone so far, was incompetent to go further, so as to produce figs. 4 and 6, Pl. LVI., and that those forms must have arisen by some unknown agency? It is true, they have not arisen by simple variation, or *sports*, in one generation, but, as we shall presently see, by an external agency accumulating the modifications of many generations in two diverging directions. As the connecting links have not all been found, they may be called species: the word is of little importance. The habits of all are the same. When I had collected only two or three of the most distinct, I considered them separate species; but intermediate forms successively occurred, every capture tending to link the whole more closely together. The explanation that the whole are the result of hybridization from a few originally distinct species cannot at all apply in this case, because the distinct forms whose inter-crossing would be required to produce the hybrids are confined to districts situated many hundred miles apart.

None of these *Leptalides* have been found in any other district or country than those inhabited by the *Ithomiæ* which they counterfeit. A species very closely allied to *L. Lysinoë*, var. *Argochloë* (Pl. LVI. fig. 6), has been received from Mexico (*L. Antherize*); but an *Ithomia*, of nearly the same colours (*I. Nero*) also inhabits Mexico. Many other species of *Leptalis*, of much larger size than the one here discussed, also mimic *Heliconidæ*, the objects of imitation not being *Ithomiæ*, but other genera of the family. Two of these are figured on Pl. LVI. *L. Orise* (Pl. LVI. fig. 8) is a remarkably exact counterfeit of *Methona Psidii* (fig. 8 *a*), the resemblance being carried to minutiæ, such as the colour of the antennæ and the spotting of the abdomen. *L. Amphione*, var. *Egaëna* (Pl. LVI. fig. 7), is very curious, as being a satellite of *Mechanitis Polymnia*, var. *Egaënsis* (fig. 7 *a*), both peculiar to the district of Ega,—the typical *L. Amphione* being found at Surinam, in company with the typical *M. Polymnia*, which it resembles—local varieties or sister species of *Leptalis Amphione* accompanying local varieties of *Mechanitis Polymnia* in other parts of tropical America.

Several species of *Dioptis*, a genus of Moths, and *Ithomeis*, a genus of *Erycinidæ*, also accompany these species or distinct local forms of *Ithomia*. A few of the Moths are figured on Pl. LV. figs. 10, 11, 12, 13. The imitations may not appear very exact from the figures; but when the insects are seen on the wing in their native woods, they deceive the most experienced eye.

A similar series of mimetic analogies occurs in the Old World, between the Asiatic and African *Danaidæ*, or representatives of the *Heliconidæ*, and species of other families of Butterflies and Moths. No instance is known in these families of a tropical species of one hemisphere counterfeiting a form belonging to the other. A most remarkable case of mimicry has been recorded by Mr. Trimen* in a *Papilio* of Southern Africa, *P. Cenea*, whose male wears to deception the livery of one species of *Danais*, namely, *D. Echeria*, whilst the female resembles a quite different one, *D. Chrysippus*,—both African. Mimetic analogies, however, are not confined to the Lepidoptera; most orders of insects supply them; but they are displayed only by certain families. Many instances are known where parasitic Bees and two-winged Flies mimic in dress various industrious or nest-building Bees, at whose expense they live in the manner of the Cuckoo. I found on the banks of the Amazons many of these Cuckoo Bees and Flies, which all wore the livery of working Bees peculiar to the country.

The instances of this kind of analogy most familiar to European entomologists are those of the European species of *Trochilium* (a genus of Moths), which strangely mimic various

* 'Rhopalocera Africæ Australis,' p. 21. Cape Town.

Bees, Wasps, and other Hymenopterous and Dipterous insects. The parallelism between these several forms and their geographical relations have not yet, I believe, been investigated. The resemblances seem to be more closely specific in tropical countries than in Europe; and I think it likely that the counterfeits in high latitudes may not always be found in company with their models. It is possible the geographical relations between the species concerned may have been disturbed by the great climatal and geological changes which have occurred in this part of the world since the date when they first came into existence.

Not only, however, are *Heliconidæ* the objects selected for imitation; some of them are themselves the imitators; in other words, they counterfeit each other, and this to a considerable extent. Species belonging to distinct genera have been confounded, owing to their being almost identical in colours and markings; in fact, many of them can scarcely be distinguished except by their generic characters. It is a most strange circumstance connected with this family, that its two sections, or subfamilies, have been mingled together by all authors, owing to the very close resemblance of many of their species. Analogies between the two subfamilies have been mistaken for affinities. It is sometimes difficult to understand in these cases which is the imitator and which the imitated. We have, however, generally a sure test in the one set exhibiting a departure from the normal style of colouring of their congeners, whilst the other are conformable to their generic types. The species of *Napeogenes* are, by this criterion, evidently all imitators of *Ithomiæ*; they are also rare insects, like the *Leptalides*. The mimetic species of *Heliconius* must be, for the same reason, imitators.

These imitative resemblances, of which hundreds of instances could be cited, are full of interest, and fill us with the greater astonishment the closer we investigate them; for some show a minute and palpably intentional likeness which is perfectly staggering. I have found that those features of the portrait are most attended to by nature which produce the most effective deception when the insects are seen in nature. The faithfulness of the resemblance, in many cases, is not so striking when they are seen in the cabinet. Although I had daily practice in insect-collecting for many years, and was always on my guard, I was constantly being deceived by them when in the woods. It may be asked, why are mimetic analogies so numerous and amazingly exact in insects, whilst so rare and vague in the higher animals*? The only answer that I can suggest is, that insects have perhaps attained a higher degree of specialization, after their type, than most other classes: this seems to be shown by the perfection of their adaptive structures and instincts. Their being more numerous and striking in tropical than in temperate countries is perhaps attributable to the more active competitive life, and the more rapid succession of their generations, in hot than in cold countries.

It is not difficult to divine the meaning or final cause of these analogies. When we

* Two instances of mimicry in birds, quite as wonderful as those between *Leptalis* and *Ithomia*, have just been communicated to me by my old travelling companion, Mr. A. R. Wallace. He has observed two species of *Oriolidæ* (perverted from the normal facies of the family) attendant on two species of *Meliphagidæ*, and mimicking them in the most curiously minute way in colours and in general figure. The associated pairs inhabit separate islands, as follows:—
—I. Bourou, *Mimeta* (*Oriolidæ*) *Bouroënsis*, *Tropidorhynchus* (*Meliphagidæ*), n. sp.; I. Ceram, *Mimeta Forstini*, *Tropidorhynchus subcarinatus*.

see a species of Moth which frequents flowers in the daytime wearing the appearance of a Wasp, we feel compelled to infer that the imitation is intended to protect the otherwise defenceless insect by deceiving insectivorous animals, which persecute the Moth, but avoid the Wasp. May not the Heliconide dress serve the same purpose to the *Leptalis*? Is it not probable, seeing the excessive abundance of the one species and the fewness of individuals of the other, that the Heliconide is free from the persecution to which the *Leptalis* is subjected?

I think it clear that the mutual resemblance in this and other cases cannot be entirely due to similarity of habits or the coincident adaptation of the two analogues to similar physical conditions. This is a very abstruse part of our subject; for I think the facts of similar variation in two already nearly allied forms do sometimes show that they have been affected in a similar way by physical conditions. A great number of insects are modified in one direction by a seaside habitat. I found, also, the general colours of many widely different species affected in a uniform way in the interior of the South American continent. But this does not produce the specific imitation of one species by another; it only prepares the way for it.

It is perhaps true that the causes (to be discussed presently) which produce a close or mimetic analogy cannot operate on forms which have not already a general resemblance, owing to similarity of habits, external conditions, or accidental coincidence. Species or groups which have this kind of resemblance to each other have been called by Dr. Collingwood recurrent animal forms. The English Bee-Moths owe the narrow and pointed shapes of their wings, which already approximate them to Bees, to their blood-relationship to the Hawk-Moth family. Their Bee-like size, form, and flight doubtless arise from their Bee-like habits. A close specific analogy between any one of these and a Bee, such as exists between the insects discussed in this memoir, could scarcely be due to an accidental resemblance like that between the Hawk-Moth and a Bee, or to similarity of habits. It would mean an adaptation of the Moth with especial reference to the Bee.

I believe, therefore, that the specific mimetic analogies exhibited in connexion with the *Heliconidæ* are adaptations—phenomena of precisely the same nature as those in which insects and other beings are assimilated in superficial appearance to the vegetable or inorganic substance on which, or amongst which, they live. The likeness of a Beetle or a Lizard to the bark of the tree on which it crawls cannot be explained as an identical result produced by a common cause acting on the tree and the animal.

Some of the imitations by insects of inanimate and living objects are very singular, and may be mentioned in this place. Many caterpillars of Moths, but sometimes the cases only which are manufactured and inhabited by the caterpillars, have a most deceptive likeness to dry twigs and other objects. Moths themselves very frequently resemble the bark on which they are found, or have wings coloured and veined like the fallen leaves on which they lie motionless. The accidental general resemblance between the shape of Moths' wings and leaves here gives nature the ground-work for much mimetic analogy. It has been pointed out by Rössler * that the Buff-tip Moth, when at rest, is intended to represent a broken piece of lichen-covered branch,

* In an article on resemblances between insects and vegetable substances (Wiener Entomol. Monatschrift, 1861,

—the coloured tips of these wings, when they are closed, resembling a section of the wood. Other Moths are deceptively like the excrement of birds on leaves. I met with a species of Phytophagous Beetle (*Chlamys pilula*) on the Amazons, which was undistinguishable by the eye from the dung of Caterpillars on foliage. These two latter cases of imitation should be carefully considered by those who would be inclined to think that the object of mimetic analogies in nature was simply variety, beauty, or ornament: nevertheless these are certainly attendants on the phenomena; some South-American *Cassidæ* resemble glittering drops of dew on the tips of leaves, owing to their burnished pearly gold colour. Some species of Longicorn Coleoptera (*Onychocerus scorpio* and *concentricus*) have precisely the colour and sculpture of the bark of the particular species of tree on which each is found. It is remarkable that other species of the same small group of *Longicornes* (*Phacellocera Buquetii*, *Cyclopeplus Batesii*) counterfeit, not inanimate objects, like their near kindred just cited, but other insects, in the same way as the *Leptalides* do the *Heliconidæ*.

Amongst the living objects mimicked by insects are the predacious species from which it is the interest of the mimickers to be concealed. Thus, the species of *Scaphura* (a genus of Crickets) in South America resemble in a wonderful manner different Sand Wasps of large size, which are constantly on the search for Crickets to provision their nests with. Another pretty Cricket, which I observed, was a good imitation of a Tiger Beetle *, and was always found on trees frequented by the Beetles (*Odontocheilæ*). There are endless instances of predacious insects being disguised by having similar shapes and colours to those of their prey; many Spiders are thus endowed: but some hunting Spiders mimic flower-buds, and station themselves motionless in the axils of leaves and other parts of plants to wait for their victims.

The most extraordinary instance of imitation I ever met with was that of a very large Caterpillar, which stretched itself from amidst the foliage of a tree which I was one day examining, and startled me by its resemblance to a small Snake. The first three segments behind the head were dilatable at the will of the insect, and had on each side a large black pupillated spot, which resembled the eye of the reptile: it was a poisonous or viperine species mimicked, and not an innocuous or colubrine Snake; this was proved by the imitation of keeled scales on the crown, which was produced by the recumbent feet, as the Caterpillar threw itself backwards. The Rev. Joseph Greene, to whom I gave a description, supposes the insect to have belonged to the family *Notodontidæ*, many of which have the habit of thus bending themselves. I carried off the Caterpillar, and alarmed every one in the village where I was then living, to whom I showed it. It unfortunately died before reaching the adult state.

p. 164). The author enumerates many very singular cases of mimicry; he also states his belief that the mimicry is intended to protect the insects from their enemies.

There is an interesting note, by the Rev. Joseph Greene, in the 'Zoologist,' 1856, p. 5073, on the autumn and winter Moths of England, whose colours are shown by the author to be adapted to the prevailing tints of nature in the season in which the species appear.

* A remarkable instance of deceptive analogy relating to a Cricket and a species of *Cicindela* is described by Westwood in Trans. Lin. Soc. vol. xviii. p. 419. In this memoir, Mr. Westwood has enumerated many curious cases of mimetic analogy.

I think it will be conceded that all these various kinds of imitative resemblances belong to the same class of phenomena, and are subject to the same explanation. The fact of one species mimicking an inanimate object, and another of an allied genus a living insect of another family, sufficiently proves this. I do not see how they differ from the adaptations of organs or instincts to the functions or objects they relate to. All are adaptations, either of the whole outward dress or of special parts, having in view the welfare of the creatures that possess them.

Every species in nature may be looked upon as maintaining its existence by virtue of some endowment enabling it to withstand the host of adverse circumstances by which it is surrounded. The means are of endless diversity. Some are provided with special organs of offence, others have passive means of holding their own in the battle of life. Great fecundity is generally of much avail, added to capabilities, active or passive, of wide dispersion; so that when the species is extirpated in one part of its area of distribution, the place is refilled by migration of individuals from another part. A great number have means of concealment from their enemies, of one sort or other. Many are enabled to escape extermination, or obtain subsistence, by disguises of various kinds: amongst these must be reckoned the adaptive resemblance of an otherwise defenceless species to one whose flourishing race shows that it enjoys peculiar advantages.

What advantages the *Heliconidæ* possess to make them so flourishing a group, and consequently the objects of so much mimetic resemblance, it is not easy to discover. There is nothing apparent in their structure or habits which could render them safe from persecution by the numerous insectivorous animals which are constantly on the watch in the same parts of the forest which they inhabit. It is probable they are unpalatable to insect enemies. Some of them (*Lycorea, Ituna*) have exsertible glands near the anus, which are protruded when the insects are roughly handled; it is well known that similar organs in other families (*Carabidæ, Staphylinidæ*) secrete fetid liquids or gases, and serve as a protection to the species. I have noticed also that recently killed specimens of Danaoid *Heliconidæ*, when set out to dry, were always less subject than other insects to be devoured by vermin. They have all a peculiar smell*. I never saw the flocks of slow-flying *Heliconidæ* in the woods persecuted by birds or Dragon-flies, to which they would have been easy prey; nor, when at rest on leaves, did they appear to be molested by Lizards or the predacious Flies of the family *Asilidæ*, which were very often seen pouncing on Butterflies of other families. If they owe their flourishing existence to this cause, it would be intelligible why the *Leptalidæ*, whose scanty number of individuals reveals a less protected condition, should be disguised in their dress, and thus share their immunity.

This explanation, however, would not apply to the imitation of Danaoid *Heliconidæ* by other species of the same subfamily. Moreover, there are several genera of other groups (*e. g.*, *Heliconius*, *Papilio*) which contain mimetic species side by side with species that are the objects of mimicry by members of other families, as will be seen by reference to the Table at p. 503. There is no reason to conclude that some of these possess the peculiar means of defence of the Danaoid *Heliconidæ*, whilst their near kindred are de-

* Mr. Wallace tells me the *Euplœæ* of the Eastern Archipelago have also this peculiar smell.

prived of them. It is not unreasonable to suppose that some species are taken by insectivorous animals, whilst others flying in company with them are avoided. I could not, from their excessive scarcity, ascertain on the spot that the *Leptalides* were thus picked out. I noticed, however, that other genera of their family (*Pieridæ*) were much persecuted. We have proof, in the case of Sand-Wasps, which provision their nests with insects, that a single species is very generally selected out of numbers, even of the same genus, existing in the same locality. I was quite convinced in the case of *Cerceris binodis* of South America, which destroys numbers of a *Megalostomis* (family *Clythridæ*), that the great rarity of the Beetle was owing to its serving as prey to the *Cerceris*. We cannot point out all the conditions of life of each species concerned in these mimetic analogies. All that we can say is, that some species show, by their great abundance in the adult state, that during this period, before they propagate their kind, they enjoy by some means immunity from effective persecution, and that it is therefore an advantage to others not so fortunate, and otherwise unprovided for, if they are so like as to be mistaken for them.

The process by which a mimetic analogy is brought about in nature is a problem which involves that of the origin of all species and all adaptations. What I have previously said regarding the variation of species, and the segregation of local races from variations, the change of species of *Heliconidæ* from one locality to another, and the probable vital necessity of their counterfeits which accompany them keeping to the exact imitation in each locality, has prepared the way to the explanation I have to give. In the cases of local variation of the *Heliconidæ*, there was nothing, as before remarked, very apparent in the conditions of the localities to show why one or more of the varieties should prevail in each over their kindred varieties. There was nothing to show plainly that any cause of the formation of local varieties existed, other than the direct action of physical conditions on the individuals, although this might be seen to be clearly incompetent to explain the occurrence of several varieties of the same species in one locality. We could only conclude, from the way in which the varieties occur in nature, as described in the case of *Mechanitis Polymnia*, that the local conditions favoured the increase of one or more varieties in a district at the expense of the others—the selected ones being different in different districts. What these conditions were, or have been, was not revealed by the facts. With the mimetic species *Leptalis Theonoë* the case is different. We see here a similar segregation of local forms to that of *Mechanitis Polymnia*; but we believe we know the conditions of life of the species, and find that they vary from one locality to another. The existence of the species, in each locality, is seen to depend on its form and colours, or *dress*, being assimilated to those of the *Ithomiæ* of the same district, which *Ithomiæ* are changed from place to place, such assimilation being apparently its only means of escaping extermination by insectivorous animals. Thus we have here the reason why local races are formed out of the natural variations of a species: the question then remains, how is this brought about?

The explanation of this seems to be quite clear on the theory of natural selection, as recently expounded by Mr. Darwin in the 'Origin of Species.' The local varieties or races cannot be supposed to have been formed by the direct action of physical conditions on the individuals, because, in limited districts where these conditions are the same, the most widely contrasted varieties are found existing together, and it is inexplicable how they could have produced the nice adaptations which these diverse varieties exhibit. All the varieties figured on Pl. LV. figs. 2, 7, 9, and on Pl. LVI. figs. 1, 2, 3, 4, 6, are found at St. Paulo, within a mile of each other, in the same humid forest. Neither can these adapted races, as before remarked, have originated in one generation by *sports* or a single act of variation in each case. It is clear, therefore, that some other active principle must be here at work to draw out, as it were, steadily in certain directions the suitable variations which arise, generation after generation, until forms have resulted which, like our races of *Leptalis Theonoë*, are considerably different from their parent as well as their sister forms. This principle can be no other than natural selection, the selecting agents being insectivorous animals, which gradually destroy those sports or varieties that are not sufficiently like *Ithomiæ* to deceive them. It would seem as though our *Leptalis* naturally produced simple varieties of a nature to resemble *Ithomiæ*; it is not always so, as is proved by many of them figured in the places above quoted. There is some general resemblance, it is true; and this is not purely accidental; for it is quite natural that the parent *Leptalis* should produce offspring varying in the direction of *Ithomiæ*, being itself similar to an *Ithomia*, and having inherited the property of varying in this manner through a long line of ancestors. We cannot ascertain, in this case, whether changed physical conditions have had any effect, quantitative or qualitative, on the variability of the species after migrating to a new district. At any rate, the existing varieties of our *Leptalis* show that the variations of *Leptalis* and *Ithomia* are not quite coincident, and that the agency of natural selection is required to bring the slowly forming race of one to resemble the other. I do not forget that at each step of selection the forms of *Leptalis* must have had sufficient resemblance to an *Ithomia* to lead to their preservation, or, at least, to prevent their complete extinction: as, however, the two analogues so much resemble each other at the commencement of the process, these steps would not be numerous. In many cases of mimetic resemblance, the mimicry is not so exact as in the *Leptalides*. This would show either that the imitator has only inherited its form from remote ancestors who were actively persecuted, the persecution having ceased during the career of its immediate ancestors; or it would show that the persecutor is not keen or rigid in its selection; a moderate degree of resemblance suffices to deceive it, and therefore the process halts at that point. I leave out of consideration all resemblances which can only be accidental, or which are resemblances of affinity.

If a mimetic species varies, some of its varieties must be more and some less faithful imitations of the object mimicked. According, therefore, to the closeness of its persecution by enemies, who seek the imitator, but avoid the imitated, will be its tendency to become an exact counterfeit,—the less perfect degrees of resemblance being, generation after generation, eliminated, and only the others left to propagate their kind. The actual state of *Leptalis Theonoë* is not the same in all of its three districts. A few varieties, or *sports*, are seen at Ega (65° W. long.) and St. Paulo (69° W. long.), namely, those figured Pl. LV. figs. 4, 5, 7, 8, and 9, which have an indeterminate resemblance. On the Cuparí

(55° W. long.) the resemblance is perfect (Pl. LV. fig. 1); and this is the only form of the *Leptalis* known in the locality. The varieties figured Pl. LVI. figs. 1, 2, 3, show different degrees of resemblance to *Ithomia Chrysodonia* (fig. 3 *a*); these, therefore, exhibit the selection in process. Thus, although we are unable to watch the process of formation of a new race as it occurs in time, we can see it, as it were, at one glance, by tracing the changes a species is simultaneously undergoing in different parts of the area of its distribution.

The fact of one of the forms of *Leptalis Theonoë*, namely *L. Lysinoë*, mimicking at Ega, not an *Ithomia*, but a flourishing species of another quite distinct family (*Stalachtis Duvalii*), shows that the object of the mimetic tendencies of the species is simply disguise, and that, the simple individual differences in that locality being originally in the direction, not of an *Ithomia*, but of another object equally well answering the purpose, selection operated in the direction of that other object. This point is well illustrated by the species of a small group of Longicorn Beetles already cited, some of which mimic a piece of bark, and others insects of another family—and by hunting Spiders, many of which wear the form of insects, and many that of inanimate objects amongst which they seek their prey.

When the persecution of a variable local form of our *Leptalis* is close or long continued, the indeterminate variations naturally become extinct; nothing then remains in that locality but the one exact counterfeit, whose exactness, it must be added, is henceforward kept up to the mark by the insect pairing necessarily with its exact counterpart, or breeding *in and in*. This is the condition of *Leptalis Theonoë* (Pl. LV. fig. 1) in its district; and it is the condition of all those numerous species of different orders which now appear fixed and distinct. When (as happens at St. Paulo, where a greater abundance of individuals and species, both of *Ithomia* and *Leptalis*, exists than in the locality of the last-named) many species have been in course of formation out of the varieties of one only, occasional intercrossing may have taken place; this would retard the process of segregation of the species, and, in fact, aid in producing the state of things (varieties and half-formed species) which I have already described as there existing.

In what way our *Leptalis* originally acquired the general form and colours of *Ithomiæ* I must leave undiscussed. We may conclude (if we are to reason at all from existing facts) that, as the antecedent forms of our races of *Leptalis* which are still undergoing change were themselves similar to *Ithomiæ*, the form has been inherited through a long line of ancestors, which have been more or less subjected to similar conditions. The instance of one of our forms leaving the *Ithomiæ* to mimic a species of another family may show us how a new line of mimetic analogy and gradual modification may have been originally opened.

Such, I conceive, is the only way in which the origin of mimetic species can be explained. I believe the case offers a most beautiful proof of the truth of the theory of natural selection. It also shows that a new adaptation, or the formation of a new species, is not effected by great and sudden change, but by numerous small steps of natural variation and selection. Some of the mutual resemblances of the *Heliconidæ* already mentioned seem not to be due to the adaptation of the one to the other, but rather, as they have a real affinity, the genera to which they belong being throughout very similar in colours and markings, and all equally flourishing, to the similar adaptation of all to the same local, probably inorganic, conditions. The selecting agent, which acts in each locality by destroying the variations unsuitable to the locality, would not in these cases be the same as in *Leptalis*; it may act, for anything we know, on the larvæ; in other respects, however, the same law of nature appears, namely, the selection of one or more distinct varieties by the elimination of intermediate gradations *. The conditions of life of these creatures are different in each locality where one or more separate local forms prevail, and those conditions are the selecting agents. With regard to the *Leptalides*, I believe we may be said to know these conditions. To exist at all in a given locality, our *Leptalis Theonoë* must wear a certain dress, and those of its varieties which do not come up to the mark are rigidly sacrificed. Our three sets of *Leptalides* may be compared to a variable flowering plant in the hands of a number of floriculturists, whose aims are different, each requiring a different colour of flower, and attaining his end by "roguing" or destroying all variations which depart from the standard.

It may be remarked that a mimetic species need not always be a rare one, although this is very generally the case; it may be highly prolific, or its persecution may be intermitted when the disguise is complete.

The operation of selecting agents, gradually and steadily bringing about the deceptive resemblance of a species to some other definite object, produces the impression of there being some innate principle in species which causes an advance of organization in a special direction. It seems as though the proper variation always arose in the species, and the mimicry were a predestined goal. This suggested the only other explanations that I have heard of, namely, that there may be an innate tendency in the organization to become modified in a given direction—or that the parent insect, being powerfully affected by the desire of concealment from the enemies of its race, may transmit peculiarities to its offspring that help it to become modified, and thus, in the course of many generations, the species becomes gradually assimilated to other forms or objects. On examination, however, these explanations are found to be untenable, and the appearances which suggest them illusory. Those who earnestly desire a rational explanation, must, I think, arrive at the conclusion that these apparently miraculous, but always

* Some of the close resemblances amongst the *Heliconidæ* themselves seem to be kept up by their varying in a precisely similar way. There is a very singular instance in three species of three different genera, *Melinæa, Mechanitis* (*Mothone*), and *Heliconius*, which are all, in East Peru, orange and black in colour, and in New Granada orange, black, and yellow. This seems to be a case of coincident, simple variation; for if three forms are quite alike in colours, it is conceivable that they may vary alike when placed under new conditions by migration. Our *Leptalides* have been shown not to vary precisely like their models; and therefore the case just quoted does not throw any difficulty in the way of the explanation I have given; but it is a very extraordinary one.

I have not thought it necessary to mention cases of close resemblances in insects which are only accidental, or which are explicable by the blood-relationship or affinity existing between the species which display them. Some orders of insects contain an almost infinite variety of forms, and it will not be wonderful, therefore, if species here and there be found to resemble each other, although inhabiting opposite parts of the earth, and belonging to widely different families. Such analogies are accidental, and can have nothing at all to do with the evidently intentional system of resemblances, carried on from place to place, which I have discussed. Some cosmopolitan families present very similar species in all parts of the earth; it can scarcely be necessary to say that close resemblances between New and Old World forms in these cases are resemblances of affinity, and not mimetic analogies.

beautiful and wonderful, mimetic resemblances, and therefore probably every other kind of adaptation in beings, are brought about by agencies similar to those we have here discussed.

HELICONIDÆ.

I have mentioned, in a note at p. 496, that I should follow the example of Dr. Felder in separating the Danaoid *Heliconidæ* from the remainder of the family, and combining them with the *Danaïdæ*. I shall, however, consider these groups as subfamilies, instead of families. The modifications in the classification thus introduced will be seen by the following synopsis of the section Rhopalocera.

Order LEPIDOPTERA.

Section Rhopalocera.

Family 1. Hesperidæ. Six perfect legs in ♂ ♀; hind tibiæ, with few exceptions, having two pair of spurs. Larva inhabiting a rolled-up leaf; pupa secured by many threads, or enclosed in a slight cocoon. (These characters approximate the family to the Moths, or Heterocera).

Family 2. Papilionidæ. Six perfect legs in ♂ ♀. Wing-cells (at least, of the hind wings) closed by perfect tubular nervules. Hind tibiæ with one pair of spurs. Pupa secured by the tail and a girdle across the middle in an upright position. (The *Papiliones* have a leaf-like appendage to the fore tibiæ, as pointed out recently by Dr. Adolf Speyer; the character approximates the family to the Hesperidæ and Moths.)

Family 3. Lycænidæ. Six perfect legs in ♀; four in ♂; the fore tarsi wanting the tarsal claws, but densely spined beneath. Wing-cells (except in *Eumæus*) not closed by perfect nervules. Pupa secured by the tail and a girdle across the middle.

Family 4. Erycinidæ. Six perfect legs in ♀; four in ♂; the fore tarsi consisting only of one or two joints, and spineless.

Subfam. 1. Erycininæ. Pupa recumbent, flattened beneath, secured by the tail and a girdle across the middle.

Subfam. 2. Stalachtinæ. Pupa not flattened beneath, secured rigidly by the tail in an inclined position, without girdle.

Subfam. 3. Libythæinæ. Pupa suspended freely by the tail.

Family 5. Nymphalidæ. Fore legs imperfect in both sexes; in the ♀ wanting the tarsal claws; in the ♂ the fore tarsi aborted, consisting of one or two joints. Pupa suspended freely by the tail.

a. Lower disco-cellular nervule, especially of the hind wing, more or less atrophied.

Subfam. 1. Nymphalinæ (*Nymphalidæ, Ageronidæ, Eurytelidæ,* and *Morphidæ*, part, of authors).

b. Lower disco-cellular nervule perfect.

Subfam. 2. Heliconinæ.

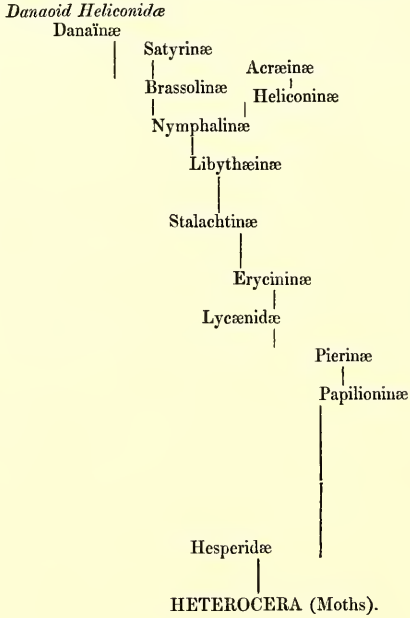
Subfam. 3. Acræïnæ.

Subfam. 4. Brassolinæ.

Subfam. 5. Satyrinæ.

Subfam. 6. Danaïnæ.

The *Danaoid Heliconidæ*, as before mentioned, are considered to stand at the head of the order Lepidoptera, as being the perfection of the Lepidopterous type. This position might be disputed with them by the *Satyrinæ* on account of the degree of atrophy of the fore legs, which is perhaps as great in some species of *Satyrinæ* as it is in the most advanced genera of Danaoid *Heliconidæ.* The order of affinities does not range in a line; there are branches; and so it may happen that two groups may be nearly equal in their grade of perfection through each standing at the head of its branch. The true relationships of the groups of Rhopalocera may be therefore better explained by a diagram.



Subfamily DANAÏNÆ.

A. Danaïnæ proper
(*Danaïdæ* of authors).

Genus Danaïs, Latreille.

1. Danaïs Erippus, Cramer.

Papilio Erippus, Cram. Pap. Exot. t. 3. f. A, B.

A common and well-known insect. It is found in waste grounds and open places everywhere throughout the region of the Lower Amazons. Its larva feeds on *Asclepias Curassovica.*

2. Danaïs Gilippus, Cramer.

Papilio Gilippus, Cram. Pap. Exot. t. 26. f. C, D.

This is a rarer species than the foregoing. It is found in similar situations at Pará.

3. DANAÏS ERESIMUS, Cramer.

Papilio Eresimus, Cram. Pap. Exot. t. 175. f. G, H.

This is the common species in the interior of the country. It is very abundant at Ega, on the Upper Amazons, where *D. Erippus* did not occur.

B. DANAOID HELICONIDÆ

(*Heliconidæ*, part, of authors).

Genus LYCOREA, Doubleday.

Doubleday and Hewitson, Gen. Diurn. Lepid. p. 107.

The six described species of this genus differ from each other by such slight characters (small differences in colours, and in the arrangement of the pattern on the wings, being the only points which distinguish them), that they might fairly be considered as varieties of one only. I have not yet seen specimens, however, which connect all the forms together, and these are mostly the products of different geographical areas; it will be more convenient therefore to treat them independently, than to combine them under the head of one polymorphic species. A good collection of specimens from all parts of the area of distribution of the genus would here be very instructive. We should then be able to ascertain the metropolis and probable area of origination of each of the various forms. I have seen only *L. Halia* in collections from S.E. Brazil. *L. atergatis* is peculiar to Columbia and the Upper Amazon region; but a striking variety of it prevails over the type in this last-mentioned district, and another, *L. Pales* (Felder), occurs on the Rio Negro. *L. Cleobæa* (which is scarcely more different from *L. atergatis* than the just-mentioned *L. atergatis,* var., is from its type) is reputed to occur in the West India Islands. At Pará three forms, including *L. Halia,* are found together; and here some intermediate varieties occur, making it probable that the segregation of the quasi-species is not in that district complete.

1. LYCOREA CERES, Cramer.

Papilio Ceres, Cramer, Pap. Exot. t. 90. f. A.

This species occurs in the Amazon region at Pará, and on the banks of the Tapajos. It is also an inhabitant of Surinam. Cramer's figure is made from an example rather aberrant in the markings of the hind wings; otherwise it agrees very well with the specimens I have before me. I have a variety from Pará which connects this form with *L. Halia.*

2. LYCOREA PASINUNTIA, Cramer.

Papilo Pasinuntia, Cram. Pap. Exot. t. 316, A, B, C.

This form occurs throughout the whole of the Amazon region, from 48° to 70° W. long. The extreme western examples, found at St. Paulo on the Upper Amazons, show a change of colour in the yellow irregular belt of the fore wing, which has acquired the same orange-tawny shade as the rest of the wing. The same substitution of colour occurs in several other species of Heliconidæ, found in that locality—a curious result of peculiar local conditions. Cramer figures a slight variety as the ♂ of the species (fig. A).

3. Lycorea Halia, Hübner.

Eueides Halia, Hübner, Exot. Schmett.

Found in company with *L. Ceres* and *L. Pasinuntia* at Pará. As I have before remarked, this is the form of *Lycorea* which prevails in S.E. Brazil. A variety, found also at Pará, connects it with *L. Ceres*, the chief Guianian form, and suggests the conclusion that both the extreme local races or species were one and the same at not a very distant period of time.

4. Lycorea atergatis, Doubleday.

L. atergatis, Doubled. and Hewits. Gen. Diurn. Lep. pl. 16. f. 1.

The figure here quoted was made from a Venezuelan specimen. I did not find the species on the Lower Amazons; but it was the most abundant form of the genus at Ega, on the upper river. Many of the individuals there occurring, however, form a strongly marked variety, in which the ground-colour is dark brown, suffused more or less with blackish. Further to the west of Ega, this variety is the prevailing form.

Genus Ituna, Doubleday.

Doubled. and Hewits. Gen. Diurn. Lep. p. 113.

The species of this genus, like those of *Lycorea*, seem to be all geographical forms of one only. But in this instance the segregation of races is complete, whilst in *Lycorea* we have seen it to be in many of the forms only in process. Three *Itunæ* are known: one, *I. Lamyra*, Latr., occurs in New Granada; the second, *I. Ilione*, Cram., inhabits Guiana and, I believe, Brazil, along the Atlantic coast; the third, *I. Phenarete*, Dbld., is peculiar to Bolivia and the Upper Amazons. All three are tolerably distinct in colours and markings.

Ituna Phænarete, Doubleday.

I. Phænarete, Dbld. and Hewits. Gen. Diurn. Lepid. pl. 17. f. 1.

I met with one example only, at Tabatinga, Upper Amazons.

Genus Methona, Doubleday.

Dbld. and Hewits. Gen. Diurn. Lep. p. 115.

This genus, which is so closely allied to the following (*Thyridia*) that the species of both have always been confounded, is distinguished from it by structural characters, viz. the neuration of the hind wings and the form of the male fore legs, which are of great systematic importance in another part of this family, but here can scarcely be considered even of generic value. The internal (abdominal) nervure of the hind wing is long, and terminates on the outer margin; the lower disco-cellular is placed at a right angle with the median, is much longer than the middle disco-cellular (which is straight), and strongly angulated. The fore legs of the male have the tibiæ and tarsi linear in shape, although much shorter than the femur; they differ in length in individuals of the same species, but are never so far aborted as to form a mere round knob at the tip of the femur, as in *Thyridia.* In *Thyridia* the lower disco-cellular is short and straight, and placed at an obtuse angle with the median, whilst the middle disco-cellular is very long and angulated; and the internal (abdominal) nervure is short, terminating on the abdominal border.

1. Methona Themisto, Hübner.

Thyridia Themisto, Hübn. Zuträg. f. 163–4.

I found this species at Pará, where it was associated with *M. Psidii.* Like the other species of the genus, its flight is somewhat slow and heavy. It frequents thinned parts of the virgin forest, moving about the lower trees and underwood. It differs from *M. Psidii*, principally, in the absence of a black belt across the disk of the hind wings. It is probably a modification of it.

2. Methona Psidii, Linnæus (Pl. LVI. fig. 8 *a*).

Papilio Psidii, Linnæus, sec. Cramer.
—— ——, Cram. Pap. Exot. t. 257, f. F.

Mr. Doubleday and all subsequent authors have considered the *P. Psidii* of Linnæus and Cramer to be a *Thyridia.* I cannot imagine how their mistake has arisen, all the numerous examples of the insect represented by Cramer as *P. Psidii* which I have examined having the wing-neuration and male fore legs of *Methona.* It is an exceedingly common insect throughout the Amazon region. The figure of Cramer is accurate: the small, rounded shape of the hyaline area near the tip of the hind wing, crossed by two nervures only, and the opake black colour of the basal part of the hind margin of the fore wing reaching the median nervure (both good specific characters), are well given. The colour of the thorax varies in almost every specimen. In all there is a round grey spot on the wing-lappets; but in some examples the edges of these organs are also grey, and in others the surface of the thorax is much variegated with grey colour.

Genus Thyridia (Hübner), Doubleday.

Doubld. and Hewits. Gen. Diurn. Lep. p. 117.

Thyridia Ino, Felder.

Thyridio Ino, Feld. Wien. Ent. Monatschr. 1862, p. 75.

I found this species at Villa Nova, on the Lower Amazons, in company with *Methona Psidii.* Dr. Felder's specimens came from the Upper Rio Negro. It is distinguishable from *M. Psidii* at once by its structural generic characters, as will be seen from the description above given of the genus *Methona*; but in size and colours the two resemble each other so much, that I could not distinguish them when on the wing. It is replaced in South-East Brazil by the *Th. Pytho* of Felder, which I consider a local form of the same species.

Genus Dircenna, Doubleday.

Doubld. and Hewits. Gen. Diurn. Lep. p. 119.

In this genus the hind-wing neuration resembles that of *Methona*, inasmuch as the lower disco-cellular is strongly angulated, and emits a recurrent nervule; but the middle disco-cellular in the ♂ is bent, and directed towards the apex of the wing. The internal nervure is very short, terminating on the abdominal edge. In the fore wing the first median branch is thrown off at a moderate distance from the base of the wing, terminating on the hind margin, close to the posterior angle, the cell being much broader than in *Methona* and *Thyridia*. The body is slender; the antennæ moderately elongated, and thickened towards the tip into an elongate club. The palpi are clothed in front with long porrect hairs, their third joint being long and pointed. The male fore tibiæ and tarsi are aborted, being reduced to a small knob at the apex of the femur.

Doubleday left the list of species referable to this genus in an unsatisfactory state. The following are all at present known*:—

1. *D. Klugii*, Hübn. Zutr. f. 801, 802.—Mexico.
2. *D. Jemima*, Hübn. ib. f. 807, 808.—Venezuela and New Granada.
   D. Iambe, Doubled. and Hewits. Gen. Diurn. Lep. pl. xvii. f. 2.
3. *D. Dero*, Hübn. Zutr. f. 243, 244.—South-East Brazil, Bahia.
4. *D. Rhoëo*, Felder, Lepidop. Fragment., p. 40.—South-East Brazil, Pará, and Amazons.
5. *D. Xantho*, ib. p. 40.—South-East Brazil, Bahia.
6. *D. Zelia*, Guér. Icon. Règne Animal, text, p. 470.—Bolivia.
7. *D. Epidero* (Boisduval, MS.), n. sp.—Amazons.
8. *D. Lenea*, Cram.† t. 231, f. D. ♂.
   D. Melanida, Cram. t. 231, f. F. ♀.
   D. Zælo, Boisduval, MS.

1. Dircenna rhoëo, Felder.

D. rhoëo, Felder, Lepidop. Fragment., p. 40.

This form differs from the *D. Dero* of Hübner only in the greater breadth and irregularity of the dusky-black border of the hind wing, especially in the ♀, and in the

* *Dircenna Duillia*, Hewits. Trans. Ent. Soc. vol. ii. N.S., pl. xxiii. f. 3, is a *Hymenitis*.

† This species is imperfectly known. Cramer's figures are very unsatisfactory. In Cayenne examples, the wings are clearer hyaline than represented by him; the basal half of the fore wing, the anal quadrate patch of the hind wing, and the nervures are suffused with bright fulvous. The nervures near the apex of the fore wing are bright yellow. It appears to be a rare species. In Dr. Boisduval's collection, typical examples stand under the MS. name of *D. Zælo*. I am indebted to Dr. Boisduval for the present of a fine example. I believe, however, that *D. Lenea* (Guiana), *D. Epidero* (Amazons), *D. Zelia* (Bolivia), and *D. Xantho* (Bahia) might be all treated as geographical forms of one and the same species.

nervures which traverse the disk of the same wing being of a yellowish colour instead of black. In the ♀ the discocellulars and the terminal parts of the median branches are accompanied by dusky streaks. It cannot be considered, however, otherwise than as a local variety of *D. Dero*, which has the hyaline disks of the wings always clearer, and the black borders more sharply defined than *D. Rhoëo*. *D. Dero* is peculiar to South-East Brazil, and is not found in the Amazon region, where the local form *D. Rhoëo* takes its place. I have seen specimens of *D. Rhoëo* also from the neighbourhood of Bogotá, New Granada. It flies in thinned parts of the forest in Ygapó, or flooded districts, in the dry season. The species is always accompanied by the following, *D. Epidero*, to which it has so close a general resemblance, that I always found it difficult to distinguish one from the other when on the wing. The two forms, however, have no very close real relationship, there being points of difference in their structure, namely, in the shape and neuration of the hind wings in the males. The constant companionship of the two species can only be explained by the social and gregarious instincts of the *Heliconidæ*.

2. DIRCENNA EPIDERO (Boisduval MS.), n. sp.

Expanse 2″ 5‴. ♂. Wings hyaline, a patch of bright yellow across the middle and apical regions of the fore wing and the basal half of the hind wing. *Fore wing*: *above*, with the margins blackish, a triangular spot on the hind part of the cell, near the base, and a narrow belt across the disco-cellulars, extending down the second median branch (and partly down the third) to the hind margin, also blackish, the dark colour on the posterior margin extending quite to the median nervure and its first branch. *Beneath*, the same, except that there are two or three white specks at the tip of the wing. *Hind wing*: *above*, with the margins blackish, the portion between the second median branch and the abdominal edge very much broader; a narrow dusky belt from the costa across the disco-cellulars to the hind margin, most frequently interrupted in the middle, also blackish; the nervures across the basal part clear light yellow. *Beneath*, the same, except that the base of the costa has a stripe of orange-colour, and that the tip has two, and the hind margin near the anal angle four, white specks.

The hind wing is short and subquadrate, the apex being sharply truncated; the lower disco-cellular is angulated (with a recurrent nervule) close to the junction of the lower radial. The species varies in the broad black border, near the anal angle of the hind wing, having a reddish streak in the middle, through which shine the white marginal specks of the under surface.

♀. Very variable in colours. The following are the chief variations:—

1. Same as the ♂, except that the broad anal black border of the hind wing is of a clear orange-red colour in the middle.

2. The wing much suffused with blackish, leaving two broad belts across the fore wing, the basal part and a subapical spot of the hind wing alone hyaline; the apical belt of the fore wing has a patch of light yellow, and the nervures traversing the basal part of the hind wing are reddish.

Generally distributed throughout the Amazon region, in thinned parts of the forest, invariably associated with *D. Rhoëo.* Both have a weak, slow flight, and are generally seen in company with *Ithomiæ* of various species.

Genus Callithomia, nov. genus.

Generic Characters.—Head, palpi, and antennæ same as in *Dircenna*; the long hairy palpi, and their long pointed third joint, being characters which distinguish both from *Ithomia* and its allied genera. Hind wing in the ♂ short, subquadrate, in the ♀ elliptical; in both sexes with the lower disco-cellular straight, rather long, placed at an obtuse angle with the median; the middle disco-cellular angulated (with a recurrent nervule), in the ♂ very long, bent, and directed outwards towards the apex of the wing. Fore tibiæ and tarsi in the ♂ rudimentary, reduced to a small knob at the tip of the femur; tarsi in the ♀ slender, filiform, the joints not being contracted and crowded at the tip.

The shape of the wings, structure of the head, antennæ, and palpi give this genus very much the aspect of *Dircenna*, from which the neuration of the hind wing amply distinguishes it. In this latter respect, it bears a similar relation to *Dircenna* that *Thyridia* does to *Methona*. In the hind-wing neuration it resembles also the genus *Olyras*, but differs from it in the palpi and male fore legs. In colours it differs from *Dircenna*, the wings being rendered opake by fulvous-coloured scales, instead of being naked and hyaline. The species are very rare, and seem to be confined to the far interior of Equatorial America: none have yet been noticed by authors.

1. Callithomia Alexirrhoë, n. sp.

Expanse, ♂, 2″ 2‴; ♀, 2″ 7‴. ♂. *Fore wing*: *above*, with a large opake orange-tawny spot occupying the basal third of the wing—a round spot in the middle of the cell, and a line running along the apical part of the first median branch being black; to this succeeds an irregular belt of light yellow, semitransparent on its outer edge—the rest of the wing from the end of the cell being black, with a row of five large, yellowish, semitransparent spots, of which the fourth is placed out of line, near to the outer margin. In the ♀ the apical part of the outer margin has a row of three or four pale spots. *Beneath*, the same, except that there is a marginal row of six large subtriangular silvery-white spots.

Hind wing: *above*, subopake orange-tawny, with a row of four large subrounded black spots along the wing behind the cell, of which the outermost is very small in the ♂, and a marginal series of six subtriangular black spots, through which, on the edge, shine the white marginal spots of the under side. *Beneath*, the same, except that there is a long, subcostal, black stripe and a row of seven silvery-white marginal spots. Body black, beneath yellow; collar with two small yellow spots; wing-lappets each with one large spot of the same colour. Antennæ pale fulvous, the basal part black.

I found two or three examples of this very elegant insect in the forest at St. Paulo, on the Upper Amazons, flying in company with the *Ithomiæ* and *Ceratiniæ* of the locality.

2. Callithomia Zeuxippe, n. sp.

♀. Expanse 2″ 6‴. Very similar to the preceding. It differs in having the fore wing, the base of the costa, and the posterior margin broadly blackish: the apical part of the wing is brown, the margins of the nervures, at the end of the cell, being reddish; the row of pale spots across this part is reduced in number to three. *Beneath*, the marginal row of pale spots in both wings is clear yellow, instead of silvery white as in *C. Alexirrhoë*. The neuration of the hind wing is slightly different from that of *Alexirrhoë*, inasmuch as the upper radial is brought much nearer the subcostal, and the upper disco-cellular is very minute.

One example taken on the banks of the Cuparí, an affluent of the Tapajos.

3. Callithomia Thornax, n. sp.

♀. Expanse 2″ 10‴. Wings elongate, orange-tawny. *Fore wing*: *above*, with a large, rounded spot in the middle of the cell, the base of the costa, and the whole of the hind margin black; the apical third is also blackish, leaving a submarginal row of six triangular spots and the edges of the nervures at the end of the cell orange-tawny; there is also a subapical row of four elongate, semihyaline spots. *Beneath*, the same, except that the submarginal row of fulvous spots is expanded into an irregular belt, and that there is an interrupted row of minute yellowish spots on the extreme outer margin.

Hind wing: *above*, with a row of four subquadrate spots along the wing, close behind the cell; the margins are spotless. *Beneath*, the same, except that there is a broad subcostal black stripe, and a fifth spot added to the central series; the black stripe curves at the end, so as to meet the line of spots; the hind margin, towards the anal angle, has a row of four whitish spots.

Body and antennæ the same as in the two preceding species. The neuration of the hind wing is different from that of the preceding, inasmuch as the upper radial appears as a branch of the subcostal after the cell.

A single example taken at Tabatinga, on the frontier of Peru.

Genus Ceratinia (Hübn.), Doubleday.

Doubld. and Hewits. Gen. Diurn. Lepid. p. 127.

This genus, which Doubleday thought most convenient to treat as a section of *Ithomia*, forms part of a group of genera or subgenera (comprising *Ceratinia*, *Napeogenes*, *Oleria*, *Mechanitis*, *Sais*, *Ithomia*, *Hymenitis*) which agree in their palpi being destitute of hairs in front, in their terminal joint being short, very slender, pointed, and projecting from the forehead, and in the antennæ being somewhat elongate, only slightly and very gradually thickened towards their tips. These genera or subgenera, however (at least, such of them as I think it will be advantageous, for the sake of clearness, to adopt), differ from each other greatly in the neuration of the hind wings.

Ceratinia has the hind wing elongated in both sexes. In the male, the lower disco-cellular forms a very obtuse angle with the median, is angulated, and emits a recurrent nervule near or close to the junction of the lower radial, the middle disco-cellular being long and straight, directed outwards, and the upper straight, nearly reaching the apex of the wing. In the female, the lower disco-cellular forms a less obtuse angle with the median; the recurrent nervule is emitted either close to the junction of the lower radial or from the middle disco-cellular; the latter is directed across the wing, joining the subcostal; the upper radial, is either emitted close to this junction, or is situated as a branch of the subcostal, after the cell. The male fore tibiæ and tarsi are reduced to a small knob; the femur is not notably abbreviated. The female fore tarsi have the joints slender and filiform.

This genus is interesting as exhibiting the wing-neuration in a vacillating state. Not only do the sexes show an important difference in the position of the angle and recurrent nervule of the hind wing disco-cellulars, but individuals of the same species vary in the position of certain nervures. Those parts of structure which form fixed generic characters in other groups are here variable in the sexes and in individuals of the same sex. *Ceratinia* is nearly allied to *Mechanitis* (as defined in this memoir), on the one hand, and to *Ithomia*, through such species as *I. Iphianassa*, on the other.

1. Ceratinia Ninonia, Hübner.

Ceratinia Ninonia, Hübn. Exot. Schmett.

Hübner's figures represent an insect with rather broad fore and hind wings, and with two large yellow spots across the middle of the fore wing, besides a crooked yellow belt across the black apical part. I found a species extremely common at different stations on the Amazons, which was evidently the same as *Ninonia*, but very variable in shape and colours, and presenting very few examples which agreed exactly with Hübner's figures. The species, however, evidently varies in different ways in different localities; yet the local varieties are not definite, the segregation of the races is not complete; so that it is embarrassing to decide whether to treat the form as one polymorphic species, including the variations under one and the same definition, or to describe separately the type and the local varieties. Besides these incomplete local modifications, easily traceable to the type, there are, as often happens in the case of prolific, widely distributed, and variable species, a number of other forms rather more strongly marked and better defined, which inhabit regions rather more distant from the locality of the type than those which the mere varieties inhabit. These are admitted on all hands to be distinct species; but I think it would be difficult to prove that these were not also varieties of *C. Ninonia*, which have become more completely segregated from the parent form. Such are, amongst others, *C. Thea* (Hewits.), Rio Negro; *C. Leprieurii* (Feisthamel), Cayenne; *C. Fenestella* (Hewits.), Venezuela; *C. Melphis* (Hübn.), S.E. Brazil; and *C. Fimbria* (Hewits.), New Granada.

The following are the chief varieties of *Ceratinia Ninonia* occurring in the Amazon region.

Var. 1. *C. Barii* (Boisduval's Coll.).

Expanse 2″ 1‴ to 2″ 3‴. Hing wings in both sexes much narrower than in the type;

the two yellow spots across the middle of the fore wing are pale and semitransparent; the basal area of the hind wing is also semitransparent.

This variety occurs in company with the typical *C. Ninonia* at Cametá, on the Tocantins, in much greater abundance than its type. I met with it also on the banks of the Tapajos, but there without the true *C. Ninonia.* It is found also at Cayenne, in company with *C. Leprieurii,* a form which I did not meet with in the Amazon region.

Var. 2. Expanse 2″–5‴ Much larger than var. 1. The yellow spots across the middle of the fore wing are entirely wanting, there being only a crooked yellow belt across the black apical part. Both wings are much broader than in var. 1; and the hind wing is strongly angulated about the middle of outer margin.

This variety occurs much further to the west. It is found, to the exclusion of var. 1, at Obydos, on the Guiana side of the Lower Amazons, and, again, on the Upper Amazons, at all the stations I examined, from the mouth of the Rio Negro to Peru. With it are found many individuals agreeing in colours with var. 1, although not in shape; others occur intermediate between vars. 1 and 2.

2. Ceratinia Thea, Hewitson.

Ithomia Thea, Hewits, Exot. Butt. *Ithomia,* fig. 11.

I consider this a well-marked and fixed local variety or race of *C. Ninonia.* It has not been found hitherto elsewhere than on the banks of the Rio Negro, whose climate, soil, and forests are different from those of the main Amazons.

3. Ceratinia Xanthostola, n. sp.

♂. Expanse 2″ 5‴. In colours resembling *C. Thea*; the wings very different in shape. The fore wing is long and narrow, very much longer than the hind wing (as in fig. 4, *Ithomia,* pl. 2. Hewits. Exot. Butt.). Opake orange-tawny; costal edge and a faint spot in the centre of the cell blackish; apical third (or more) black, crossed by a curved yellow belt, which reaches only the second median branch; margin with a row of seven large rounded yellow spots.

Hind wing semioval, the costal and subcostal nervures rigid and straight, reaching the apex, which forms a sharp angle: *above,* opake orange-tawny, with a broad, somewhat regular dusky margin, in which is a row of seven rounded yellow spots. *Beneath,* the same, except that the base of the costa is yellow, that there is a stripe of dusky colour along the costal nervures, and a central dusky stripe along the wing, passing close behind the cell.

This insect has the appearance of an aberration or extraordinary variety of *C. Ninonia,* in company with which and its varieties it is found. Many individuals, however, occurred; and I think it is a form whose peculiarities are probably hereditary.

4. Ceratinia Vallonia, Hewitson.

Ithomia Vallonia, Hewits. Exot. Butt. *Ithomia,* fig. 13.

This beautiful species was very rare at Pará. In colours it resembles much *Napeogenes Cyrianassa.*

5. Ceratinia Fluonia, Hewitson.

Ithomia Fluonia, Hewits. Exot. Butt. *Ithomia,* fig. 26.

In this species the hind-wing upper radial nervure in the female is always connected with the cell by means of an upper disco-cellular. It is a distinct, well-marked form, closely allied, however, to *C. Ninonia,* and appears to be confined in its range to the region of the Upper Amazons.

6. Ceratinia Anastasia, n. sp.

♂ ♀. Expanse 2″ 9‴. A very large broad-winged species, having very much the appearance of *Mechanitis Maëlus,* Hewits. Exot. Butt. *Mechanitis,* fig. 9. Dark orange-tawny. *Fore wing* broad, rounded at the apex: *above,* with a transverse zigzag belt after the end of the cell, from the costal to the second median branch, and a submarginal row of seven large, rounded spots, bright yellow; it has the following spots and marks of black colour:—a streak along the base of the costa, a large triangular spot within the base and a double spot at the apex of the cell, two large spots between the 1st and 2nd median branches, and a broad stripe on the hind margin, not reaching the median nervure or the hind angle: the transverse belt and the submarginal spots are also margined with black. *Beneath,* the same.

Hind wing nearly oval in shape: *above,* with a broad stripe crossing the hind part of the cell, the apical margin, and a row of large elongate marginal spots black; the marginal spots towards the apex are small, the others blend more or less with the central stripe. *Beneath,* the same, except that there is a broad black subcostal stripe and two small marginal yellow spots near the apex.

This very large and remarkable species is found only on the Upper Amazons, at Ega and St. Paulo, where it flies in company with *Melinæa* (or *Mechanitis*) *Maëlus,* to which it is assimilated in colour. Both inhabit the shades of the lofty and humid forest, and are slow flyers.

7. Ceratinia Manaos, n. sp.

♂. Expanse 2″ 5‴. Resembles much in shape and colours *C. Rowena* (Hewitson, Exot. Butt. *Ithomia,* fig. 123). It differs in the yellow transverse belt extending over the terminal part of the cell. The hind wing has a central black stripe composed of five subquadrate spots passing behind the cell, and a marginal row of six semicircular dull black spots. *Beneath,* all the wings have a submarginal row of white spots, and the hind wing has the usual black subcostal stripe.

This species, together with *C. Rowena,* cited above, have the appearance of small examples of *Mechanitis Polymnia*; their neuration, however, shows that they belong to *Ceratinia. C. Manaos* was taken on the banks of the Rio Negro, at the Barra.

Genus Sais, Doubleday (part).

Doubld. and Hewits. Gen. Diurn. Lepid. p. 131.

The type of Doubleday's genus *Sais* is the *Papilio Rosalia* of Cramer, a species which differs in the structure of the fore legs of the male and in the hind-wing neuration from the allied forms of Heliconidæ. Doubleday, however, made the definition of his genus impossible, by placing in it a series of species (*S. Cyrianassa* and others) which have no resemblance to *S. Rosalia* in the features mentioned. *S. Cyrianassa* and its allies form a distinct group, which I have named *Napeogenes*. *Sais* may be known by the following characters.

The hind-wing lower disco-cellular in the ♂ runs in a line with the median nervure; the middle disco-cellular also runs nearly in the same straight direction, but it is angular, and emits a recurrent nervule; the upper disco-cellular is short, and placed near the apex of the wing. In the ♀ the position of the lower and middle disco-cellulars is the same; but the upper disco-cellular is wanting, the upper radial being placed as a branch of the subcostal. The costal and subcostal nervures amalgamate for nearly the whole course of the costal, as in the genus *Mechanitis*. The fore legs of the ♂ are quite rudimentary; not only are the tibiæ and tarsi reduced to a small knob, but the femur also is greatly abbreviated. In the ♀ they are much elongated, and the tarsi are filiform. The head is very small; the antennæ are very long and slender.

In this genus the elongation of the hind-wing cell and the attraction of the radial neuration within the domain of the median, reach their extreme point. In one sense, *Sais* may be considered to be the highest development of the Heliconide (or Danaine) type on the American continent, in the sense of receding furthest from *Danais* and the Nymphalidæ. The group *Hymenitis* exhibits probably as great a deviation from the Nymphalideous type as *Sais*, but in *Hymenitis* this deviation runs in a different and nearly opposite direction.

Sais Rosalia, Cramer.

Papilio Rosalia, Cram. Pap. Exot. t. 246, f. B.

Cramer's figure, made from a Surinam specimen, represents the apex of the fore wing of the same orange-tawny colour as the rest of the surface. I did not meet with any examples coloured in this manner. The species varies much according to locality, as is usual with the Heliconidæ; but the variations do not embrace all the individuals in each locality; in other words, the segregation of race is not complete.

Var. 1. Pale orange-tawny; apical part of the fore wing clear black.

All the examples met with in the Pará and Tapajos districts were conformable to this type. I did not find it at all on the Upper Amazons.

Var. 2. Dark orange-tawny; apical part of the fore wing black, hind wing having a series of blackish stripes extending from the central macular vitta to the marginal lunules.

Examples of this occurred at Ega, in company with the following:—

Var. 3. Pale orange-tawny; apical part of the fore wing dusky, with a large irregular fulvous spot in the centre.

Ega.

Var. 4. Dark orange-tawny; apical part of the fore wing black, with a series of short narrow isabella-coloured stripes accompanying the nervures; hind wing having a series of blackish stripes extending from the central macular vitta to the marginal lunules.

Ega and St. Paulo. At St. Paulo this was the prevailing form of the species. These dark varieties certainly do not inhabit the region of the Lower Amazons.

Genus Mechanitis (Fab.), Doubleday.

Doubld. & Hewits. Gen. Diurn. Lepid. p. 130.

After a careful examination of nearly all the species, I find that two widely distinct generic types were comprised by Doubleday under *Mechanitis.* One of these (which comprehends his section 1, including, however, *M. Polymnia*, placed in his section 2) is closely allied to *Ceratinia, Sais, Napeogenes*, and *Ithomia*, agreeing with them in the shape and position of the palpi and the rudimentary condition of the fore legs of the ♂; the other (in which the fore tibiæ and tarsi of the ♂ are nearly of the same shape as in *Danais*, being only a little shortened, more or less, according to the species, and the terminal joint of the palpi does not project in front of the forehead) approaches *Olyras, Tithorea*, and *Eutresis.* This group (Doubleday's sect. 2, in part) I shall name *Melinæa*; the other (sect. 1) will retain the name of *Mechanitis.* We have here an illustration on a smaller scale of the same deceptive analogy which has led to the junction of the Heliconinæ with the *Heliconia*-like Danainæ. There is, in truth, a very wide difference in structure between *Mechanitis* and *Melinæa*; but the great similarity in dress of the respective species, in great part pair by pair, has led to their being grouped in one genus. The distinguishing characters of *Mechanitis* are the following:—

Head small; palpi thinly clothed with scales, terminal joint pointed, projecting. Antennæ moderately long, thickened into a distinct club at the apex. Hind-wing lower discocellular nearly in a line with the median, rather short; middle discocellular at right angles with the lower, angulated, and emitting a recurrent nervule in the middle in both sexes; upper discocellular in the ♂ inclined towards the base, joining the subcostal not far from the middle of its course, in the ♀ very short or entirely wanting, in the latter case the upper radial being as a branch of the subcostal beyond the cell. Costal nervure amalgamated with the subcostal for nearly half the length of the wing in the ♀. Fore legs of the ♂ with the femur short, tibiæ and tarsi reduced to a small knob; in the ♀ slender, the tarsi filiform, the spines minute.

The genus, as thus defined, comprises two groups of species of very different general appearance,—one containing *M. Polymnia* and its allies, distinguished by their large size, opake wings, and varied coloration—the other including *M. Phyllodoce* of Hübner, and several nearly related species, remarkable for their much smaller size and pale, semitransparent wings. These latter may retain as sectional distinction the name *Oleria*, as proposed by Hübner.

Section 1. *Oleria*, Hübner.

Hübner, Verzeichniss bekannter Schmetterlinge, p. 9.

1. Mechanitis (Oleria) theaphia, n. sp.

Very similar in size, shape, and general appearance to *Mechanitis* or *Ithomia ethica* (Hewits. Exot. Butt. *Ithomia*, fig. 140).

♂ ♀. Expanse 1″ 2‴–1″ 8‴. Wings pale sulphur-white, semitransparent. Fore wing with a wide border, and a broad oblique band extending from the costa across the end of the cell to the outer margin near the hind angle, black; a submarginal row of round white spots in the outer black border, not reaching the hind angle. Beneath, the same.

Hind wing with a black border, narrow on the costa, and broad along the outer margin, the latter having a submarginal row of rounded white spots. Beneath, the same.

Body and antennæ black. Head and thorax with some whitish markings.

Found on the banks of the Cuparí, a branch of the Tapajos, and also at St. Paulo, on the Upper Amazons. At St. Paulo the individuals were larger and more vividly coloured than on the borders of the Cuparí.

Section 2. *Mechanitis* proper.

2. Mechanitis Polymnia (Linn.), Cramer, Pap. Exot. t. 191. f. E.

This species, like many others of the Heliconidæ, is subject to remarkable local variation. The varieties, taken in connexion with their geographical distribution, are a most interesting study. The species is extremely abundant wherever it is found, and the different varieties are copiously represented in collections. It is slow in flight, and inhabits thinned parts of the forest, or neglected and shady plantations near settlements. The caterpillar (figured in Sepp, Papill. de Surinam, pl. 2.) has a smooth integument. The head is round, and the body has a row of small pointed tubercles on each side. It is grey, with black spots, and ringed with yellow. It feeds on *Solanum aculeatissimum*, and is gregarious. The chrysalis is smooth.

The typical form of the perfect insect, as figured by Cramer, prevails at Pará and throughout the Lower Amazon region. All the examples collected at the different stations in those parts resemble each other pretty closely in colours and markings. At Ega, on the Upper Amazons, the species is very unstable; very few individuals were found conformable to the Cramerian type: it there varies, not only in general colour and pattern, but also very considerably in the shape of the wings, especially in the male sex. One variety seems, however, to predominate, to which I give the name of *M. Egaënsis*: I frequently found pairs of it *in copulâ*, and never observed it to mate with other varieties, from which I was inclined to conclude that the individuals preferred to pair with their exact counterparts, and therefore that the variety was in process of segregation from the type. All the intermediate forms between the typical *M. Polymnia* and *M. Egaënsis* occurred at Ega, but in fewer numbers. At St. Paulo, 260 miles further to the west, the species was again extremely variable, but the varieties were quite different from those of Ega: individuals coming very the near type occurred, but not one was found quite conformable. *M. Egaënsis* was quite absent; but, on the other hand, a new variety abounded at St. Paulo, of which there was certainly no trace at Ega; this has been figured and described as a distinct species, viz. *M. Mazæus* (Hewits. Exot. Butt. *Mechanitis*, fig. 8). Two other remarkable varieties also occurred—one near *M. Menophilus* (Hewits. *l. c. Mechanitis*, figs. 2, 3), and the other with a structural modification in the shape of the wings, described below as *M. Olivencia.*

The way in which I found this species to vary, as just described, impressed me greatly, and helped much, in conjunction with other facts of a similar tendency, not only to destroy my belief in the constancy of species, but to teach how new ones may have originated. The complete set of connecting forms found showed that I had here to deal with one species only, disseminated over a large area, and modified in certain districts under peculiar conditions there obtaining. The varieties were of such a nature as to form and colours, that it was inconceivable they could have been hybrids produced by the intercrossing of two or more originally distinct species. The amount of local modification exhibited was not in accordance with obvious differences in the local conditions; for the species was totally changed from Ega to St. Paulo, 260 miles apart and very similar in soil, climate, &c., whilst very constant on the Lower Amazons, in districts 600 miles apart and very different in physical conditions. Since returning to England, I have learned that *M. Polymnia* again varies on the eastern slopes of the Andes, whilst a cluster of remarkable varieties or local forms (some of which have been described as species) are found in the Andean valleys. Some of these (*M. Macrinus*, *M. Menophilus*, &c.) are very clearly varieties of *M. Polymnia*, like the forms found at Ega and St. Paulo; but others (*M. Mothone*, *M. Menapis*) are more sharply defined, and have the appearance of true species. Now I think the conclusion is unavoidable, that these apparently distinct species are modifications, as well as the undoubted varieties are; for we have the species in all stages of modification—simple variation, local variety scarcely distinguishable from a mere variation, complete local variety, and well-marked race or species. The forms of *M. Polymnia* found in South Brazil confirm this view. At Rio Janeiro the well-marked race or species *M. Lysimnia* alone is found; at Bahia (travelling towards the home of the type, *M. Polymnia*), *M. Lysimnia* in company with *M. Nesæa*, a form exactly intermediate between *M. Polymnia* and *M. Lysimnia*; at Pernambuco (further northward) *M. Nesæa* alone occurs; at Pará this form is seen no more, and *M. Polymnia* in its typical dress monopolizes the field.

These facts seem to teach that, in this and similar cases, a new species originates in a local variety, formed in a certain area, where the conditions are more favourable to it than to the typical form, and that a large number of such are simultaneously in process of formation from one variable and widely distributed species. The new species cannot be proved to be established as such, unless it be found in company with a sister form which has had a similar origin, and maintaining itself perfectly distinct from it. Cases of two extreme varieties of a species being thus brought into contact by redistribution or migration, and not amalgamating, will be found to be numerous when the subject is inquired into*. I found no clear instance on the banks of the Amazons of two forms of *M. Polymnia* having this relationship; but, to judge from the collections received, it exists between *M. Lysimnia* and *M. Nesæa*, in the middle parts of the Brazilian coast-country, at Bahia.

Local var. *Mechanitis Egaënsis* (Pl. LVI. fig. 7 *a*).

Expanse, ♂ 2″ 2‴–2″ 7‴, ♀ 2″ 4‴–3″. ♂. Fore wing similar in shape to that of *M. Polymnia*: *above*, dark orange-tawny or reddish brown; the basal part of the costa and a broad stripe along the hind margin, extending three-fourths the length of the wing, and touching the edge, black; there are, besides, six black spots, namely, a large quadrate one about the middle of the cell, a faintly marked one near the base, two (sometimes united) over the end of the cell, and two between the 1st and 2nd median branches. Across the wing, a little beyond the middle, is a very irregular bright-yellow belt, which begins on the costa and terminates about the middle of the outer margin: this band generally includes a quadrate spot lying within the end of the cell; its outer margin is deeply bisinuated, and broadly edged with black: in the middle of the brownish apical part of the wing, near the costa, is a large ill-defined yellowish spot. *Beneath*, the same, except that there is on the outer margin, near the apex, a series of five whitish spots, in some examples reduced in size and number, in others altogether wanting.

Hind wing short and quadrangular, the angularity most pronounced in small examples: *above*, same colour as the fore wing; there is a broad, black, zigzag stripe along the disk, behind the cell, and generally a series of marginal lunules of the same colour. The marginal lunules are wanting in some examples; in others they are large, and blended partly with the black discal stripe. *Beneath*, the same, the margin spotless; there is a yellow spot at the base of the costa.

♀. Similar to the ♂ in colours: the hind wing is not angular, but elliptical in shape, and has generally a trace of the marginal white spots on the under surface. Individuals occur much darker in colour, with the black marks spreading partly over the surface.

Extremely abundant all the year round at Ega, in thinned parts of the forest; but found in no other part of the Amazon region. It occurred in company with the typical *M. Polymnia* and numerous individuals exhibiting all the gradations between the two extreme forms. I add descriptions of some of these intermediate varieties.

* I have given a case in the first paper published of this series, "On the Insect Fauna of the Amazon Valley," in 'Transactions of the Entomological Society of London,' n. s. vol. v. p. 354, *Papilio Vertumnus* and *P. Hierocles*. It seems to me that, as only those local varieties become species which maintain themselves distinct when brought by redistribution in contact with their sister-forms, natural selection comes here into play. It is an advantage to a form to have a sphere of life different from its allies: when two sister forms keep themselves distinct in a locality, it is a sign they have acquired sufficient difference to fill two separate spheres; if they paired together, they would soon become one again. Nature may be said to place a premium on diversity; for she thus destroys the incompletely formed race, and preserves the completely formed one.

The case of *Mechanitis Polymnia* differs from that of *Leptalis Theonoë*, in exhibiting the production, generally, of only one local form in a district, instead of many. As far as my observations go, this seems to have been the most frequent course in nature. More than one new race would with difficulty be formed in a limited area, where the individuals live in close neighbourhood, except in such cases as our *Leptalis*, where rigid destruction of intermediate forms is going on, thus restricting the choice of mates to the surviving forms, or in such genera as *Ithomia*, where there is no doubt the insects carefully select their exact counterparts in pairing.

Var. 1. Same as *M. Polymnia*, Cram., except that the ground-colour is of a dark orange-brown, nearly as in *M. Egaënsis*.

This variety was numerously represented, and in both the sexes.

Var. 2. Between var. 1 and *M. Egaënsis*.

The wings are dark isabella-colour, or orange-brown; the black stripe along the hind margin of the fore wing touches the edge for great part of its length; and there is a large irregular yellow spot, bordered with tawny, in the centre of the black apical part. Hind wing of the ♂ more angular than in *M. Polymnia*, the apex being as if truncated.

Many examples of this variety occurred at Ega. Few were exactly alike; some approach *M. Egaënsis*, and others the var. 1 above described.

Local var. *Mechanitis Mazæus*, Hewits. Exot. Butt. *Mechanitis*, fig. 8.

This form prevailed at St. Paulo, 260 miles to the west of Ega, in the same way as *M. Egaënsis* did in its locality. There is a wide contrast in colour between the two varieties, and at a first glance they would be pronounced distinct species. Examples occurred at St. Paulo, however, which connected *M. Mazæus* with *M. Polymnia* type. The other varieties found at the same locality are so numerous that they cannot conveniently be described in detail: some are intermediate between *Mazæus* and the var. 2 of *M. Egaënsis*; others are remarkable for their rich colouring of black, yellow, and orange-brown, the black spots at the end of the fore-wing cell forming a belt, which divides the yellow part into two sinuous belts. One (found paired with *Mazæus*) resembles *M. Menophilus* (Hewits. Exot. Butt. *Mechanitis*, fig. 3). All of these varieties, however, have the marginal row of white spots beneath; and none agree with the *M. Egaënsis*. The following merits a separate name and description, on account of the modified shape of its wings.

Local var. *Mechanitis Olivencia*.

♀. Expanse 2″ 10‴. Similar in colours to *M. Mazæus*. Fore wing much shorter, the apex being obtuse and the outer margin less oblique, so that the end of the cell is brought much nearer to the apex, reducing the extent of the dark-coloured part near the apex: orange-tawny; the costal margin near the base and a broad stripe along $\frac{3}{4}$ths of the posterior margin, touching the edge, black. There is a triangular spot in the basal part of the cell, a large quadrate one in the middle, and a large twin spot across the end of the cell, also black; beyond the twin spot there is a short undulated belt of a rather paler tawny than the ground-colour, which is yellow near the costa, and bordered exteriorly with black, the apical part of the wing beyond this belt being orange-tawny like the ground-colour: there is a black spot in the angle between the 1st and 2nd median branches, and a twin spot posterior to it, nearer the outer edge, of the same colour. *Beneath*, the same, except that there are three white marginal spots near the apex.

Hing wing: above, the same as in *M. Mazæus*; *beneath*, the same as above, except that the margin is destitute of white spots, or has only a slight indication of them. Body and antennæ the same as in *M. Polymnia* and all the varieties of it here described.

Found in company with the *M. Mazæus* at St. Paulo. It is a variety of *M. Polymnia*, which varies in an important part of structure.

Genus Napeogenes, nov. gen.

Head small; palpi thinly clothed with scales, not hairy, the terminal joint slender and projecting in front of the forehead. Antennæ moderately short, and distinctly thickened towards the apex, fore-wing median nervure emitting its first branch at a short distance from the root of the wing, hind-wing lower and middle disco-cellulars running at an obtuse angle with the median nervure; both of the same length, directed obliquely towards the costa near the apex (a little less oblique in the ♀ than in the ♂), straight or very slightly bent, and without recurrent nervules: upper disco-cellular in the ♂ rather long, joining the subcostal near its termination; in the ♀ short, joining the subcostal far from its termination. The costal and subcostal nervures of the hind wing, in both sexes, are free and wide apart. Fore tibiæ and tarsi in the ♂ aborted; femur not abbreviated: fore tarsi in the ♀ slender filiform.

The species of this genus, such as were then known, were included by Doubleday under his genus *Sais*; they are, however, perfectly distinct from *Sais* both in the wing-neuration and in the structure of the fore legs of the ♂. Most of the species mimic corresponding species of the allied genus *Ithomia*, in the same way as the *Leptalides* do. In every locality where *Ithomiæ* are found in abundance, species of *Napeogenes* are almost sure to be found also, mimicking one or more of them,—the *Ithomiæ* being always abundant, whilst their imitators are very generally scarce in individuals. The resemblance between species of the two groups is so great that it is difficult to imagine it not to be one of real affinity; the neuration of the wings, however (a constant and important character), is a sure guide in distinguishing them. They are always represented with this feature carefully marked in the beautiful figures given by Mr. Hewitson in his 'Exotic Butterflies.'

* *Collar and wing-lappets orange; antennal club less abruptly thickened.*

1. Napeogenes Cyrianassa, Doubleday.

Sais Cyrianassa, Doubld. and Hewits. Gen. Diurn. Lep. pl. 18. f. 1.
Ithomia Cyrianassa, Hewits. Exot. Butt. *Ithomia,* fig. 65.

Occurs at Pará, in humid parts of the forest, abundantly. It is distributed over a wide area in the Amazon valley, but in each locality it suffers modification. The amount of this modification is not in proportion to geographical distance. Thus, at Fonte Boa, 1500 miles to the west of Pará, it scarcely differs from the Pará type, having only the discal area of the hind wings less transparent; but on the banks of the Cuparí, only 500 miles west of Pará (all these places are in the same latitude), it exists only under the form of a well-marked and constant local variety or race (our *N. Adelphe*); a short distance (150 miles) to the west of Fonte Boa, it occurs again as a distinct local variety (our *N. Tunantina*).

The species much resembles, when on the wing, *Ceratinia Ninonia,* var. *Barii.* It is a slow flier, and, although abundant in individuals, is confined to limited areas in the districts where it is found.

2. Napeogenes Tunantina.

♀. Size, shape, and general colour of *N. Cyrianassa*. Apical yellow spot of the fore wing oval in shape, rounded on its inner edge, sinuated in the middle, leaving the dusky crossbelt of undiminished thickness to the outer margin. Disk of the hind wing semi-opake, fulvous. The rest as in *N. Cyrianassa*.

Found in the forest at Tunantins, north shore of the Upper Amazons. All the individuals seen were conformable to the above description.

3. Napeogenes Adelphe.

♂ ♀. Size, shape, and general colour of *N. Cyrianassa*. The wings are throughout more opake. The apical yellow spot of the fore wing is oblong, of nearly uniform width; its inner margin has two slight sinuations: the black transverse belt between it and the disk commences at the subcostal nervure, and is gradually attenuated to its termination on the outer margin.

This constant local form differs from *N. Cyrianassa* more than *N. Tunantina* does. It is peculiar to the forests of the Cuparí, a branch river of the Tapajos. All the individuals found were constant to their type.

4. Napeogenes Inachia, Hewitson.

Ithomia Inachia, Hewits. Exot. Butt. *Ithomia*, fig. 66 (not 67) *.

This species closely resembles *N. Cyrianassa* in form and colours. The basal part of the fore wing, however, has a rather larger extent of yellowish hyaline; the subapical spot is regularly oblong oval, and the black crossbelt is gradually narrowed, its edges being straight, from the costa to the outer margin. The antennæ are entirely black. The hind wing beneath wants the basal costal yellow spot which is so constant in *N. Cyrianassa* and its local varieties.

Found in company with *N. Cyrianassa* at Pará. Although the two species are so closely allied and fly together, they appear to maintain themselves perfectly distinct. Nothing resembling a hybrid example or connecting form ever occurred. I strongly suspect that we have here a case of mimetic adaptation; because most of the numerous local varieties of *N. Inachia* are modified to represent species of *Ithomia* occurring in the same localities.

5. Napeogenes Pyrois.

♂ ♀. Size, shape, and colour of antennæ of *N. Inachia*. The subapical yellow spot of the fore wing, and its accompanying black crossbelt, as well as the broad fulvous border of the hind wing, are also precisely the same. The ground-colour of the wings, however, is quite different. The basal area of the fore wing and the discal portion of the hind wing (with their nervures) are straw-coloured and semitransparent. The submarginal

* Fig. 67 is given by Mr. Hewitson as a variety of *Inachia*. It differs only in colour, and is without a doubt a local variety of *Inachia*. It occurs abundantly at Bahia, where it seems to mimic *Ithomia Euritæa* of that region. It should have a distinctive name for the sake of clearness; I propose that of *N. sulphurina*.

row of white spots on the fore wing is partly obsolete. Beneath, it wants (like *N. Inachia*) the yellow spot of the hind wing at the base of the costa.

Found, in company with *N. Adelphe*, on the banks of the Cuparí. It is evidently a local modification of *N. Inachia*, although having a strikingly different appearance through the change in its coloration. It is remarkable that the Cuparí form of *N. Cyrianassa* (*N. Adelphe*) should have changed so little, whilst *N. Pyrois*, the Cuparí form of *Inachia*, is so considerably modified from its type.

6. Napeogenes Pharo, Felder.

Ithomia Pharo, Feld. Wien. Entomologische Monatsschr. 1862, p. 76.
Ithomia Inachia, var., Hewitson, Exot. Butt. *Ithomia*, figs. 143, 144.

Tabatinga, near the frontier of Peru, Upper Amazons. I believe, with Mr. Hewitson, that it is a variety of *N. Inachia*, but is a well-marked one, the product of a distinct area, and constant in its differential characters; it merits, therefore, a separate name and mention. I did not meet with it in any other part of the Amazon region, except the locality mentioned above. Dr. Felder has received it from the Upper Rio Negro. It is similar in colours to the *N. sulphurina* (the race of *N. Inachia* peculiar to S. E. Brazil), but differs from it in the broader black borders and the much paler colour with semi-transparency of the discal areas of the wings.

7. Napeogenes Ercilla, Hewitson.

Ithomia Ercilla, Hewits. Exot. Butt. *Ithomia*, fig. 128.

Found only at Fonte Boa, on the Upper Amazons. It mimics very curiously in colours and markings a group of *Ithomiæ* which are peculiar to the same part of the country, viz., *I. Ælia*, *I. Illinissa*, *I. Priscilla*, and *I. Gunilla*. It agrees so nearly in all essential characters with *N. Inachia*, notwithstanding the totally different coloration, that I think there can be no doubt it is another local form of that species. In support of this view, I would adduce that it is the only form of the *N. Inachia*-group found in the locality, where some one or other might be expected to occur, from being found always in company with *Ithomiæ* where these latter exist abundantly. I found it flying amongst a crowd of the above-named species, within a limited area in the interior of the forest; it was much rarer than the *Ithomiæ*, and quite undistinguishable from them on the wing.

8. Napeogenes Ithra, Hewitson.

Ithomia Ithra, Hewits. Exot. Butt. *Ithomia*, fig. 74.

Agrees with *Inachia* in the colour of the body and antennæ, but differs from it totally in the colours of the wings. It has a remarkable and evidently mimetic resemblance to *Ithomia Cymo*. Both are peculiar to the neighbourhood of Para—the *Ithomia* being very abundant, whilst *N. Ithra* is an extremely rare species.

9. Napeogenes Corena, Hewitson.

Ithomia Corena, Hewits. Exot. Butt. *Ithomia*, fig. 142.

Found only at St. Paulo. Agrees with *Inachia* in the colour of the body and antennæ, but is totally different in the coloration of the wings from that and all the allied species or varieties. It wears, in fact, the peculiar livery of a species of *Ithomia* characteristic of the locality in which it is found, in this respect being like the two preceding species.

** *Collar and wing-lappets black; antennal club more abruptly thickened.*

10. Napeogenes pheranthes, n. sp.

♂ ♀. Expanse 2″. Wings narrow; shape and position of the black parts same as in *N. Inachia*, except that the borders are wider. *Fore wing*: *above*, with the basal and apical hyaline areas faintly margined with purple, stained in the middle with light yellow, the black posterior border reaching and slightly passing the median nervure and its first branch; outer margin spotless. *Beneath*, same as above, except that the marks which are black above are of a fulvous colour, and the apical margin has three white spots.

Hind wing: *above*, with the discal hyaline area faintly margined with purple, yellow in the middle; the hind border wide and orange-coloured, margined with black, as in *N. Inachia*. *Beneath*, the same, except that the costa has a long fulvous stripe, and the outer margin a series of five white spots.

Body black: collar and wing-lappets spotted with white; a central line on the mesothorax also white. Antennæ black: club yellow.

Taken at Fonte Boa. Rare.

11. Napeogenes crocodes, n. sp.

♂. Expanse 2″. Colours above and beneath almost precisely as in *Napeogenes Pharo*, Hewits. (Exot. Butt. *Ithomia*, figs. 143, 144). The hyaline areas are rather paler straw-colour, the wings much narrower. Antennæ black; club yellow.

Body black; collar and wing-lappets spotted with white; a central line on the mesothorax also white.

Taken at Tabatinga, in company with *N. Pharo*. It is evidently a local modification of *N. pheranthes*, modified in colours to mimic *N. Pharo*.

12. Napeogenes Duessa, Hewitson.

Ithomia Duessa, Hewits. Exot. Butt. *Ithomia*, fig. 137.

I did not meet with this species myself. It was taken by M. de Gand at Nauta, on the Upper Amazons.

It will be useful to enumerate the rest of the described species which I consider to belong to this genus: I include a description of a new one in the list.

1. N. Tolosa, Hewits. Exot. Butt. *Ithomia*, fig. 72.

Mexico.

2. N. Larina, Ibid. *Ithomia*, fig. 90.

New Granada.

This is the mimetic analogue of *Ithomia Celemia*, Hewits. (l. c. *Ithomia*, fig. 22), found in the same country. Mr. Hewitson, in the text, has called attention to the close resemblance, stating that he had been inclined to refer them to the same species.

3. N. Apulia, Hewits. l. c. *Ithomia*, fig. 127.

New Granada. This species, different in style of coloration from any Heliconide found in the Amazon region, affords another instance of the strange adaptive resemblances existing in this genus. It mimics a small group of *Ceratiniæ* which are also peculiar to New Granada, namely, *C.* (or *Melinæa*?) *Villula* (Hewits. Exot. Butt. *Ithomia*, fig. 126) and *C. Cœno* (*ib.* fig. 84).

4. N. Xanthone, n. sp.

♂. Expanse 2″. Belongs to our first section, and is probably another local form of *N. Inachia*. Wings elongate-narrow. *Fore wing*: *above*, with the black borders and crossbelt arranged as in *N. Inachia*, except that the crossbelt is much more oblique, commencing nearer the base of the wing; basal area opake bright fulvous; the crossbelt very broad on the costa, then narrower, but continuing of equal breadth from the cell to the outer margin; subapical spot oblong-oval, bright clear yellow; outer margin spotless. *Beneath*, the same, except that there is a submarginal row of seven white spots.

Hind wing: *above*, with outer margin from before the end of the costa to the anal angle broadly black, enclosing an orange-coloured stripe; discal area bright clear yellow. *Beneath*, the same, except that the basal part of the costa is yellow, and that there is a black stripe along the subcostal nervure, and a submarginal row of six white spots.

Body dark grey; collar and wing-lappets orange-coloured. Antennæ black.

Bahia and S. E. Brazil. It somewhat resembles in its general colours *Mechanitis Nesæa*, a prolific species peculiar also to the same part of Brazil.

5. N. sulphurina, nob. *Ithomia Inachia*, var., Hewits. Exot. Butt. *Ithomia*, fig. 67.
Bahia.

Genus Ithomia, Doubleday.

Doubld. and Hewits. Gen. Diurn. Lep. p. 122.

I propose to limit this genus to those species in which the hind-wing disco-cellular nervule is placed so as to form a right or acute angle with the median nervure, and is directed across the wing (instead of towards the apex) in both sexes. The head and palpi are constructed precisely as in *Ceratinia, Sais, Mechanitis,* and *Napeogenes*. The antennæ are long, and thickened towards the tips; sometimes they are excessively elongated and filiform. Even when thus limited, the genus contains a considerable diversity of forms, constituting groups which perhaps have an equal right with *Ceratinia* and *Napeogenes* to be called genera. The chief groups are the three following:—

1. *Ithomia* proper.

The hind-wing lower radial is visible on the disk, and terminates on the hind margin, the median branches not being widely separated. There is a long middle disco-cellular nervule which is directed obliquely outwards. The arrangement of the upper radial and upper disco-cellular is very variable, there being a gradation from those species which stand nearest to *Ceratinia*, which have an upper disco-cellular in both sexes, to those approaching *Hymenitis*, in which this nervule disappears, the upper radial being then as a branch of the subcostal (in the ♀) or totally wanting (in the ♂).

2. *Hymenitis*, part (Doubleday).

In this series of species the lower radial and upper disco-cellular exist in the ♂, although the lower radial is more or less aborted, whilst in the ♀ the upper radial becomes joined as a branch to the subcostal, its corresponding (the upper) disco-cellular being wanting. The lower radial is removed nearer the costa, terminating at the apex of the wing, the median branches being rather widely spread.

3. *Hymenitis*.

The hind-wing lower disco-cellular, in the extreme forms of the group, anastomoses immediately with the subcostal in both sexes; consequently both middle and upper disco-cellulars are entirely absent, the lower and upper radials being as branch and sub-branch of the subcostal. The median branches are very widely spread, and the wing-cell is thrown close to the fore margin of the wing. In the less extreme species, both disco-cellulars exist in the ♂; but they are very short, and the lower radial is always placed nearer the subcostal than in group 2.

The explanation of this diversity in the system of neuration of the hind wing in the genus *Ithomia* seems to be this:—The species exhibit from one end of the scale to the other the gradual determination of the nervures towards the costa. In *Napeogenes*, in *Ceratinia*, in *Mechanitis*, and still further in *Sais*, we have seen the radials brought within the domain of the median nervure; in *Ithomia* they show the opposite tendency, namely, to connect themselves with the subcostal system of nervures—a tendency which progresses through our sections 1 (*Ithomia* proper) and 2, and culminates in *Hymenitis*. *Hymenitis*, therefore, exhibits the extreme development of a plan of wing-neuration totally unlike anything existing in the rest of the section Rhopalocera.

In this direction it may be said to display the type of the beautiful order Lepidoptera in its greatest perfection. It is a curious fact that none of the delicate species comprised in the subgenus *Hymenitis* are found in the Amazon plains: they seem to be confined to the more elevated valleys of the Andes, in Peru and New Granada, and to the higher tropical latitudes of Mexico and S. E. Brazil*.

* The following described species of *Ithomia* belong to the *Hymenitis* section:—

1. *I. diaphana*, Drury, ii. pl. 7.—Jamaica, St. Domingo.
2. *I. esula*, Hewits. Exot. Butt. *Ithomia*, fig. 83.—New Granada.
3. *I. Theudelinda*, Hewits. Exot. Butt. *Ithomia*, fig. 146.—New Granada.
4. *I. Duillia*, Hewits. Trans. Ent. Soc. n. s. vol. ii. pl. 23. fig. 3.—New Granada.
5. *I. Andromica*, Hewits. Exot. Butt. *Ithomia*, fig. 38.—Venezuela.
6. *I. Eruca*, Hewits. Exot. Butt. *Ithomia*, fig. 81.—Brazil, 30° S. lat.
7. *I. Morgane*, Hübner, Zuträge, figs. 869, 870.—Mexico.
8. *I. Dercetis*, Doubled. & Hewits. Gen. Diurn. Lep. pl. 18. fig. 6.—Venezuela.
9. *I. Nero*, Hewits. Exot. Butt. *Ithomia*, fig. 37.—Mexico.
10. *I. Oto*, Hewits. Exot. Butt. *Ithomia*, fig. 39.—Guatemala.

The species of *Ithomia* are very numerous; 107 have already been described, but many still exist unpublished in collections. They are most numerous in the equatorial parts of America, decreasing towards either tropic. One only is found in the West India Islands, and none, I believe, in extra-tropical North America. Two or three occur in 30° S. lat.; but the genus is unknown in Chili and to the south of the Rio de la Plata. Most of the species have curiously limited ranges; many of those inhabiting the banks of the Upper Amazons do not extend more than 100 or 200 miles, although there are no apparent physical barriers to their dissemination; and it is probable, from the number of new ones received in collections made in newly explored localities, that most of the Andean valleys have their peculiar species.

They are prolific insects, and gregarious in their habits, flocks of many different species associating together. Their flight is low and weak; and they affect only certain parts of the forest, generally shady hollows, where many hundreds may often be seen sporting together, although not an individual is found in any other part of the neighbourhood.

1. Ithomia Eurimedia, Cramer.

Papilio Eurimedia, Cram. Pap. Exot. t. 126. f. C, D.
—— —— *Ægle*, Hübner, Samml. Ex. Schm.

A common species at Pará and throughout the Lower Amazon region. It is often found in company with *Leptalis Eumelia*, to which it has so great a resemblance that the two seem to be of the same species when on the wing. It is found also at Surinam (in company with the *Leptalis*); and I have examples from Bahia, in S. E. Brazil, where a variety of it also occurs which is widely disseminated over South and extra-tropical Brazil.

2. Ithomia Nise, Cramer.

Papilio Nise, Cram. Pap. Exot. t. 231. f. E.
—— *Selene*, Cram. Pap. Exot. t. 315. f. F, G.
—— *Neso*, Hübn. Samml. Ex. Schm.

Cramer's figures of this species are very bad; but I think they are recognizable with the assistance of the descriptions in the text, and that they represent the same species as that figured by Hübner under the name of *Neso*. It is an abundant species at Pará, but is not found anywhere else in the Amazon region. I have specimens of both sexes from Demerara, and find that they do not differ from Pará examples; at Cayenne, however, a local variety prevails in which both wings have above a submarginal row of pale spots, and the general colour is much paler. It is the only *Ithomia* known to me in which the sexes are strikingly different in appearance. The wings of the ♂ are more transparent, and much paler in colour that those of the ♀, especially the discal area of the hind wing. The peculiar texture of the surface of the wings is owing to the extreme fineness of the scales with which they are covered. I consider *I. Azara* (Hewits. Exot. Butt. *Ithomia*, f. 23), which occurs on the banks of the Napo, a local modification of this species, several connecting forms being known. The very beautiful *Iolaia* (Hewits. *l. c.* f. 97) of New Granada is probably also another local variety *.

* *I. Tutia*, Hewits. Exot. Butt. *Ithomia*, ii. 6 (a species allied to *I. Nise*), is given as an Amazonian species erroneously. It is a native of Venezuela.

3. Ithomia pœcila, n. sp.

♂. Expanse 2″ 2‴. Texture of the wings precisely as in *I. Nise*; but both wings are considerably narrower, as in *I. Azara*. *Fore wing*: *above*, semitransparent, with the basal half orange-tawny; the costal edge, the hind margin, a narrow triangular spot at the base of the cell, and two rounded ones placed obliquely at the end of the cell blackish; the apical third of the wing dusky black, the space between this part and the orange-tawny basal part occupied by a rather broad, oblique, light-yellow crossbelt; the inner edge of the black apical part has many indentations, and near the hind angle there is a narrow dusky streak running from the outer margin halfway along the second median branch. *Beneath*, the same, except that there is a row of 5–6 small white spots very near the outer margin, and a series of 4–5 fulvous spots across the dusky-black apical part.

Hind wing semitransparent: *above*, orange-tawny, with a straight macular stripe along the disk running behind the cell, composed of four semioval spots, which are connected together, and a marginal row of four or five nearly semicircular spots, all black. *Beneath*, the same, except that the costal edge is yellowish, and that there is a marginal row of six small white spots.

Body blackish; thorax spotted with greenish yellow; abdomen beneath wholly greenish yellow. (Antennæ wanting).

My example of this species was received from Bogotá, New Granada. There is a specimen in the British Museum from Nauta, Upper Amazons.

4. Ithomia Synnova, Hewitson.

Ithomia Synnova, Hewits. Exot. Butt. *Ithomia,* f. 136.

A distinct and beautiful species, found only in the forest at Tunantins, on the northern bank of the Upper Amazons. Its nearest relative is no doubt the following, *I. Gunilla.*

5. Ithomia Gunilla, Hewitson.

Ithomia Gunilla, Hewits. Exot. Butt. *Ithomia,* f. 130.

Found at Fonte Boa, Upper Amazons, flying in company with the two following. All three stand in the closest relationship with each other; they are identical in colours, differing only in their arrangement or pattern. They all seem to keep themselves perfectly distinct.

6. Ithomia Priscilla, Hewitson.

Ithomia Priscilla, Hewits. Exot. Butt. *Ithomia,* f. 131.

Fonte Boa; equally abundant with the preceding and following.

7. Ithomia Illinissa, Hewitson. (Pl. LV. fig. 6 *a*).

Ithomia Illinissa, Hewits. Exot. Butt. *Ithomia,* f. 2 and 132 (aberration).

This species has a wider range than the two preceding, being found much further eastward, at Ega, and probably also westward in Peru. I found, at Fonte Boa, with the type, a few individuals of a variety which connects the species with *I. Priscilla.* I am inclined to think that all three are modifications of one and the same species. They may have arisen in separate localities, and have been afterwards brought by altered distribution into contact; but it is not necessary to suppose this, as the *Ithomiæ* always pair with their exact counterparts, so that separation is probably not requisite to aid the segregation of races, when the variations have once arisen.

The flocks of Butterflies, all of the same colour, and undistinguishable from one another when on the wing, which fly together in the same dry hollows of the forest at Fonte Boa, comprise, besides the three preceding species, also a fourth *Ithomia* (*I. Ælia*, belonging to a different section of the genus) and *Napeogenes Ercilla*. A *Leptalis* (Pl. LV. fig. 6), coloured in the same way, occurs in company with *I. Illinissa*, at Ega; and an *Ithomeis** (*I. aurantiaca*, belonging to the widely different family *Erycinidæ*) flies

* ITHOMEIS, nov. gen. (Family ERYCINIDÆ).

Allied to *Lymnas* and *Pheles*. Facies of *Ithomia*, having similar elongated fore wings and whitish spots near the apex, imitating the transparent ones usual in the species of that genus.

Head clothed with even, soft hair-scales: palpi extremely short, thick, thinly and smoothly clad with scales. Antennæ moderately slender, elongate, not pale-ringed; thickened towards the apex into an elongate, slender, compressed club. Fore wing elongate, apex more or less rounded: subcostal and median nervures straight; the former two-branched, emitting its first branch just before, its second much beyond, the end of the cell: upper disco-cellular very short; middle disco-cellular much longer, transverse; lower disco-cellular slanting outwards, nearly perfectly tubular, joining the median beyond its second branch. Hind wing suboval; upper radial appearing as a continuation of the subcostal, the terminal part of the subcostal placed as a branch of it; middle disco-cellular short, transverse; lower disco-cellular in the same relative position as in the fore wing. Legs thinly clad with scales, stout; fore legs of the ♂ densely hairy; fore legs of the ♀ long, thinly clad, claw-joint very large, oblong-oval, claws minute.

In the shape and clothing of the head, palpi, and antennæ, this genus is extremely similar to *Lymnas*, *Pheles*, *Zeonia*, *Themone*, and the allied genera. Its nearest relationship is with *Pheles*, from which it differs in the second subcostal branch of the fore wing being emitted after, instead of before, the end of the cell. The species of *Pheles* have somewhat the aspect of *Ithomiæ* and *Stalachtes*, but those of *Ithomeis* have a much closer resemblance to those genera.

1. ITHOMEIS AURANTIACA, n. sp.

♂. Expanse 1″ 9‴. *Fore wing: above*, black; a long triangular spot at the base of the cell, a smaller one just after the cell, a rounded one between the 1st and 2nd median branches, and a belt of three similar spots across the wing, between the radials and the 2nd and 3rd median branches, whitish; the costal margin at the base, a large spot between the median and postmedian nervures, and a narrow, somewhat regular, submarginal band beginning on the costa, running parallel to the outer margin, arched, and reaching the hind margin, orange. *Beneath*, the same.

Hing wing: above, orange, the whole margin narrowly, and a large triangular spot on the basal part of the disk, black. *Beneath*, the same, except that there are two white spots at the base of the wing.

Antennæ black. Body black; forehead silvery white; abdomen beneath orange.

Found at Caiçara, between Ega and Fonte Boa, in company with *Ithomia Ælia*, which it very much resembled on the wing.

2. ITHOMEIS STALACHTINA, n. sp.

♂. Expanse 1″ 8‴. *Fore wing: above*, black; the costal and hind margins near the base slightly tinged with tawny orange; a long stripe within the base, a speck beyond the cell, a spot between the 1st and 2nd median branches, and a short macular crossbelt, placed rather more than halfway between the cell and the apex, white. *Beneath*, the same, except that the tawny-orange marks near the base appear as distinct stripes, and that there is a short, narrow, obscure tawny belt parallel to the outer margin.

Hind wing: above, black; a broad tawny-orange stripe begins at the base, runs along the abdominal margin, bending before reaching the anal angle, and continues thence to the apex; there is also a dull tawny-orange spot in the middle of the costal margin. *Beneath*, the same, except that there are two white spots at the base.

Body and antennæ black; forehead silvery white; abdomen beneath orange.

with *Ithomia Ælia* in another locality. A species of Bombycide Moth (*Dioptis Æliana*, Pl. LV. fig. 10) is also seen mingled with the crowd in the forests of Fonte Boa. None of these are found in any other part of the Amazon region, nor indeed in any other part of America, to my knowledge, than the places inhabited by their counterparts.

Found at Ega, in company with *Stalachtis Duvalii* and *Ithomia Theonoë*, var. *Lysinoë*. I think there can be no doubt it is of the same stock as *Ithomeis aurantiaca*, and has become modified in colours by natural selection, like *Leptalis Lysinoë*, to adapt it to the prolific and flourishing *Stalachtis Duvalii*.

3. Ithomeis Heliconina, n. sp.

♂. Expanse 1″ 2‴. *Fore wing: above*, black; a large triangular spot on the basal part of the disk, traversed by the median nervure and its first branch, a short crossbelt beyond the cell, traversed by the costal, upper and lower radials, and 3rd median branch, white; a narrow submarginal curved belt, beginning on the costa and ending near the hind margin, reddish. *Beneath*, the same.

Hind wing: above, black, with the disk (behind the cell), including the central part of the abdominal margin, greyish white, semitransparent; the nervures dusky: the broad black hind border has a narrow reddish-orange stripe in its middle. *Beneath*, the same, except that there is a white spot at the base.

Body and antennæ black; forehead silvery white; abdomen beneath orange.

Found at St. Paulo, flying in company with *Ithomia Ilerdina*, which it resembles when on the wing.

4. Ithomeis mimica, n. sp.

♂ ♀. Expanse 1″ 3‴–1″ 9‴. *Fore wing: above*, dull black, with a reddish tinge on the margins near the base; a triangular spot traversed by the median nervure in the basal part of the disk, and an obscure spot between the 2nd and 3rd median branches, dull greyish white; a broad arched tawny-orange belt parallel to but distant from the outer margin, beginning on the costa, and not reaching the hind angle. *Beneath*, the same, except that the tawny-orange belt is yellower, and that there is a stripe of the same colour on the costal and hind margins, near the base.

Hind wing: above, dull black; the disk crossed behind the cell by an obscure, narrow, greyish stripe, traversed by the dusky nervures; a broad regular submarginal stripe along the hind margin and the abdominal edge orange-tawny. *Beneath*, the same, except that there is a whitish streak at the base of the costa.

Body and antennæ black; forehead silvery white; abdomen beneath orange.

This species is found at St. Paulo and at Ega. It has a great resemblance in colours (though much smaller in size) to *Stalachtis Euterpe*, which inhabits in great numbers both localities.

5. Ithomeis Satellites, n. sp.

♂. Expanse 1″ 8‴. *Fore wing: above*, black; a very large triangular spot, occupying the basal part of the disk, extending nearly to the end of the cell and to the hind angle, and a macular crossbelt consisting of six spots, half-way between the cell and outer margin, greyish white, slightly transparent; a submarginal belt, beginning on the costa and extending nearly to the hind margin, reddish orange. *Beneath*, the same.

Hind wing: above, with the whole disk grey, semitransparent; the costal edge black; a broad submarginal band, beginning on the costa and running parallel with the margin to the abdominal edge, reddish orange, bordered on each side with black. *Beneath*, the same, except that the red submarginal belt runs also along the costal margin to the base of the wing, which has also on its black costal edge a whitish stripe.

Body and antennæ black; forehead silvery white; abdomen beneath orange.

This species has the light-coloured portions of the wings much greater in extent, and much clearer in hue, than any of its kindred. It is found in the forests of the Cuparí, a branch of the Tapajos, in company with *Ithomia Flora*. It is in accordance with the rest of the facts of adaptive resemblances here recorded, that this *Ithomeis*, the *Leptalis* of the locality (*L. Theonoë*), and the *Ithomia* which they both mimic (*I. Flora*), are all much more transparent and clearer in colour than their allied forms of the Upper Amazons.

I believe that all the five species of *Ithomeis* here described belong to one stock. It is remarkable that the colours of the antennæ and body are identical in all five. This seems to show that the modifications have played only upon the colours of the wings, and this strictly in accordance with the *Ithomiæ* or *Stalachtes* which abound in the locality they respectively inhabit. They are all excessively rare. I found but one specimen each of four of the species, during eleven years' research.

8. Ithomia Ilerdina, Hewitson. (Pl. LVI. fig. 4 *a*.)

Ithomia Ilerdina, Hewits. Exot. Butt. *Ithomia,* f. 129, 145.

This is closely allied to *I. Illinissa*. It entirely takes the place of that species at St. Paulo, differing from it only in the white disk of the hind wing and orange submarginal band of the fore wing. It is clearly only a local modification of the same, whose segregation from the original stock is complete. A variety of *Leptalis Lysinoë* (*L. Leuconoë*, Pl. LVI. fig. 4) exists at St. Paulo in company with it, and presents precisely the same modifications of colour; also the Erycinide *Ithomeis Heliconina*, and a species of Bombycide Moth (*Dioptis*, Pl. LV. fig. 11). The three mimicking species were very rare, whilst *I. Ilerdina* was extremely abundant. *I. Ilerdina* varies a little in the white nervures of the disk of the wings being partly black, showing the process of transition to the peculiar white hue which distinguishes it from the allied species.

9. Ithomia Onega, Hewitson. (Pl. LV. fig. 2 *a*.)

Ithomia Onega, Hewits. Exot. Butt. *Ithomia,* f. 1.

This handsome species is found in abundance throughout the Upper Amazon region, where it seems to take the place of *Ithomia Flora*, which is peculiar to the region nearer the Atlantic. I believe it to be a local modification of *I. Flora*. A *Leptalis* of similar colours (*L. Melanoë*, Pl. LV. fig. 2) and a Bombycide Moth (*Dioptis Onega*) accompany it. The *Leptalis* is undoubtedly a variety or descendant from the stock of *L. Theonoë*, which, we have seen, inhabits only those places where *Ithomia Flora* occurs. *Leptalis Melanoë* has been found nowhere but in company with *Ithomia Onega*.

10. Ithomia Flora, Cramer. (Pl. LV. fig. 1 *a*.)

Papilio Flora, Cramer, Pap. Exot. t. 257. f. B, C (poor figure).
Ithomia Flora, Hewitson, Exot. Butt. *Ithomia,* f. 68, 69.
—— *Egra,* ibid., f. 4 (a slight aberration).

This species abounds in the forests of the Amazon Delta, and as far up the river as the banks of the Cuparí (a branch of the Tapajos), 120 miles above the mouth of that river. Unlike the *Ithomiæ* of the Upper Amazons, its wings have a very large portion of their surface clear of scales and transparent. *Leptalis Theonoë* (Pl. LV. fig. 1), *Napeogenes Ithra*, and the Bombycide Moth *Dioptis Cyma*, have a great resemblance to it, and are found only in the regions which it inhabits. *Dioptis Cyma*, however, is an exception; it has acquired a wider range, being found at Ega, where no clear-winged *Ithomiæ* are met with. The *Ithomiæ* increase in transparency in receding from the equator. They are numerous in Venezuela, South Brazil, and Mexico. The tendency to transparency reaches its acme in *Ithomia* (*Hymenitis*) *diaphana* of Jamaica. Nearly all the species of the Upper Amazon region have opake wings.

11. Ithomia Doto, Hübner.

Ithomia Doto, Hübner, Samml. Exot. Schmett.
—— *Sisera,* Hewits. Exot. Butt. *Ithomia,* f. 6.

Abundant on the banks of the Tocantins, at Baiao. Found also at Pará.

12. Ithomia Antisao.

Ithomia Sao, Hewitson, Exot. Butt. *Ithomia,* f. 110, 111.

This form requires to be distinguished by a separate name from *I. Sao* of Hübner, although it be only a local variety of it, on account of its wings being less clear, the nervures tinged and bordered with reddish, and the hind-wing border having a reddish stripe within it. The true *Sao* of Hübner, of which I examined the typical example in Dr. Boisduval's collection, has very clear wings, sharply defined nervures, and the hind-wing border wholly dark brown. I did not find this in the Amazon region, the whole of the examples collected agreeing with the figs. 110, 111 of Hewitson. On the Upper Amazons it is an extremely abundant species.

With this species commences the tendency to determination of the hind-wing neuration towards the costa. In the ♂ the upper radial is placed as a branch of the subcostal near the apex, and consequently there is no upper disco-cellular nervule. In the ♀ the upper radial is connected with the cell by means of an upper disco-cellular, in the same way as in the typical *Ithomia I. Flora* and its allies.

13. Ithomia Tucuna, n. sp.

♂ ♀. Expanse 1″ 9‴–2″ 4‴. Closely resembles in shape, markings, and neuration *Ithomia Zerlina* (Hewitson, Exot. Butt. *Ithomia,* f. 94–96). Differs in colours. *Fore wing* hyaline: *above,* the entire margin evenly bordered with dark brown, which colour also forms a short oblique belt running from the costa across the end of the cell; the hyaline part brownish, with a large spot in the middle of the cell, a crossbelt beyond the cell, and a row of elongate spots between the nervures, near the margin, light yellow; the costal stigma, with the nervures crossing it, and the base of the upper radial light yellow. *Beneath,* the same, except that the outer margin, from the costal stigma to the hind angle, is orange-coloured, edged with black, and that there are two white spots at the apex.

Hind wing: above, more broadly margined with dark brown, except on the abdominal edge; the whole basal part of the disk, extending to the abdominal margin, with the nervures traversing it, light yellow; an elongate spot over the lower radial, also, same colour. *Beneath,* the same, except that the margin is orange, edged with black, and that there is a marginal row of five white spots set in black semicircles.

Body black; thorax spotted with white; abdomen yellow beneath. Antennæ black; club orange-yellow.

Abundant in humid parts of the forest, at St. Paulo, Upper Amazons. The hind-wing upper radial is totally wanting in the ♂.

14. Ithomia Salapia, Hewitson.

Ithomia Salapia, Hewits. Exot. Butt. *Ithomia,* f. 15.

The collar and wing-lappets are rufous, and the antennal club yellow; otherwise it very closely resembles *I. Primula.*

Banks of the Napo.

15. Ithomia Vestilla, Hewitson.

Ithomia Vestilla, Hewits. Exot. Butt. *Ithomia,* f. 17.

Very abundant in the forests of the Upper Amazons. It is always seen in company with *I. Antisao*; at Ega these two species seem to prefer each other's company to that of any of their kindred. At Fonte Boa there were two places in the forest peopled by *Ithomiæ*: one was tenanted only by *I. Illinissa* and its allies, as already described; the other by *I. Antisao, I. Vestilla, I. Virginia,* and *I. Onega.* The same occurred at St. Paulo: their societies were there increased by the attendance of *I. Oriana.*

The hind-wing upper radial is deficient in the ♂, and is placed as a branch of the subcostal a short distance after the cell in the ♀. This is a further approximation towards *Hymenitis.*

16. Ithomia Primula, n. sp.

♂ ♀. In size, shape, and markings, identical with *I. Vestilla.* It differs in colours. The hyaline parts of the wings in their centres are sulphur-yellow, as also the nervures which traverse them. In the fore wing there are two dusky lines, instead of one, extending from the short black stripe at the end of the cell, namely, one accompanying the 2nd, and the other the 3rd median branch. The dark border of the hind wing is much wider than it is in *I. Vestilla.*

These points of difference are constant in all the examples (many hundreds) which I examined. I believe, however, that *I. Primula* and *I. Vestilla* have descended from the same stock at no remote period. The grades of modification have not been found, and probably no longer exist; but allied species show, by their variations, a segregation in progress of two or more species from one stock not less dissimilar than the two species in question. The range of *I. Primula* does not coincide with that of *I. Vestilla.* It is not found at Ega, which seems to be the head-quarters of *I. Vestilla,* but makes its first appearance further west, at St. Paulo, where it is more abundant than its sister species.

The hind-wing upper radial is totally wanting in the ♂, and is placed, as a branch of the subcostal, a long distance beyond the end of the cell in the ♀.

17. Ithomia Ælia, Hewitson.

Ithomia Ælia, Hewits. Exot. Butt. *Ithomia,* fig. 7.

As before stated, this species flies in company with the similarly coloured *I. Illinissa, I. Gunilla,* and *I. Priscilla.* It differs from them considerably in the neuration, the upper radial being placed as a branch of the subcostal after the cell in the ♀, although (unlike *I. Vestilla* and *I. Primula*) it is present in the ♂ and connected with the cell by means of an upper disco-cellular nervule.

It is found at Ega, and at various places in the forest thence to Fonte Boa.

18. Ithomia Orolina, Hewitson.

Ithomia Orolina, Hewits. Exot. Butt. *Ithomia,* fig. 141, ♂.

Found abundantly at St. Paulo.

Expanse 1″ 7‴. It is a very variable species; and one at least of the varieties appears to have reached an advanced stage of segregation from the parental stock. They all fly together in the same places, and their differences are so slight and graduated that they cannot fittingly be treated as independent forms or species. They are as follows:—

Var. 1. *I. Aureola.*

♀. Size and general colours of *I. Orolina. Fore wing*: *above*, with a complete black border; the apical part has a large, broad, oblong, opake orange spot occupying more than one-third of the wing; posteriorly the spot reaches only the 2nd median branch, but covers entirely the 3rd; interiorly it is bordered by the short dusky belt running across the end of the cell: rest of the wing clear, transparent. *Beneath*, the same, except that there are three greyish-white spots at the apex.

Hind wing clear, transparent, the nervures edged with blackish; costal and posterior margins widely bordered with blackish, the latter having a rufous line in the centre. *Beneath*, the margins are orange-coloured, bordered with blackish, the margin without spots.

Body and antennæ black; thorax with a few faint whitish marks.

Found in company with *I. Orolina*, whose ♀ usually does not differ in markings from the ♂. It is a mere variety of the ♀, but necessary to distinguish, as it connects together the extreme modifications of the species.

Var. 2. *I. Oncidia.*

♀. In size, shape, and markings, similar to *I. Orolina. Fore wing*: *above*, with a complete narrow dusky border; the apical part has an arcuated orange belt, which is indistinctly limited on the inner side, but reaches nearly the hind angle, and leaves both the 2nd and 3rd median branches visible for the greater part of their length; rest of the wing transparent: the cell in middle part is broadly fuliginous; there is a thick dusky belt across the end of the cell, and the median branches are edged with blackish; a spot over the end of the cell and two spots between the median branches milky white. *Beneath*, the same, except that the apical margin of the wing has a greyish-white stripe.

Hind wing broadly margined with blackish, the hind border having in the middle a narrow orange-coloured line; the whole of the discal portion, with its nervures, milky white. *Beneath*, the same, except that the margins have a broadish orange line, widely margined with dusky, and the apex has a short greyish-white stripe.

Body and antennæ black; head and thorax with a few faint whitish marks.

This variety of the ♀ is interesting, as furnishing proof of the variability in colour, from smoky hyaline to milky white, of the discal portions of the wings and their nervures. We can understand from this how *Ithomia Ilerdina*, and its imitator *Leptalis Leuconoë*, may have originated.

Var. 3. *I. Chrysodonia.* (Pl. LVI. fig. 3 *a.*)

Very similar in colours and markings to *I. Orolina*, but much larger; the hind wings in the ♂ different in shape.

♂ ♀. Expanse 2″ 1‴. *Fore wing* the same in colours and markings as *I. Orolina* (fig. *cit.*), the only differences being that the orange belt of the apical border is neatly margined with blackish on its inner side, between the 2nd and 3rd median branches, and that it wants, beneath, the greyish-white marginal stripe at the apex; the upper disco-cellular is rather longer.

Hind wing with the costal edge much more dilated before the apex than in *I. Orolina*, and the apex itself in consequence is more broadly and transversely truncated; the two radials are much closer together, the upper partly atrophied, and the lower not visible on the disk; the third median branch is directed more towards the apex of the wing; the colours of the hind wing are the same as in *I. Orolina*, except that the dusky border is deeper in colour, more distinctly limited, and has an orange stripe running through the middle, which is most distinct towards the apex. *Beneath*, it wants the short grey-white macular marginal stripe at the apex.

Body and antennæ black; head and thorax with a few faint white markings. The elongate cup-like depression between the costal and subcostal nervures of the hind wing in the ♂, connected with the pencil of hairs, is much larger in this form than in *I. Orolina*.

This is the most abundant form of the species, and should be properly taken as the type, *I. Orolina* being subordinated with the other forms as its varieties. I follow the usual practice in taking the first-described form as the type.

Var. 4. *I. Aureliana*.

In shape and markings this form comes between *I. Sarepta* (Hewits. Exot. Butt. *Ithomia*, fig. 3.) and *I. Chrysodonia*. ♂. Expanse 2″ 2‴. *Fore wing* much elongated, upper disco-cellular wanting: *above*, the subapical orange belt, as in *I. Sarepta*, is broadly margined along its entire inner edge with black; but it is much narrower, being broadest near the costa, narrowing gradually to the 3rd median branch, thence very narrow to the hind angle; it thus leaves between the upper radial and 1st median branch a series of four successively larger whitish transparent spots: the dusky belt across the apex of the cell is large; the transparent parts are whitish, and all the nervures are broadly bordered with blackish: the black apical margin has a row of four obscure whitish spots. *Beneath*, the same, except that the nervures around the end of the cell are orange-coloured, and the marginal spots near the apex are large and of a clear grey white.

Hind wing oblong, costal border broad, apex rounded; outer margin with a broad dusky border, in the middle of which runs a broad orange stripe; the hyaline disk is whitish, the nervures dusky. *Beneath*, the oblong pouch near the costa is much larger than in *I. Chrysodonia*; colours as above, except that there is near the apex a marginal row of four elongate greyish-white spots.

Body and antennæ black; head and thorax with a few faint white marks. The hind-wing lower radial (♂) is not visible on the disk, and the upper radial is partially aborted.

Taken, in company with the four preceding, at St. Paulo.

19. Ithomia Sarepta, Hewitson.

Ithomia Sarepta, Hewits. Exot. Butt. *Ithomia*, fig. 3.

Found at Barra, on the Rio Negro, by myself; and at Guia, several hundred miles further up the same river, by Mr. Wallace. I did not find it at St. Paulo.

I treat this as an independent form, because it appears to have separated itself completely from the parental stock, *I. Orolina*, and inhabits a distinct area of country. *Ithomia Cidonia* (Hewitson, Exot. Butt. *Ithomia*, fig. 122), of New Granada, is another local race of the same stock. *I. Sarepta* comes nearest to *I. Aureliana*, and *I. Cidonia* to *I. Chrysodonia.* The five varieties found mingled together at St. Paulo cannot be thus separated, although they show, as we have seen, differences of structure as well as of colour and markings. They form a graduated series, and have not reached the stage of complete segregation. The differences in the veining of the wings are evidently the correlated result of the altered shape and increased or diminished size of the wings. I consider this *Orolina* group of *Ithomiæ* to be nearly equivalent to the *Illinissa* group; the difference between the present condition of the two is that in *Ithomia Orolina* and its allies the segregation of the forms is only partially complete, whilst in *I. Illinissa* and its kindred it is almost perfectly so.

A variety of *Leptalis Lysinoë* (*L. Erythroë*, Pl. LVI. figs. 1, 2, 3), a *Napeogenes* (*N. Corena*), and a Bombycide Moth (*Dioptis*, n. sp.), all assimilated in colours to *L. Orolina* and its varieties, occur in company with them at St. Paulo.

20. Ithomia Oriana, Hewitson.

Ithomia Oriana, Hewits. Exot. Butt. *Ithomia*, fig. 134.

Abundant at St. Paulo, in the moister parts of the forests.

21. Ithomia Virginia, Hewitson. (Pl. LVI. fig. 6 *a*.)

Ithomia Virginia, Hewits. Exot. Butt. *Ithomia*, fig. 18.

Banks of the Upper Amazons, from the mouth of the Rio Negro to St. Paulo. It is probably a local variety of *I. Cymo.* The upper radial is partly aborted in the ♂.

22. Ithomia Cymo, Hübner.

Ithomia Cymo, Hübn. Samml. Exot. Schm.
—— *Galita*, Hewits. Exot. Butt. *Ithomia*, fig. 5.

Very abundant at Para, in company with *I. Flora.* The upper radial is totally wanting, and the lower disco-cellular partly aborted in the ♂.

23. Ithomia Nephele, n. sp.

♂ ♀. Expanse 2″ 5‴. Hyaline, slightly fuliginous. *Fore wing* with a narrow black border, which is broadest along the hind margin; there is a short, broadish, oblique black belt across the end of the cell, and beyond this an oblique chalky-white belt, beginning on the costa, where it forms an opake white stigma, and nearly reaching the middle of the 3rd median branch; the nervures which it traverses are also white; the 2nd and 3rd median branches, as well as the rest of the nervures, are black; there is also a series of obscure whitish spots between the nervures, near the outer border. *Beneath*, the black borders and belt are reddish orange.

Hind wing with a narrow, clearly defined black border, which beneath is reddish orange.

Body and antennæ black; head and thorax marked with white.

This species, which is the only *Ithomia* found in the Amazon region that might be considered a *Hymenitis*, is found only at Tabatinga, on the Peruvian frontier. It resembles much *I. Edessa* (Hewitson, Exot. Butt. *Ithomia*, fig. 42.), a native of S. E. Brazil; but it is a little larger, and differs considerably in the hind-wing neuration of the ♂. In *I. Edessa* there is a middle and an upper disco-cellular nervule, and the upper radial is only partially aborted; indeed, the neuration is identical with that of *I. Virginia* and *I. Oriana*; but in *Nephele* the approximation to *Hymenitis* is carried a step further; for the middle and upper disco-cellulars, as well as the upper radial, are all quite aborted, although the lower disco-cellular and radial are not attached to the subcostal. In the ♀ the middle disco-cellular joins the subcostal, and there is no trace of an upper radial.

Genus Melinæa, nov. genus.

The species of this distinct group were placed by Doubleday in section 2 of the genus *Mechanitis*; but he failed to mention or misstated most of the principal characters of the section. The genus is nearest allied to *Olyras* and *Thyridia*; in fact, it approximates these much more closely than it does *Mechanitis*. From *Olyras* it differs in the fore legs of the ♂, in the palpi, and slightly in the wing-neuration; from *Thyridia* also in the fore legs of the male, in the palpi, and in the antennæ. The following are its principal characters.

Palpi short, smoothly clothed with scales, and closely applied to the forehead; third joint not porrect as in *Mechanitis* and the allied genera. Antennæ very long and slender. Fore legs of the ♂ with the tibiæ and tarsi more or less abbreviated, but never reduced to a rounded knob; the tibia always shorter than the femur. Fore tarsi of the ♀ long, filiform, spines wide apart. Hind-wing costal widely separated from the subcostal in both sexes, in the ♂ long, reaching nearly the apex of the wing, in the ♀ very short, terminating on the costa: the lower disco-cellular in both sexes straight, nearly in a line with the median nervure; the median nervure, in fact, describes a gentle curve, the lower radial being placed as though it were a fourth median branch: the middle disco-cellular is at right angles with the lower, strongly angulated in its middle, and emitting a recurrent nervule: upper disco-cellular rather long, transverse, joining the subcostal at about one-half the length of the wing.

The great resemblance in colours and markings between the species of *Melinæa* and those of *Mechanitis* has led to the confounding of the two genera; in other words, a relation of analogy has been mistaken for one of affinity, just as in the case of the two subfamilies *Heliconinæ* and *Danaïnæ*. There is, however, as will be seen on comparing the characters of the two genera, a wide structural difference in the palpi, fore legs of the male, and neuration of the hind wings. Some species of *Melinæa* so nearly resemble species of *Mechanitis*, that they might easily be mistaken for them. The two analogous forms accompany each other; but I think I found proof that they are not *adapted* one to the other, in the fact that the species of the two genera do not coincide in any locality on the Amazons, but vary and segregate races without any mutual specific similarity. They are very frequently accompanied by a *Heliconius* assimilated to them in colours and markings: in the case of this genus, adaptation seems to be intended. The following are all the cases of this complex association known to me:—

Nicaragua.

Heliconius Zuleika.
Melinæa Hezia.
Mechanitis, n. sp.

New Granada.

Heliconius Ismenius.
Melinæa Messatis.
No Mechanitis.

———

Heliconius, n. sp.
Melinæa, n. sp.
Mechanitis Menophilus.

East Peru and Bolivia.

Heliconius, n. sp.
Melinæa, n. sp.
Mechanitis Mothone.

Upper Amazons.

Heliconius Pardalinus.
Melinæa Pardalis.
No Mechanitis.

———

Heliconius Aurora.
Melinæa Lucifer.
No Mechanitis.

Pará.

Heliconius Sylvana.
Melinæa Egina.
No Mechanitis.

———

Heliconius Numata.
Melinæa Mneme.

Pernambuco.

Heliconius Ethra.
Mechanitis Nesæa.
No Melinæa.

Rio Janeiro.

Heliconius Eucrate.
Mechanitis Lysimnia.
No Melinæa.

The new species mentioned are contained in the British Museum Collection.

1. Melinæa Egina, Cramer.

Papilio Egina, Cram. Pap. Exot. t. 191. f. D.
—— *Ludovica*, Cram. Pap. Exot. t. 297. f. E.

This is a common species throughout the Amazon region, and appears to be very constant in character throughout the whole area. The ♂ fore legs are in a more rudimentary condition than in other species of the genus, the tibiæ and tarsi forming simply an elongate-conical point at the apex of the femur. It flies, in company with *Mechanitis Polymnia*, *Melinæa Mneme*, *Heliconius Sylvana*, and *H. Numata*, slowly, amongst the lower trees in thinned parts of the forest.

2. Melinæa Mneme, Linnæus.

Papilio Mneme, Linn. Syst. Nat. ii. 756. n. 59.
—— ——, Cram. Pap. Exot. t. 190. f. C.

Also found at all stations throughout the Amazon region. It is constant in its specific characters, with the exception of a frequent aberration in the blending of the black central and marginal stripes of the hind wing, which many *Heliconidæ* are subject to. The fore tibiæ and tarsi of the ♂ are nearly as long as the femur.

3. Melinæa Equicola, Cramer.

Papilio Equicola, Cram. Pap. Exot. t. 297. f. F.

This species seems intermediate between *M. Mneme* and *M. Egina*, not only in colours, but in the structure of the fore legs in the ♂. It is found at Ega. In my example the yellow belt across the end of the cell in the fore wing is less distinct than it is in Cramer's figure; the apical half of the wing is black, with two yellow macular belts, as in *M. Egina*; there is a black spot in the angle formed by the first median nervure and its first branch; and the marginal row of pale spots is indistinctly marked.

4. Melinæa Lucifer, n. sp.

♀. Expanse 2″ 9‴. Similar in size and general appearance to *M. Mneme*; differs from it in the absence of the yellow crossbelt, and the presence of a very large subapical yellow spot on the fore wing. *Fore wing*: *above,* tawny orange; the costal margin near the base, a stripe along the middle of the hind margin, an irregular spot within the cell before the middle, a short oblique belt across the end of the cell touching the costa, a spot between the 1st and 2nd median branches near the median nervure, and the apical fourth of the wing black; the black apical part extends along the outer margin, and is connected with an oblong spot which ascends between the 1st and 2nd median branches; there is a yellow spot on the costa, at the end of the cell, and a very large oblong yellow spot in the middle of the apical part, crossed by three nervures; near the middle of the black outer border are two large orange-tawny submarginal spots. *Beneath,* the same; margin spotless.

Hind wing: *above,* tawny orange; a stripe along the costa from the base to the apex, and a very large rounded spot which occupies the anal half of the wing, black; there is also a small black spot between the two radial nervures. *Beneath,* the same; margin spotless.

Body and antennæ precisely as in *M. Mneme* and *M. Egina.* Fore tibiæ and tarsi of the ♂ elongated, but much shorter than the femur.

St. Paulo; Upper Amazons. Its mimetic analogue, *Heliconius Aurora,* was found in its company.

5. Melinæa Mænius, Hewitson.

Mechanitis Mænius, Hewits. Exot. Butt. *Mechanitis,* fig. 6.

This species was plentiful at Ega.

6. Melinæa Maëlus, Hewitson.

Mechanitis Maëlus, Hewits. Exot. Butt. *Mechanitis,* fig. 6, ♀.
—— *Marsæus,* Hewits. *l. c.* fig. 10, ♂.

Also plentiful at Ega, in company with *M. Mænius.* The two sexes are somewhat dissimilar in the colours of the wings.

7. Melinæa Pardalis.

Mechanitis Maëlus (part), Hewitson, Exot. Butt. *Mechanitis,* fig. 9.

Mr. Hewitson considered this form to be a variety of *M. Maëlus*: both were very abundant at Ega, and I did not find them to intermingle; it will be better, therefore, to keep them apart. The two sexes are alike in colours, as in the vast majority of the *Heliconidæ.* I did not meet with *M. Pardalis* at St. Paulo; but at Tabatinga, 80 miles further west, it again occurred, not however under precisely the same form as at Ega, but in a modified state, the yellow crossbelt and the spot at the hind angle of the fore wing having become of the same dark orange-brown hue as the rest of the wing. The same transformation of colour takes place in many species of *Heliconidæ* in travelling from east to west, and I am inclined to think it is due to the direct action of the physical conditions of the localities on the early states of the insects.

8. Melinæa Mnasias, Hewitson.

Mechanitis Mnasias, Hewits. Exot. Butt. *Mechanitis,* fig. 5.

Found at Pará, where it is rare. The species mimics most accurately in colours the *Ceratinia Ninonia*, var. *Barii.*

Genus Tithorea, Doubleday.

Doubled. and Hewits. Gen. Diurn. Lep. p. 99.

1. Tithorea Harmonia, Cramer.

Papilio Harmonia, Cram. Pap. Exot. t. 190. f. C.
Tithorea Megara, Doubled. and Hewits. Gen. Diurn. Lep. pl. 14. fig. 2.

Cramer's figure was made from an aberrant example, in which, as frequently happens in the *Heliconidæ,* the black central stripe of the hind wing is partially connected with the hind border; on this account Doubleday and other authors have passed it over, and given a new name to the species. The figure, however, is a very fair one, and recognizable by the tricuspid termination, on the outer border, of the fore-wing central yellow crossbelt, which distinguishes the species from all others. It is found pretty generally throughout the Amazon region, in the moister parts of the forest, and in company with *Melinæa Mneme*, *Mechanitis Polymnia,* &c.

2. Tithorea Cuparina.

♂ ♀. Size, shape, and general coloration of *T. Harmonia.* *Fore wing*: *above*, with the basal half orange-tawny, the outer edge of this colour running very obliquely from the middle of the costa to the outer margin; this is followed by an irregular and oblique clear yellow belt which crosses the costal part of the end of the cell and terminates in an obtuse point in the middle of the outer margin; the apical part beyond the yellow belt is black, and is crossed in the middle by three yellow spots; the basal third of the costa, the median nervure to the 1st branch, and the whole of the hind margin are bordered with black, besides which there are three black spots on the disk of the wing, namely, a triangular one in the middle of the cell, one across the end of the cell, and one between the 1st and 2nd median branches. *Beneath*, the same, except that there is (in some examples) a row of four white spots along the outer margin.

Hind wing precisely as in *T. Harmonia*, namely, tawny-orange, with a broad stripe along the fore margin not reaching the costa or the apex, an outer border, widening towards the anal angle, and a central stripe from the abdominal edge to the lower radial, crossing part of the cell, black. *Beneath*, the same, except that there is a row of fourteen silvery-white submarginal spots.

Common on the banks of the Cuparí (branch of the Tapajos), where it replaces *T. Harmonia*, of which it is a tolerably well-marked local variety. I found it only in the district just named; whilst *T. Harmonia* ranges, under its typical form, over a wide tract of country, from Surinam, Pará, and the Tocantins to the banks of the Upper Amazons.

Subfamily HELICONINÆ *.

Genus Heliconius.

Heliconius †, Felder, Wien. Entom. Monatsschr. 1862, p. 79.
Heliconia (Latr.), Doubled. and Hewits. Gen. Diurn. Lep. p. 101, and authors.

1. Heliconius Sylvana, Cramer.

Papilio Sylvana, Cramer, Pap. Exot. t. 364. f. C, D.

This species is common throughout the Amazon region, in company with *H. Numata*, *Melinæa Egina*, *Mechanitis Polymnia*, and other species of *Heliconidæ*. I have found examples which almost link it to *H. Numata*; indeed the three forms *H. Numata*, *H. Sylvana*, and *H. Eucoma* might be treated as so many varieties of one stock, being in an incomplete state of segregation.

2. Heliconius Numata, Cramer.

Papilio Numata, Cram. Pap. Exot. t. 297. f. C, D.

This species is so variable that it is difficult to find two examples exactly alike. Cramer's figure represents a frequent aberration, in which the central stripe of the hind wing is connected by dark lines with the hind border; in the markings of the fore wings, however, it exhibits nearly the most common form of the species. It differs from *H. Sylvana* in the following points:—

1. The yellow crossbelt of the fore wing lies wholly beyond the cell; the black apical part is much smaller; and there is only one transverse row of spots, which are three in number and widely separated.

2. The black spot in the middle of the fore-wing cell is connected with a line of the same colour, which runs to the base.

* Synonymous with our Acræoid *Heliconidæ*, p. 496. The small nervule mentioned (in the note on that page) as one of the distinguishing characters of the Danaoid *Heliconidæ*, was considered by Doubleday (who noticed it in the *Danaidæ* proper) to be the internal nervure. It is connected with the *submedian* nervure, and not the *median*, as stated by inadvertence.

† Dr. Felder proposes this innovation of the masculine for the feminine termination, on the grounds that the name *Heliconia* clashes with that of a group of plants inhabiting the same region, and that Linnæus first used the word in the masculine form, *Papiliones Heliconii*.

3. The black central stripe of the hind wing runs from the middle of the abdominal edge to the apex of the wing.

4. The pale submarginal spots of the upper surface are wanting.

It is curious that these points of difference between *H. Numata* and *H. Sylvana* are almost precisely the same as those which distinguish *Melinæa Mneme* from *M. Egina*. I judge from this that a mimetic resemblance is intended between the *Heliconii* and the *Melinææ*—*H. Numata* and *M. Mneme*, *H. Sylvana* and *M. Egina*,—the Heliconine insects being adapted to the Danaïne species. If we trace the species or races allied to *H. Numata* over the whole of Tropical America, we shall find that each one mimics a Danaïne species in its locality; and I think it probable that they are all of the same stock as *H. Numata*. Thus, in Eastern Brazil *H. Ethra* mimics *Mechanitis Nesæa*; and in the southern parts of the same country, *H. Eucrate* precisely imitates *Mechanitis Lysimnia*. I have already mentioned these and other cases occurring in New Granada, Nicaragua, Eastern Peru, and the Upper Amazons: the *Heliconii* are adapted sometimes to a *Mechanitis*, and sometimes to a *Melinæa*.

H. Numata varies in structure as well as in colours. The wings are sometimes broader, sometimes narrower; and their edges are simple in some examples, and festooned in others. The yellow crossbelt is sometimes blended with the ground-colour of the wing; in many examples which connect the species with *H. Eucoma* it is narrow, and in others very broad, as represented in Cramer's figure.

The central black stripe of the hind wing is often very broad, covering part of the cell; at other times it is very narrow, and passes much behind the cell.

The species is found abundantly throughout the Amazon region; it occurs in thinned parts of the forest, where it is seen sporting about by twos and threes in the sunlight, or floating lazily in the air. The following is a remarkable variety occurring only on the Upper Amazons.

Var. *H. Isabellinus.*

♂ ♀ similar in shape and in the position of the black markings to *H. Numata*. Pale orange-tawny; in the fore wing the two macular belts, which in *H. Numata* are distinct and of a yellow colour, are blended together and of the same pale orange-tawny hue as the rest of the wing; the nervures, at the point where the two belts touch, are margined with blackish; the apical part of the wing is black, as usual, and is crossed by a row of four pale spots.

Two examples occurred, one at St. Paulo, and one (much smaller) at Tunantins.

3. Heliconius Eucoma, Hübner.

Eueides Eucoma, Hübner, Zuträge, f. 577, 578.

This species differs from *H. Numata* in the yellow crossbelt of the fore wing being narrow and submacular, consisting of four or five more or less distinct elongate spots, and also by its being separated from the cell by a series of black spots, more or less joined together in the form of an oblique belt. It is, however, extremely variable. At St. Paulo and other stations on the Upper Amazons, many examples occurred of a very dark orange-brown colour, more or less suffused with black; one variety is so distinct that it merits a distinctive name, as follows :—

Var. *H. Pardalinus.*

♂. Similar in size and shape to *H. Numata* and *Eucoma.* *Fore wing*: *above,* rich orange-brown; the basal half of the costal margin, a broad stripe on the hind margin, broadest in the middle, and an irregular border along the outer margin black; an elongate spot within the cell touching the base, a quadrate spot at the end of the cell, and two rounded spots, one between the 1st and 2nd, the other between the 2nd and 3rd median branches, also black; beyond the cell is an oblique bright-yellow belt, consisting of five elongate spots, and between it and the apex is a second yellow belt of four smaller spots: the outer edge of the first belt, the nervures beyond it, and an irregular spot around its extremity are black. *Beneath,* the same.

Hind wing: *above,* rich orange-brown; a stripe along the costa, a broad central one, and a marginal series of very large connected angular spots black. *Beneath,* the same, except that there is on the hind margin, towards the anal angle, a series of ten short yellowish-white lines.

Body and antennæ as in *H. Numata.*

The rich orange-brown colour of the apical part of the wing, divided into spots by the dark lines which accompany the nervures, gives a distinct appearance to this form, which, however, in all essential points is very closely allied to *H. Eucoma.* It is found in company with *H. Eucoma* at St. Paulo. It very much resembles *Melinæa Pardalis* of the same neighbourhood.

4. Heliconius Aurora.

♀. Size and shape of *H. Numata.* *Fore wing*: *above,* clear tawny orange; the basal half of the costa, a broad stripe on the hind margin, touching the edge, but not reaching the hind angle, an elongate spot at the base of the cell, a stripe across the end of the cell, from the costa to the outer margin, consisting of two elongate spots which meet at the hind angle of the cell, and the apical fourth of the wing black: in the middle of the black apical portion is an elongate yellow spot, crossed by four nervures. *Beneath,* the same; margin spotless.

Hind wing: *above,* clear tawny orange; a subcostal stripe, bent before the apex towards the upper radial, and a very large rounded spot occupying more than the anal half of the wing, black. *Beneath,* the same; margin spotless.

Body and antennæ precisely the same as in *H. Numata* and the allied species and varieties.

This apparently distinct species occurred at St. Paulo; it has a striking resemblance to *Melinæa Lucifer* of the same locality. It agrees in all essential points with *H. Numata,* and is most likely a modification of that species; but the intermediate connecting forms are wanting.

5. Heliconius Antiocha, Linnæus.

Papilio Antiocha, Linn. Syst. Nat. ii. add. 1068. n. 12.
—— ——, Cramer, Pap. Exot. t. 38. f. E, F.

A widely distributed species; found in Venezuela, Guiana, and throughout the Amazon region, with the exception of the district near Pará.

6. Heliconius Clytia, Cramer.

Papilio Clytia, Cram. Pap. Exot. t. 66. f. C.

This species is very abundant at all the places I visited on the banks of the Amazons. In many places a variety occurs in company with the type, in which the first yellow belt of the fore wing is narrow, and similar in shape to the first white belt of *H. Antiocha.* The colour of the belts in Cramer's figures of *P. Clytia* is given as white, probably by error of the colourist.

7. Heliconius Rhea, Cramer.

Papilio Rhea, Cram. Pap. Exot. t. 54. f. C, D.

Also a generally distributed and abundant species throughout the Amazon region.

8. Heliconius Leucadia.

♂. Expanse 2″ 6‴. Similar in size, shape, and general colours to *H. Rhea*; differs chiefly in having a series of eight large geminated whitish spots on the posterior margin of the hind wing. The first yellow belt of the fore wing is in the form of an oval spot, divided in two by the median nervure. The hind wing, beneath, is considerably different from the same part in *H. Rhea*; the red streaks and spots at the base are as follows:—there is an elongated streak along the basal part of the costa, a shorter one between the basal parts of the costal and subcostal nervures, a round spot within the base of the cell, another similar one at the base, between the median and post-median nervures, and a macular vitta running in a curve from the base of the abdominal edge to the third median branch. The marginal geminated spots of the upper surface are represented by large elongated white spots, one between each nervure.

One example, taken at St. Paulo.

9. Heliconius Hermathena, Hewitson.

Heliconia Hermathena, Hewits. Exot. Butt., *Heliconia,* fig. 5.

This very beautiful species was found only on the banks of the Tapajos, in scattered woods on the campos opposite Aveyros. It is not closely allied to any known species; as Mr. Hewitson observes, it partakes of the characters of *H. Phyllis* (of Rio Janeiro) and *H. Charitonia* (of the West India Islands), which are the two extreme forms of the genus.

10. Heliconius Erato, Linnæus.

Papilio Erato, Linn. Mus. Lud. Ulr. 231 (1764).
—— *Amathusia*, Cram. Pap. Exot. t. 177. f. F. (1770).
—— *Doris*, Linn. Mant. 536 (1771), var.
—— ——, Cram. Pap. Exot. t. 337. f. C. (1782).
—— *Quirina*, Cram. *l. c.* t. 65. f. A, B. (1779).

The two forms, *Erato* and *Doris*, offer a striking contrast in their colours, one being red, the other blue, and were naturally considered two perfectly distinct species. I thought they were such myself, until I bred them from precisely similar larvæ, which fed together in one cluster on the same tree. There are males and females in about equal numbers of both forms. I did not find, in the many hundreds of examples which I examined, any intermediate variety; the species, therefore, offers a case of dimorphism of which it is difficult to surmise the purpose. This case of variation in colour may, however, help to explain how the very diversified species of this genus have originated. *H. Erato* exists in both forms throughout the delta region of the Amazons, Guiana, and New Granada; but on the Upper Amazons, at St. Paulo, I found one of them absent, the blue one (*Doris*) only existing there; it occurred, however, in great numbers.

The larva has a series of moderately long hispid spines on each segment of the body: the head is bifid; in colour it is yellow, with narrow black bands. The chrysalis is smooth, without angles; the head, however, is prolonged to a point. It is suspended freely by the tail. The pupa-state lasts eight days.

11. Heliconius Metharme, Erichson.

Heliconia Metharme, Erichson in Schomburgk's Reise in Brit. Guiana, p. 595.

This species has very much the appearance of *H. Erato* (var. *Doris*), but it wants the patch of blue at the base of the hind wings above; it has, on the other hand, a series of short bluish lines near the hind margin, which are absent in *H. Erato*. It was rather a common insect at Ega and St. Paulo, but did not occur at all on the Lower Amazons. The species is found only in the interior of the forest, flying slowly, and delighting to settle on the scarlet blossoms of a climbing-plant; whilst *H. Erato* is seen only on the skirts of the woods and in damp waste places.

12. Heliconius Melpomene, Linnæus.

Papilio Melpomene, Linn. Syst. Nat. ii. 758. n. 71.
—— ——, Cramer, Pap. Exot. t. 191. f. C.

Found only in the middle part of the Lower Amazon region, at Obydos and Santarem, where the dry, hilly country of Guiana from the north, and that of interior Brazil from the south, reach the banks of the river. The soil in this part of the banks of the Amazons is light and sandy; the dry and wet seasons are more strongly contrasted, and the forests thinner, than in the rest of the river valley. The species also occurs throughout Guiana, Venezuela, and in New Granada. It is quite absent, however, from the humid forests of the Amazons, both to the east and to the west of the places above mentioned.

An allied species, *H. Thelxiope* of Hübner, exists there in its stead, having very similar habits, and filling, as it were, the same sphere in the economy of nature. These two forms (*H. Melpomene* and *H. Thelxiope*) have all the appearance of two thoroughly distinct species; but they are connected together by an unbroken series of varieties, the principal of which occur, not in the places where the two species come in contact, but in two isolated limited areas—at Serpa (west of Obydos) and on the banks of the Tapajos (near Aveyros). These connecting links cannot be the hybrid progeny of two originally distinct species, on account of their geographical position; many of them (and others not met with on the Amazons) occur also in Surinam and Cayenne, where *H. Thelxiope* has not been found. I believe there can be no doubt that *H. Thelxiope* is descended from *H. Melpomene*, and that the intermediate varieties are remnants of the steps of modification. The following are the principal intermediate varieties; they are all very scarce, whilst the species they connect exist in great profusion:—

Var. 1. *H. Callycopis*, Cramer, Pap. Exot. t. 190. f. E, F.

Same as *H. Melpomene*, except that the red belt of the fore wing is either very broad and irregular, or is broken into a number of various-sized spots.

Surinam and Obydos, Lower Amazons, in company with *H. Melpomene.*

Var. 2. *H. Elimæa*, Erichson, in Schomburgk, Reise in Brit. Guiana, p. 595.

The same as *Callycopis*, except that, in addition to the irregularity of the red belt, the basal part of the fore wing has a large red patch.

Obydos, in company with *H. Melpomene.*

Var. 3. *H. Lucia*, Cramer, Pap. Exot. t. 350. f. E, F.

Same as *H. Melpomene*, except that the red crossbelt of the fore wing is narrow and curved outwards, and that there is a large quadrate yellow spot within the end of the cell. This is the commencement of the chain of variations which leads to *H. Thelxiope.* The *H. Lucia* of Cramer was found at Surinam. I have Amazonian examples, taken at Serpa and on the Tapajos, which differ in the yellow spot of the cell being scarcely perceptible.

Var. 4. The same as *H. Lucia*, except that the base of the fore wings has a large red spot, and that the base of the hind wing is also red.

Serpa, Lower Amazons; banks of the Tapajos, near Aveyros; Cayenne.

Var. 5. *H. Erythræa*, Cramer, Pap. Exot. t. 189. f. A.

Santarem, in company with *H. Melpomene*; Surinam.

Var. 6. *H. Andremona*, Cramer, l. c. t. 297. f. A.

Surinam.

Var. 7. *H. Udalrica*, Cramer, *l. c.* t. 297. f. B.

"Pará" (Cramer). Taken probably somewhere on the banks of the Lower Amazons, as no trace of any of these forms exists at Pará.

These three varieties (5–7) seem to be intermediate between *H. Melpomene* and *H. Vesta*. I once took a ♀ *Erythræa* in copulâ with a ♂ *Melpomene*. *H. Vesta* would appear, from this, to be descended from the same stock as *H. Thelxiope*. It has, however, receded, as a form, further from the common parent than *H. Thelxiope*, and has acquired a much wider range.

Var. 8. *H. Tyche*, nob.

Fore wing as in var. 2, viz., black, with the basal third and a broad belt across the middle rosy red, leaving a narrow black intermediate space. The hind wing above and beneath is precisely as in *H. Thelxiope*.

Taken at Serpa.

Var. 9. *H. Hippolyte*, nob.

Fore wing black; the basal fourth and a narrow oblique belt crossing the wing beyond the cell, from the costa nearly to the hind angle, rosy red; there is also a yellow spot on the costa, on the inner side of the red belt, and another obscure one within the cell. Beneath, the same. Hind wing, above and beneath, as in *H. Thelxiope*.

Serpa and banks of the Tapajos.

The approximation towards *H. Thelxiope* in this and the preceding variety is very considerable.

Var. 10. *H. Cybele*, Cramer, Pap. Exot. t. 188. f. A.

Serpa. In this beautiful variety the fore wing has the arrangement of yellow spots very similar to that of *H. Thelxiope*; but the hind wing is black, as in *H. Melpomene*, with the exception that there is a red spot at the base.

13. Heliconius Thelxiope, Hübner.

Nereis festiva Thelxiope, Hübn. Samml. Exot. Schmett.

Very abundant at Pará and on the banks of the Tocantins, also on the Upper Amazons, from the mouth of the Madeira to Peru. The geographical position of the complete chain of transition-forms just enumerated seems to show that *H. Thelxiope* originated in a variety of *H. Melpomene*, which was naturally selected out of the many that arose in the species on its descending into moist areas, as being better adapted to the humid forests of the Amazon plains than the parent form. It varies much in the shape and position of the yellow spots of the fore wing, but the most general form is that figured by Hübner. The following are the more important varieties.

Var. 1. *H. Aglaope*, Felder, Wiener Entomologische Monatsschrift, 1862, p. 79.

Differs from *H. Thelxiope*, Hübner, in having simply a narrow, oblique, slightly curved, yellow macular belt, consisting of seven spots, which crosses the fore wing considerably beyond the cell.

Pará, and north coast of the island of Marajó. Dr. Felder describes it as a species, from specimens received from the Upper Rio Negro.

Var. 2. *H. Vicinus*, Ménétriés, Cat. d. l. Coll. de l'Ac. Imp. de St. Pétersbourg, p. 114.

In this variety the yellow macular belt is placed close to the end of the cell; the spots are much elongated, and form, with the yellow spot within the end of the cell, a large compact macular patch.

Pará and Upper Amazons. Neither of these varieties shows a tendency to become local, or separate itself from the parent form.

14. Heliconius Estrella.

♂ ♀. Size, shape, and colour of *H. Thelxiope*: markings of the hind wing nearly the same as in *H. Vesta*. *Fore wing: above*, black, the basal third reddish carmine; the nervures bordered with black; a narrow macular belt, consisting of six light yellow spots, crosses the wing much beyond the end of the cell, nearly reaching the 2nd median branch. *Beneath*, the same, except that the red at the base of the wing is scarcely shown.

Hind wing: above, black; the centre of the cell and six narrow streaks radiating from the base, and running between the nervures, but not reaching the margin, reddish carmine; the second streak from the abdominal edge has a black mark near the base. *Beneath*, the same, except that the cell has simply two red streaks, that there is a round red spot between the median and abdominal nervures, and that the costa is yellow at the base.

Body differently marked from *H. Thelxiope*, the thorax being black, with six distinct rounded yellowish spots and two transverse lines behind.

This form seems to be intermediate between *H. Melpomene* and *H. Vesta*. It agrees with the latter in the design of the hind wings, but the shape and colour of the wings are different from it. In *H. Vesta* the shade of red is always inclining to orange, whilst in *H. Estrella* it is of the same crimson tint as in *H. Melpomene* and *Thelxiope*. This is most perceptible in living specimens. I look upon *H. Estrella* as a race, or a variety tending to become a race, equivalent to *H. Thelxiope* and *H. Vesta*, and to have segregated from the common stock, independently of the other forms.

I met with it only in the Delta lands of the Amazons; at Pará; and on the northern coast of the island of Marajó.

15. Heliconius Vesta, Cramer.

Papilio Vesta, Cram. Pap. Exot. t. 119. f. A.

This species is very abundant, and widely distributed, being found at Surinam; Cayenne; along the whole course of the Amazons, up to the Andes; in Bolivia, and at Cuenca, to the west of the Cordillera. It is further removed than *H. Thelxiope* from *H. Melpomene*, differing from both in colour and in the shape of the hind wings, their outer margin being less rounded: the yellow marks of the thorax are the same as those of *H. Estrella*. The yellow spots of the fore wing vary in the same way as in *H. Thelxiope*.

The area of distribution of *H. Vesta* embraces the lesser areas of *H. Melpomene* and *H. Thelxiope*. As intermediate forms connect it with *H. Melpomene*, there can be no doubt that it is descended from the same stock as that species; but having diverged more widely, it is not readily seen to be a modification of it, like *H. Thelxiope*. It may be the oldest-created of this cluster of imperfectly segregated species.

16. Heliconius Burneyi, Hübner.

Migonitis Burneyi, Hübn. Zuträge, f. 401, 402.

This fine, large, robust species belongs to the same group as *H. Melpomene*, &c. It seems to be confined, like *H. Thelxiope*, to the forest plains of the Amazons; it is not, however, a common insect, but is restricted to certain localities. Its strong, bold flight distinguishes it from all other species of *Heliconius*, when on the wing. Many individuals of both sexes have the hind wings black, except a patch of red at the base.

17. Heliconius Egeria, Cramer.

Papilio Egeria, Cram. Pap. Exot. t. 34. f. B, C.

This resembles much *H. Burneyi* in size and general appearance; it seems, however, to be a perfectly distinct species, recognizable by the glossy light-brown hue with paler streaks between the nervures, of the under surface of the wings. The hind wing beneath has a red streak near the abdominal edge, and there is a yellow spot on the costa at the base. It is a rare species: I took it at Para: it is found also at Cayenne, where *H. Burneyi* appears not to occur. My specimens differ from the one figured by Cramer, in the design of the upper surface of the hind wing, the red colour of the basal half being continued in a series of eight short, wedge-shaped streaks into the broad, black marginal half of the wing.

18. Heliconius Aœde, Hübner.

Migonitis Aœde, Hübn. Zuträge, f. 129, 130.
Heliconia Astydamia, Erichson in Schomburgk's Reise in Brit. Guian. p. 595 (aberration).

The antennæ in this species are much shorter than in the *Heliconii* generally, and more thickly clavate. It appears to be confined to the Amazon region and Guiana. In Guiana (Demerara and Cayenne) a species is found* which closely resembles it in shape and colours, but differs in having slender antennæ, like the typical *Heliconii*.

* Heliconius Xanthocles, n. s.

♂. 3″ 2‴. *Fore wing: above*, black; the basal third clear orange-red; a large quadrate spot within the cell at the end, and a belt of seven large spots close after the end of the cell, clear yellow; near the apex is a small oblong yellow spot, crossed by three nervures. *Beneath*, the same.

Hind wing very broad, nearly circular: *above*, black, with two short red streaks at the base. *Beneath*, the same, except that there is a small yellow spot at the base of the costa, and four small red spots between the nervures at their origin. Body black; head with a few white marks; mesothorax with four small spots in front, in a transverse line, and two large ones in the middle, yellow. Scutellum and two spots on the metathorax also yellow. The abdomen has a series of narrow yellow bands, the tip of each segment being edged with yellow. Antennæ long and slender, black.

Demerara; Cayenne.

H. Astydamia of Erichson differs from the type in wanting the radiating lines of the hind wing. We have already seen that this is a common form of aberration in the *Heliconii* of this group.

19. Heliconius Ricini, Linnæus.

Papilio Ricini, Linn. Syst. Nat. ii. 756. 63.
—— ——, Cramer, Pap. Exot. t. 378. f. A, B.

A common and well-known species. It appears to be distributed throughout the whole of the northern part of tropical America. It differs in habits from the other species of the genus, inasmuch as it frequents the skirts of woods, semicultivated grounds, and gardens. Its antennæ are short, and strongly clavate: in this feature, as well, indeed, as in size, shape, and habits, it approaches the genus *Eueides*.

Genus Eueides, Doubleday.

Doubled. & Hewits. Gen. Diurn. Lepid. p. 145.

1. Eueides Isabella, Cramer.

Papilio Isabella, Cram. Pap. Exot. t. 350. f. C, D.
Papilio Isabella Nereis fulva Dianasa, Hübn. Samml. Exot. Schm. (slight var.).

This is a common and abundant species throughout the Amazon region It does not inhabit the forest, but frequents open bushy places on the skirts of woods, flying in the usual sailing manner of the *Heliconii*. Like the species of *Heliconidæ* which have the same style of coloration (*Heliconius Numata*, *Mechanitis Polymnia*, &c.), it is a variable insect on the Upper Amazons, although constant in its specific characters at Pará. *H. Dianasa* of Hübner is a slight variety.

2. Eueides Hübneri, Ménétriés.

Eueides Hübneri, Ménét. Cat. d. l. Coll. de l'Ac. Imp. de St. Petersburg, p. 116, pl. 8. f. 5.

Ega, rare. Although very closely allied to *Eu. Isabella*, this is a well-marked form, which probably maintains itself distinct from that species. It differs somewhat in the shape of the wings; the pale central crossbelt is divided into separate spots; the antennæ are black, with the club pale beneath. It is an approximation towards *Eu. Cleobæa* (Hübn.) of Mexico.

3. Eueides Lampeto, n. s.

♀ 3″. *Fore wing* broader, the costa more arched than in *Eu. Isabella*: *above*, orange-tawny; a small portion at the apex, a narrow outer margin, and a broad stripe near the hind margin, extending from the base to near the hind angle, black; there are also four black spots on the disk, viz. a large wedge-shaped spot within the cell near the base, a small one over the disco-cellulars, a large rounded one between the 2nd and 3rd, and an indistinct one between the 1st and 2nd median branches; close to the apex are two whitish spots. *Beneath*, the same, except that there are three white apical spots.

Hind wing: *above*, orange-tawny; a line along the basal half of the subcostal nervure, a broad central stripe of six elongate spots behind the cell, and a broad hind border black; a submarginal row of whitish spots, interrupted in the middle. *Beneath*, the same, except that the costal nervure is also black, and the submarginal spots are larger and of a clearer white, there being two between each nervure, except near the apex, where there is only one, instead of two.

Body brown; antennæ yellow, except the extreme base, which is black; forehead and two spots on the crown white; mesothorax with four large rounded orange-tawny spots, namely, two wide apart on the shoulders and two near together in the middle.

This fine large species is deceptively like *Stalachtis Calliope*. It appears to be very rare. I met with only one individual; at St. Paulo. *Stalachtis Calliope* is a very abundant species.

4. Eueides Mereaui, Hübner.

Colænis Mereaui, Hübn. Zuträge, f. 201, 202.

The sexes differ considerably in the colours and design of their wings. The ♂ is dark orange-tawny; the apical half of the fore wing is black, sometimes crossed by a short orange-tawny belt; the hind wing has a broad and rather well-defined black border. The ♀ is paler in hue, and has two or three large ochreous spots in the middle of the fore wing; the apical half is black, sometimes with an ochreous spot on the costa, half-way between the cell and the apex; the black border of the hind wing is ill defined, shading off gradually into the ground-colour of the wing.

I met with this species on the Tapajos and Upper Amazons. It is found within the forest, flying about the tops of low trees in sunny openings. It has no near ally in the Amazon region, to my knowledge.

5. Eueides Lybia, Fabricius.

Papilio Lybia, Fab. Syst. Ent. p. 460, n. 73.
—— *Hypsipile*, Cramer, Pap. Exot. t. 177. f. C. D.

A very common species throughout the country. It flies in open sunny places on the skirts of the forest, or in semicultivated grounds. The caterpillar resembles in all essential points those of *Heliconius Erato* and the species of *Argynnis*. Each abdominal segment is furnished with a row of rather long hispid spines; the head has two similar spines, longer than those of the abdomen; the colour is pale red; the spines black. The chrysalis is angular, and spinose on its dorsal surface. The pupa state lasts eight days.

6. Eueides Thales, Cramer.

Papilio Thales, Cram. Pap. Exot. t. 38. f. C, D.
Eueides Thales, Hewitson, Journal of Entomology, i. pl. 10. f. 3 (var.).

A common and generally-distributed species in equatorial America. It closely resembles *Heliconius Vesta*, in company with which it is frequently found.

7. Eueides Eanes, Hewitson.

Eueides Eanes, Hewits. Journ. of Entom. i. pl. 10. f. 1.

This species also closely resembles *Heliconius Vesta*. It is found only on the Upper Amazons, at St. Paulo, flying over bushes on the skirts of the forest.

8. Eueides Aliphera, Godart.

Papilio Aliphera, Godt. Encyclopédie Méthodique, t. ix. p. 246.

A widely distributed species, being found over nearly the whole of tropical America. It seems to be constant throughout. I met with it at St. Paulo.

Subfamily ACRÆINÆ.

Genus Acræa, Fabricius.

1. Acræa Thalia, Linnæus.

Papilio Thalia, Linn. Syst. Nat. ii. 757, n. 67.
—— ——, Cramer, Pap. Exot. t. 246. f. A.

I took (at Pará) only one individual of this sole species of *Acræa* found in the Amazon region.

EXPLANATION OF THE PLATES.

The Plates are designed to show a few examples out of a great number of mimetic analogies between various Lepidopterous insects and the Heliconidæ. The insects figured belong to four families, very widely dissimilar in structure and metamorphosis: *Leptalis* (fam. Pieridæ), *Dioptis* (Bombycidæ, Moths), *Stalachtis* (fam. Erycinidæ), *Ithomia*, *Mechanitis*, *Methona* (fam. Heliconidæ). The figures also illustrate the process of the origination of a mimetic species through variation and natural selection. Reasons have been given (p. 504 *et seq.*) for considering the species of *Leptalis* and *Dioptis*, amongst others, as having been adapted by this process to the species of *Stalachtis* and the genera of Heliconidæ—the colours being brought into exact resemblance by the *successive* preservation of such naturally arising variations as tended more and more to resemble. One species only, *Leptalis Theonoë*, furnishes a good example of the process, it being one which, by a rare chance, shows in its existing varieties the process in different stages of completion. The figures indicated by a simple numeral represent the *adapted* forms; those marked *a*, the species to which they are adapted.

Plate LV.

Fig. 1*. *Leptalis Theonoë* (Hewitson).—Inhabits Cuparí, 55° W. long.

Fig. 1 *a*. *Ithomia Flora* (Cramer).—Inhabits Cuparí, 55° W. long.; also the mouth of the Amazons and Surinam.

Neither of these forms is found further westward on the Upper Amazons, where the following allied species and varieties alone occur.

Fig. 2. *Leptalis Theonoë*, var. *Melanoë*.—St. Paulo, Upper Amazons, 69° W. long.

Fig. 2 *a*. *Ithomia Onega* (Hewitson).—Upper Amazons, from 58° to 70° W. long.

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* The specimen of *L. Theonoë* in the British Museum collection, which served Mr. Hewitson for his figure of the species, is very much larger than the one figured in this Plate. But the *Leptalides* are apt to vary very much in size.

Fig. 3. *Leptalis Theonoë*, var. *Lysinoë* (Hewitson. Described by this author as a distinct species. The white fore part of the hind wing is merely a sexual character, and is hidden by the fore wing in the natural position of the wings).—Ega, Upper Amazons, 65° W. long.

Fig. 3*a*. *Stalachtis Phædusa*, var. *Duvalii* (Perty).—Ega, Upper Amazons, 65° W. long.

The resemblance between these two is very great, when flying in their native woods. The *Leptalis* is quite unlike any *Ithomia* found in the whole region, and is supposed to have been adapted to the *Stalachtis*, because its original variations were in the direction of *Stalachtis*, and this disguise equally well served the purpose of preservation with that of an *Ithomia*.

Fig. 4. *Leptalis Theonoë*, var.—Ega. Described by Hewitson as a variety of *L. Lysinoë*, Exot. Butt. *Leptalis*, fig. 13.

Fig. 5. *Leptalis Theonoë*, var.—Ega.

Fig. 6. *Leptalis Theonoë*, var.—Ega. This has considerable resemblance to *Ithomia Illinissa*, fig. 6 *a*.

Fig. 7. *Leptalis Theonoë*, var.—St. Paulo.

Fig. 8. *Leptalis Theonoë*, var.—Ega.

Fig. 9. *Leptalis Theonoë*, var.—St. Paulo.

These six varieties occurred only in single or very few examples: they imitate (with the exception of fig. 6) no other insect, and are supposed to be either simple variations (*sports*) or remnants of the steps of modification which have led to the various complete adaptations in the two districts where they are found. In any case (since it is impossible to suppose that each is an unmodified descendant of a parent originally created, in the usual sense of the term) they may be taken as affording proof of the variability of the species in several divergent directions, tending towards resemblance to *Ithomiæ*.

Fig. 6 *a*. *Ithomia Illinissa* (Hewits.).—Ega.

Fig. 10. *Dioptis Æliana* (n. sp. or var.?), deceptively like, when flying, *Ithomia Ælia*, a small species near akin to *I. Illinissa*, and found in company with it at Ega.

Fig. 11. *Dioptis Ilerdina* (n. sp. or var.?). Closely resembles, when flying, *Ithomia Ilerdina* (Pl. LVI. fig. 4 *a*), and found in company with it at St. Paulo.

Fig. 12. *Dioptis Onega* (n. sp. or var.?). Closely resembles, when flying, *Ithomia Onega* (Pl. LV. fig. 2 *a*), and flies in company with it at St. Paulo.

Fig. 13. *Dioptis Cyma* (Doubleday). Closely resembles *Ithomia Cymo*, a species similar to *I. Flora* (fig. 1 *a* of the present Plate), and flies in company with it at Pará.

Plate LVI.

Fig. 1. *Leptalis Theonoë*, var. *Erythroë*.—St. Paulo, 69° W. long.

Fig. 2. *Leptalis Theonoë*, var. *Erythroë*.—St. Paulo.

Fig. 3. *Leptalis Theonoë*, var. *Erythroë*.—St. Paulo.

Fig. 3 *a*. *Ithomia Orolina*, var. *Chrysodonia*.—St. Paulo.

The linking variations between *L. Erythroë* and *Theonoë* can be traced through the varieties 8, 5, and 6 of the preceding Plate. The substitution of red for white in the fore wings is seen to be a simple variation. Some traces of the narrowing of the red margin of the hind wing are also seen. The imitation of *Ithomia* is not nearly so close as it is in the cases of figs. 1 and 2 of the preceding and fig. 4 of the present Plate, but there is a considerable approximation, giving the appearance of a striving after a correct imitation. The selection of individuals having the most faithful likeness is here either not rigid or we see the formation of an exact mimetic analogue in process.

Fig. 4. *Leptalis Theonoë*, var. *Leuconoë*.—St. Paulo.

Fig. 4*a*. *Ithomia Ilerdina* (Hewitson).—St. Paulo.

This *Leptalis* appears at first sight an absolutely distinct species, but it is plainly a modification whose adaptation is complete. As to the fore wings, the vacillating nature of the colours is seen in figs. 4, 6, and 8 of Plate LV. in the clearest manner. The hind wings appear very peculiar, on account of the milky colour; but this is shown to arise by variation in *Ithomiæ*, which exhibit all the grades of variation from dusky to white nervures and ground of the hind wing.

Fig. 5. *Leptalis Nehemia* (of authors).—New Granada and S. Brazil.

Figured to show the normal form of the family (*Pieridæ*, called in England "Garden White" Butterflies) to which *Leptalis* belongs. The contrast in form and colours points to the conclusion that all the other forms of *Leptalis* are perverted from the usual facies of the family by long-continued process of adaptation to the Heliconidæ, in whose company (each species with its Heliconian model) they are solely found.

Fig. 6. *Leptalis Theonoë*, var. *Argochloë*.—St. Paulo.

Fig. 6 *a*. *Ithomia Virginia* (Hewits.).—St. Paulo.

The links of modification may be traced also with respect to this apparently distinct *Leptalis*. The shape of the spot of the fore wing is seen to be very variable in figs. 1, 2, 3 of this Plate, and in 9 and 4 of Plate LV.

Fig. 7. *Leptalis Amphione*, var. *Egaëna*.—Ega.

Fig. 7 *a*. *Mechanitis Polymnia*, var. *Egaënsis*.—Ega.

Fig. 8. *Leptalis Orise* (Boisduval).—Cuparí, 55° W. long.; also Cayenne.

Fig. 8 *a*. *Methona Psidii* (Linnæus).—Cuparí; also Cayenne.

ERRATUM.

At p. 515, after the characters of Family 2. Papilionidæ, insert
Subfam. 1. Papilioninæ.
Subfam. 2. Pierinæ.

XXXIII. *Observations on the Gonidia and Confervoid Filaments of Mosses, and on the relation of their Gonidia to those of Lichens and of certain freshwater Algæ.* By J. Braxton Hicks, *M.D. Lond., F.R.S. and L.S.*

Read June 5th, 1862.

For a considerable time it has been known that the Thallophytes throw off certain single cells, called *gonidia*, which are capable of reproducing the species from which they spring. It has also been known that, to a limited extent, they possess the power of segmenting before they produce a new thallus. The observations of a few Continental naturalists * pointed out that they could not be distinguished optically from the then-called *Protococcus*-forms (*Chlorococcus*).

These observations, however, had attracted but little general attention to the matter. Indeed their tendency was such that, fully carried out, they necessitated a reconsideration of all the Palmellaceæ or pseudo-unicellular Algæ (Braun) and of the true unicellular Algæ (Braun). The contemplation of such a revision might well be considered sufficient to alarm even the most persevering systematist; for it involves the very arduous task of watching the growths classed under these heads throughout a long period, and under every possible change of external conditions, with this additional difficulty, that, in case the observations produced no decisive result, they could not be admitted as absolute evidence that these forms were really unalterable, because the conditions to which they were thus exposed, perhaps, might not include all the combinations of influences to which they were liable in their natural state. Besides this, there is the fact already pointed out in the course of my observations on the gonidia of Lichens †, which increases the difficulty of proving the separate existence of these and allied growths, namely, their continuing in the same form of existence for an indefinite period, segmenting continually, till external conditions are favourable for inducing a change in the mode of growth, in which, again, they may continue for an equally indefinite period, and so on in every phase through which they are capable of passing. I believe the task just indicated has not yet been continuously undertaken; and at present any attempt at fixing the true position of these organisms would be completely vain and disappointing till more extensive researches in all directions shall furnish sufficient materials on which to argue.

The observations on the development of the gonidia of the Lichens, which I have brought forward in the 'Journal of Microscopical Science,' 1860 (July and October) and 1861 (January), also on the growth and diamorphosis of *Lyngbya muralis*, and on the statospores ‡ of *Volvox* in 1861, show that from these plants large quantities and

* *E. g.* Meyen, Itzigsohn, Kützing.

† Quart. Journ. Mic. Sc. 1860–61.

‡ See the remarks on this point by Pringsheim, in relation to this subject, on the "chronispores" of *Hydrodictyon*. Translated in Quart. Journ. Mic. Sc. April 1862.

masses of green cells are produced having all the characters of the Palmellaceæ (*Chlorococcus*, *Hæmatococcus*, *Gœlocapsa*, *Sorospora*, *Palmoglœa*, &c.), and [in the case of *Collema*] of *Nostoc*, and probably the Nostochaceæ, perfectly undistinguishable from the so-called true forms; and therefore it would be impossible to assert that any given mass of these growths was not the segmenting gonidia of these Thallophytes.

Hence, in the papers just mentioned, I have dwelt strongly upon the uncertainty attending the ranking of these as independent organisms, and the great necessity there is for re-examining carefully the entire subject afresh and with the advantage of the clue furnished by the observations above alluded to.

It is with the view of assisting in the solution of this difficult inquiry that I have brought forward the following observations—not with the presumption of being able by them to clear up the question finally, but to add information to that already acquired, upon which to make inferences regarding the separate entity of these forms—and also of introducing some other facts interesting to the vegetable physiologist.

The term *gonidium* has been applied to the single cell thrown off by the thallus-producing plants, and is probably the simplest homologue of the gemma of the higher Cryptogamia. The gemmæ of the higher kinds, consisting of several cells, are capable of growing out at once into the peculiar species from which they spring, by a process purely vegetative and agamic*. The gonidia of the Thallophytes have also the same power under certain circumstances (*e.g.* the sori of Lichens); and, besides this, they have been known to have the power of simple subdivision prior to their forming the perfect plant. That they have a far more varied and extensive property of multiplication than was originally supposed, I have shown in the papers quoted. That the production of *gonidia* is not confined to the Thallophytes, but may be abundantly traced in the Mosses, will be one of the endeavours of this communication to point out.

But, whereas in the Thallophytes they can be produced upon almost any part of the plant, except upon that especially set apart for gamic reproduction (if such be the true nature of the apothecia and spermogones of Lichens, or of the receptacle of the Hymenomycetes, &c.), we shall find, on the other hand, that in Mosses a particular portion is set apart for their production,—though it must not be understood that the other portions of the plant cannot produce them; for, as I shall be able to point out hereafter, under peculiar circumstances almost every part is so capable.

These observations were made upon a variety of our own common native Mosses, *Bryum*, *Neckera*, *Polytrichum*, *Hypnum*, *Tortula*, &c. They all showed, equally well, under the same circumstances, the phenomena to be mentioned, as far as I was able to judge.

If we examine any Moss, more particularly in the early spring, about its base, just at the junction of the true roots with the ascending axis, we shall almost invariably find, where the axes of different plants do not grow together too closely, green filaments, of indefinite length, springing out and branching, the branches frequently interlacing

* The exact value of the distinction between the simple gonidium, tubercle, gemmule, propagule, does not appear clearly marked: transitions continually occur between each and all of them. The first certainly tends more particularly to multiplication by the production of separate cells; the latter kinds to the extension of filaments leading more directly to the formation of the leafy axis.

with those of neighbouring plants. These have been known as the "confervoid filaments," or "confervoid radicles" (Pl. LVII. fig. 1).

Formerly they were not recognized as belonging to the Mosses, and were at one time very decidedly claimed by algologists *, under the name of "*Protonema*." We owe to Kützing the discovery that *Protonema* is not an Alga, but the product of Mosses †, although, before him, it was not unknown that Mosses did produce confervoid filaments from their spore ‡. Subsequently Schimper, in his excellent work on the Mosses §, confirmed the correctness of this observation of Kützing, and more fully traced the development and growth of the confervoid filaments from the spore, and the "propagule," and the origin of the leafy axis from them. As far as my observations have proceeded in this direction, they coincide with those of Schimper, and therefore I must refer those interested in the subject to his work.

Now Kützing, in his 'Phycologia Generalis,' retains the group Protonemeæ, and of them he says, "They are Confervæ nearly allied to *Cladophora*. They are particularly distinguished by growing out of water, by pushing their roots into the earth, as the Mosses do, and by never developing their fruit between the branches of the thread, but either on the end of the same or on one side." He gives two genera, *Protonema* and *Gongrosira*. Their characters he describes as follows:—

1. *Protonema*.

Trichomata radicantia, parenchymatica, ramosa, cœlogonimica. Gonidia in lineas longitudinales disposita; spermatia pedunculata, lateralia.

2. *Gongrosira*.

Trichomata radicantia, parenchymatica, ramosa, apice demum torulosa. Articuli ultimi demum in spermatia terminalia transeuntes.

That *Gongrosira* is also derived from the same origin seems clear to me; certainly *G. clavata* (Kützing), called by Dillwyn *Conferva multicapsularis*, and recognized as such by Kützing himself, is *of moss-origin*. So also is *G. sclerococcus* ('Phycologia Generalis,' tab. xvii. fig. 8), so far as can be judged from the figure given.

Besides these Protonemeæ, there is another allied family given by Kützing—Chantransieæ. In this is included the genus *Chroolepus*, the characters of which are thus given:—

"Trichomata cartilaginea, colorata, polygonimica, ramosa. Spermatia nunc lateralia, nunc terminalia."

That some of the forms figured under this name belong to the confervoid filaments of a Moss I think highly probable.

The plate of *Chroolepus* (tab. vii. fig. 2) certainly resembles a condition which the moss-growth assumes.

* See Eng. Bot. "*Protonema*," and Dillwyn's Synopsis of British Confervæ.

† Kützing, Phycologia Generalis; and Linnæa, Band viii. (1833).

‡ Hedwig, Fundamenta Muscorum, vol. ii. pp. 50, 51. Drummond, Trans. Linnean Soc. vol. xiii. p. 1. Fr. L. Nees d'Esenbeck, Nov. Act. Acad. C. L.-C. vol. xiii. Cassebeer, Entwicklung der Laubmoose. Meyen, Pflanzenphysiologie, t. iii. p. 403. Gottsche on *Haplomitrium Hookeri*, Nov. Act. Acad. Cæs. L.-C. N. C. vol. xx. p. 1.

§ Recherches sur les Mousses, 1848.

The observations of Dr. Caspary *, which show that *Chroolepus* produces zoospores, are not inimical to this view, as will be pointed out in the course of the following remarks. In addition I may also add that I have often observed the peculiar form of the end-cells giving off these zoospores, as figured by him in the older confervoid filaments of Mosses.

The gonidia mentioned by Kützing (in the characters of *Protonema*) as being thrown off from the filament were first noticed by him †, who also showed that they sprouted out again into a filament, but that whilst free they were globular and then looked like *Protococcus*-cells.

Beyond this point in their history, and the knowledge of their "peculiar fruit" (*tubercles*, Schimper) and the propagules of Schimper, I am not aware that any one has preceded me in the observations about to follow. Before proceeding further, it will be useful to describe more particularly the "confervoid filaments."

They consist of a single series of cells, of a length varying according to outward conditions, each cell possessing the property of forming branches like themselves. They are, in the first instance, produced by the germination of a spore, as has been pointed out by the observers above quoted; and although, as Schimper ‡ has beautifully shown, the ascending axis arises from them, yet the axis and the leaves in their turn give rise to the filaments, as Kützing § and Schimper also have pointed out, and which can be readily verified.

When the filament springs from either axis or leaf, or from a single unsegmented gonidium, the first change in the cell (for in either case only one cell is involved) is a bulging out of a portion of its wall, which, after growing a certain length, is shut off from the original cell by a septum at the point of origin ‖ (Pl. LVII. fig. 2). After this cell has grown a certain length, a binary subdivision of its contents takes place, upon the plan common to that form of parietal cell-formation ¶.

* Quart. Journ. Mic. Sc. vol. viii. p. 159.

† Linnæa, Band viii. p. 360.

‡ *Op. cit. suprà.*

§ Phycologia Generalis, *Protonema*.

‖ This corresponds with Nägeli's description of cell-formation in the Confervæ (Ray Soc. 1845, p. 260):—"The cell-formation occurs in a similar manner when a cell grows out sideways from the stem to produce a branch. The septum is then produced between the newly outgrown and the original portions of the cell. The cell-contents also remain unaltered here while the septum is becoming apparent." Again (Ray Soc. 1849, p. 141), "A cell grows out into a branch, and divides by parietal cell-formation into two cells, in such a way that one corresponds to the original cavity of the cell, the other to the expanded part. Here are to be enumerated the formation of branches in Algæ, Fungi, Florideæ, &c. It probably exists in all plants, but may be recognized best in organs composed of rows of cells."

¶ "The mode in which the process of division of cells takes place has been represented in different ways. While Unger explains the division of the cell-contents by the production of a dissepiment (partition), Nägeli, comprehending more correctly the relations of dependence between the formation of membrane and the contents, states, *vice versâ*, that the formation of the septum proceeds from the contents, previously divided into two halves; and Hoffmeister, in addition, directs attention here more particularly to the primordial utricle, bounding and cutting off the two parts from each other, even before the origin of the cellulose dissepiment. According to this representation, the septum is formed by the two individualized portions of contents into which the mother cell divides, and which secrete cellulose upon their whole surface after they become separately constituted, touching by their flat adjacent surfaces, whence, of course, the cellulose layers formed on the surfaces in contact become united and thus form what appears a single septum, which, however, from the nature of its origin, is composed of two plates. Referring to the *ab origine* existing contact of the daughter cells with the whole internal surface of the wall of the mother cell in the formation of

By the continuation of this process, chiefly in the terminal cell, and by the growth of the already formed cells, and by the formation of branches from branches continuously, the length of the filaments, and the area they occupy, are extended indefinitely (Pl. LVII. figs. 3, 4, 5). The branches are often commenced at an early period of the existence of the cell from whence they arise (Pl. LVII. fig. 2).

The contents of the cells vary much in appearance, according to their age. At first, in the growing end and in the half-formed cell of the branches, there is a tendency to general homogeneousness, although scarcely ever complete. In either case, very shortly after the cell is formed, the contents consist of a transparent, colourless layer (primordial utricle) lining the cell-wall, together with granules of uniform green colour (chlorophyll-granules), in greater or less quantity. In the actively growing cell, the centre contains a transparent fluid (sap-fluid); but in those which have solid, unyielding cell-walls, the endoplast fills up the interior, and the granules crowd each other, sometimes very closely.

A *nucleus* can frequently be observed in the mature cell, though not always. In the contents of the bulging commencement of a branch, no nucleus is to be observed; nor does the nucleus of the old cell undergo any change in consequence. The nucleus of the new cell must therefore be formed subsequently to the cell, which is certainly not produced by it. This, with many other facts, and with some which will hereafter be given, seem to point out that the nucleus does not necessarily play so important a part in cell-formation as some have supposed. I notice this only incidentally, as the discussion fully carried out would be foreign to the purpose of this communication. As I have remarked above, the length of each cell of the filament varies extremely, according to the external conditions. Under much moisture and heat, it is very much increased, so that it may be twenty or thirty times longer than wide; and sometimes the more terminal cells are elongated into delicate hairs, bearing a striking resemblance to the so-called cilia of the *Draparnaldiæ* (Pl. LVII. fig. 6) (which in some other respects they much imitate), their green protoplasmic contents being drawn out somewhat in the manner observable in that genus.

The general tendency of the growth of these filaments is towards an arborescent form when growing free and not crowded; and for a certain time they continue unaltered from the simple plan just described: sometimes they are scarcely branched at all (Pl. LVII. fig. 7); sometimes the secondary branches are arranged on the plan of a cyme (Pl. LVII. fig. 5).

In these forms the confervoid radicles continue to grow for an indefinite time, external circumstances remaining the same; and in course of time very large surfaces can be covered by them, unless usurped by other plants. They are perfectly capable of independent existence, whether they have arisen from a spore, leaf, stem, or root, when separated from their source; and hence the erroneous impression of their Algal origin. This is the less to be wondered at, if we notice the growth of one when placed in water. Under these circumstances the activity of its development and linear growth is wonder-

cells by division of the whole contents, Nägeli calls the formation of cells by division 'parietal cell-formation.'" —*Braun's 'Rejuvenescence in Nature,' Ray Soc.* 1853, p. 234.

fully increased, if not exposed to too much light; so that in a week it can multiply itself 200 or 300 times, while the original type has been nearly preserved, the slight alteration being in the elongations of the cells, and a decrease of their breadth.

Now, although, for the most part, these *confervoid filaments* generally preserve their peculiar appearance, and are in this manner very readily distinguished from the *true root-filaments*, whose endoplast is colourless and the cell-walls more or less stained with a brown colour, yet there is a great tendency for each, even after full formation, to pass into the other. This can be frequently seen in their natural state, and can be shown by experiment (Pl. LVII. fig. 8). The greater tendency, however, is for the radicles to pass into the confervoid filament than the contrary. The colourless endoplast of the true radicles becomes green and granular; and ultimately they exhibit all the characters of true confervoid filaments. On the other hand, I placed in the sun a glass full of the filaments which had grown, and were then growing, in water. After a week the cell-walls of the older portions had become stained brown, and they had assumed the appearance of those radicles whose contents had assumed the green colour.

Some of the filaments which I had grown in water branched in a manner very similar to *Draparnaldia tenuis* (*Stygeoclonium tenue*, Kützing); indeed, had it not been for its known origin, I should have instantly regarded it as such. I have shown one less marked at Pl. LVII. fig. 9 (the only one of which I preserved a drawing). In a glass of water, where I had placed Moss, on one occasion I found a very fine specimen of *D. tenuis*. This is a very unusual place to find this plant; and though I could not absolutely trace it to a Moss, yet, coupled with the fact that similar growths can be so originated, and also that the radicles produce elongated cilia-like cells, it seems to be a point worthy of further research, whether or not that genus, or at any rate the above species, may or may not have its origin from Moss in some one of its phases. Nor should this, in our present state of knowledge, be considered a wild speculation; for we know nothing of the agamic growth of *Draparnaldia*: we have nothing to militate against its being one mode of vegetative growth of a form considered altogether distinct; and this is not more extravagant than the known fact that these confervoid filaments can produce and spring from Mosses. I again remark, we know so little of the whole possible life-history of these simpler plants, that our want of knowledge of a precedent cannot be quoted against it.

Frequently in the larger filaments, and towards the extremity of those whose growth is not very active, may be seen here and there a considerable separation between the two adjacent cells. If this be carefully examined, it will be noticed that this space is filled by a transparent, colourless cell, which at first sight might be considered to have no contents; but upon careful examination, and the use of reagents, it will be found that there is colourless homogeneous endoplast, so closely applied to the inner side of the cell-wall as otherwise to escape detection (Pl. LVII. fig. 10). When the cells of this filament separate from one another, these transparent cells also become detached, and assume the shape of flattened spheres, or they may become quite globular. Whether they possess any further history I am unable to tell. It seems rather to be some abnormal condition of cell-formation at the line of the separation of the two portions —a portion detaching itself at the time of division, and forming around it a layer of cellulose. It bears a considerable resemblance to the heterocysts of *Nostoc* (Collema-gonidium) and the so-called Nostochaceæ, considered by Braun * as the first appearance of vegetative permanent cells,—although he considers these to be formed by a cell dividing into two unequal halves, one of which remains permanent, and the other continues to segment.

It has already been remarked that these filaments will soon cover a large space of the ground in their neighbourhood with their branches, if they are permitted to grow unrestrained; but after a time, particularly in damp, shady situations, the numerous branches begin to crowd upon each other so as to form a compact mass of filaments (Pl. LVIII. fig. 16); sometimes these intimately interlace, but more often they run upwards, parallel to one another (Pl. LVIII. fig. 16, Pl. LVII. fig. 7). Very commonly these branches are of nearly equal length, so that the surface on which they grow appears clothed with velvet. Sometimes, when they press closely upon one another laterally, they become hexagonal, and the cells of the lower portion, deprived of their due quantity of light, become nearly, and occasionally entirely, colourless.

The foregoing description applies to confervoid filaments grown under circumstances favouring active vegetation, namely, under warmth and moisture, such as in the shade of walls, banks, and sides of ditches. The same can also be very readily produced artificially, by keeping them under a glass shade in a warm room, without direct sunlight.

But drought and cold produce very marked changes in their outward form and appearances, which I shall endeavour to describe.

Under drought, more particularly during summer, the growth of the cells is much checked, and at the same time the cell-wall becomes much thicker. The cell-contents still growing, the chlorophyll-utricles crowd the interior, and press upon each other (Pl. LVII. fig. 11). Sometimes the cell-wall is itself dyed with chlorophyll, and somewhat undefined from the contents, like the segmenting gonidia of *Collema*—a condition not very uncommon in the segmenting cell generally. This tendency to the blending of the contents with the cell-wall I have endeavoured to show at Pl. LVII. fig. 11 *b*. It is very curious to observe the effects produced by alternations of weather upon these filaments, illustrations of which may be procured artificially. Some of the cells are long, with few granules; some are short, and the contents closely packed. Some have begun to branch, and become suddenly arrested in the process, the bulging part becoming covered with a dense cell-wall, precluding further growth in that direction. Some of these branches, encouraged by warmth and moisture, have rapidly grown out into narrow elongated cells, so as to look something like roots (Pl. LVII. fig. 11 *b*). As any part of the cell is capable of bulging, and as any one of the cells can do so independently of the other, and as the rate of growth of one cell is not limited by that of its neighbours, it can easily be imagined how variable and tortuous may be the forms which these confervoid filaments assume under the varying influences of our climate. Perhaps it may be best observed in those filaments which inhabit the bark of trees or dry walls, where the effect of the alternations of the seasons is more marked.

A very common effect which drought produces or increases is the development of a

* Rejuvenescence in Nature, Ray Soc. 1853, p. 146.

red or reddish-brown colour in the cellulose of the cell-wall. It occurs most frequently in those found on bark of trees and walls, and is more noticeable in summer and autumn, although it is to be met with at all seasons in the older cells (Pl. LVII. figs. 7, 11). When a new growth springs up, the young cell-walls possess no colour, showing that it is the production of age. On one occasion, I saw this colour produced in all the cells of a large quantity of confervoid filaments which had grown in water in the shade. I had placed the glass out of doors in the sun, and was surprised to find that all the older cell-walls had become dyed of a reddish-brown hue, although previously colourless: the contents within remained green. There is another change I have observed, apparently connected with drought, and probably also with a dimunution of vital activity, namely, the contents become brown or reddish brown. Pl. LVII. fig. 12 *b* shows the filament green, while at *a* it is changed to brown. That they were from the same source was readily proved, by finding the green and brown cells on one filament in varying degrees of change. These brown cells separated very readily from one another, as is the case in all the older cells of the filaments. The filament possessed somewhat the appearance of the filamentous diatoms (*Melosira*, e. g.); and this was more striking upon the separation of the cells; for both the ends of each were marked with radiating lines, which, seen in profile, proved to be ridges (Pl. LVII. fig. 12 *c*). At the same time the cell-wall was very rigid, thin, transparent, and comparatively indestructible. It seems to me that this condition is to be considered as a "*resting*" form, equivalent to that state well known in the Algæ. Their subsequent history I was not able to trace.

Having thus endeavoured to point out the more actively growing condition of the confervoid filaments, I shall attempt to show the various means by which they assist in the reproduction of the parent Moss *.

The first I shall mention is one variety of those modes in which in all cases the ascending axis is formed out of the cell of the filament. It is also one of the most direct methods by which the filament attains that end. For other modes I must refer the reader to Schimper's work above quoted.

From any cell of the filament, except from those which are concerned in the processes to be related hereafter, a branch is produced, the end cell of which divides into two cells in the ordinary way above described, the terminal one increasing considerably in size. From this, many (three or four) branches spring, in the mode of branching before mentioned, in a row or verticel; the cells of these branches are delicate and tapering, and have the property of curving in towards the centre. There is also a similar row of smaller branches springing from the same cell within the former row, surrounding as it were an imaginary axis. From this springs, by gradual increment in the number of the cells, the stem of the Moss. The first attempt at differentiation on the part of the confervoid filament is thus shown to be in the cell producing the rows of curving-in

* In the following remarks I have assumed that all these various phenomena tend, sooner or later, to the formation of confervoid filaments, and through them to the other parts of the Moss. I have not possession of definite proof of this; but, from our knowledge of kindred conditions, we may, I think, fairly assume such to be the direction of their growth.

branches. This I have drawn on Pl. LVII. fig. 12. The precise point from which the roots (true) are given off I have not observed. In Pl. LVII. fig. 13, the filament from which this ascending axis sprang is tinged with brown. This is not a necessary point; I have seen it arise from cells of the most distinctly marked Confervoid type. This mode of development is frequently to be met with, and seems to hold an analogous position to the buds on the creeping stems of Phanerogamous plants.

The next plan to be described, by which these filaments assist in reproduction, is that which has been described by Kützing as the "*peculiar fruit*" of the Protonemeæ. They are, however, by no means confined to the filaments, but can be found on any part of the plant except the spore-frond (sporange and peduncle). They are found at the end of a branch of a filament whose cells, instead of elongating, become broader, the whole assuming the form of a club, containing 5 to 8 cells. The cell-walls become thickened, and the green granular contents closely approximated. After some time the cell-walls assume a reddish-brown colour, which becomes darker by age. Segmentation sometimes takes place in a direction parallel with the axis of the filament, or even irregularly (Pl. LVII. fig. 4 *a*). When the cell-wall has assumed a full brown colour, the green colour of the contents becomes fainter, and at last they are frequently transformed into oil-granules, after the manner of the formation of the oily contents of the hypnospores of *Volvox* and other Algæ. When these gemmæ have become quite brown, they easily separate from the filament and become free. They occur at all times of the year, but are most observable during drought. When they are excited to grow, they begin to shoot out into a confervoid filament, generally from the extremities, although sometimes each cell may push out a branch laterally. At Pl. LVII. figs. 4 *a*, 5, 15 *a*, Pl. LVIII. fig. 23 *b*, are shown these "gemmæ." No doubt these are "*resting gemmæ*," one of the means by which the life of the plant is preserved during severe trials of drought and cold *.

They have been called gemmæ, and considered the homologues of the gemmæ (bulbils, &c.) of the higher plants; but although they are subservient to the reproduction of the parent, yet the ascending axis does not immediately spring out of them, but, as has been already remarked, they sprout out into confervoid filaments first, from any one of the component cells, which then pass on to the formation of the ascending axis, as above noticed. They differ, therefore, from the bulbils in not possessing a true "stirps" within themselves. It seems that we should rather consider each as a resting *compound gonidium*, —the reason for which will be more apparent as we proceed to the consideration of the single-celled gonidium itself.

But this is not the only method by which the confervoid filaments are reproduced: any one of the cells, detached from the other, is capable of continuing the growth of the filament, in the same manner as each is capable of doing it whilst forming part of the filament, by branching and division, as I have before noticed. And there is a great tendency for these cells to separate from each other, more particularly in the older filaments (see Pl. LVII. figs. 4 *b*, 10, 11, 12, 14, 15); but whether old or young, they may bulge out

* Some of these points have been already shown by Schimper, but they are here repeated in order that a clearer idea may be formed of the single gonidium.

on any side and form a branch, which, segmenting, becomes a true filament (Pl. LVII. fig. 4 *c*). Not unfrequently these cells retain their linear form, especially after the cell-wall has become dense by age, though sometimes whilst the linear growth is very active. In the latter case, the contents of these actively growing cells occasionally become more or less homogeneous, with a distinct central nucleus (Pl. LVII. fig. 15 *c*), and much resemble a single cell of *Palmoglœa*. As a rule, when the separated cell retains its linear form, and is in active growth, it does not in general branch laterally for some time, but continues in the linear direction by binary division for a considerable period. But frequently, under certain conditions, the *terminal cells*, instead of possessing an elongated form, *become more or less globular*, which shape is not confined to the last one, although it may be more marked in it, but is frequently seen in the four or five (or even more) nearest the end of the branch (Pl. LVII. figs. 10 *b*, 13, 15). Of these the terminal one possesses the greatest tendency to become free, although all of them do so very readily. These free cells, then, appear quite globular, with green contents, which are sometimes granular, though more frequently more or less homogeneous, with or without a central nucleus, as is observed in the gonidium of the Lichens (Pl. LVII. fig. 10 *c*). Where there is this tendency to the globular form of the cells near the extremity of the filaments, there is also a disposition in the cell-contents to become more deeply green. This is partly owing to the deeper tint the contents assume, and partly to the closer crowding of the chlorophyll-granules of which they are composed.

These terminal globular cells have, under certain conditions, a tendency to become quiescent; the cell-wall then becomes thicker, and, as in the cells mentioned before, it frequently assumes a reddish-brown colour, whereby the whole becomes very dark—indeed, so as to become almost a black ball (Pl. LVII. fig. 15 *b*, Pl. LVIII. fig. 16). These cells also segment in a less regular manner than do those of the same filament below it; there is an imperfect tendency to branch. The cells thus formed at the side tend to the globular form (Pl. LVIII. fig. 16 *b*, *c*). The cells, thus altered in appearance, generally detach themselves in groups of two or three cells to each, and can be carried about by the elements. They, however, occasionally do not become globular, but more or less oval, springing from the end of one cell in groups of three or four, as shown at Pl. LVII. fig. 15 *b*, each cell of which, becoming free, appears like the cell of a *Palmoglœa*, especially as in some the contents become homogeneous, with a central nucleus. As this mode is observable on the branch of the same filament which possesses the other forms at the same time, this peculiar appearance is thus traced to its true origin, which would otherwise scarcely be guessed at. The cells are more active than the globular forms; and some, as soon as they separate, begin to segment linearly, and to form a filament. These conditions were looked upon as Confervæ by the older algologists, under the name of *C. multicapsularis* (Pl. LVIII. fig. 16; see Dillwyn's 'Confervæ') and *C. umbrosa* (Pl. LVII. fig. 15 *b*). I have already pointed out Kützing's arrangement of these and other forms.

These free dark cells with crowded contents, when influenced by warmth and moisture, form branches in the manner already described, thus giving rise to new filaments. They, however, may become mother-cells, as will appear below. In Pl. LVIII. fig. 16 *a* will be seen a number of filaments crowding each other and running parallel, the terminal cells of which, having assumed the dark colour and globular form, produce a dark velvety covering to the surface upon which they grow—and thus presenting an appearance easily mistaken for Confervæ.

I have hitherto in this communication shown the multiplication of the cells upon the linear-binary form of growth; we now, however, come to another stage, where the segmentation proceeds upon the quaternary or its multiples; and this leads us into still more interesting ground.

The first time I observed this was in some filaments which I placed in water; and these, after growing some time, produced cells at various points, chiefly at their ends, which had not only segmented once upon the quaternary plan, but their subdivisions had also repeated the process. This I have shown on Pl. LVIII. fig. 17. In some the process had extended still further, and in some less regularly, so as to produce irregular masses of green cells, in varying degrees of the same form of segmentation (Pl. LVIII. fig. 17 *b*). However, in some the contents had divided into six or more portions round a common centre (Pl. LVIII. fig. 17 *c*), and the parent-cell wall, bursting, set free a group of cells ready again to divide.

Guided by these facts, I pursued my investigations in the same direction, and found that the globular cells, which I have already described, separating from the ends of the filaments, frequently underwent quaternary subdivision, and that in them the process went forward to the infinite multiplication of these green cells, the result of which repeated and rapid segmentation was to produce cells of exceeding minuteness. This, as I have formerly shown in a similar condition in the gonidia of Lichens, is dependent on the preponderance which the process of subdivision holds over individual cell-growth. When the former process is in abeyance, then the latter regains the ascendency; and these little divisions, so small as scarcely to show any distinction between cell-wall and contents, gradually increase in size so as at last to equal the original parent cell *.

At first the contents of the cells were somewhat granular, but after a generation or two they became homogeneous and, in every respect, could not be distinguished from the subdivisions of the Lichen-gonidium.

And in another respect they much resembled these latter, namely, in the great tendency for the process to keep on unvaryingly in the form in which it had begun. This can readily be observed by any one who will take the trouble. Large areas may thus be covered by the growth of these cells, which may continue for a long period of time, certainly over a year, and probably, as far as I can make out, for many years.

It may always be noticed on the face of any wall where Mosses grow, that underneath

* In both the Lichen- and Moss-gonidium, this property of repeated and incessant subdivision is commenced so early in the cell, that one subdivision is hardly fairly perceptible before the next can be recognized; indeed, in some of the cells, three and four generations are included in one parent. Upon this point Braun says, in 'Rejuvenescence in Nature' (Ray Soc. 1853, p. 239):—"There are cells which never become old, but in their earliest stage, by dividing, give up their existence again, or rather continue it in a new generation, till age finally is attained in a last generation, which never undergoes division."

each patch, a large stream of these Chlorococcus-like bodies may be seen, running downwards. I have not separately drawn these cells, because they are so like those on Pl. LVIII. fig. 18 *c*, to which I refer the reader.

Sometimes on trees I have observed that, instead of producing the globular free cells just described, as occurs in most situations, the whole cells of the filament, which is generally tapering towards the extremity, undergo this quaternary form of segmentation *in situ*. It will be first noticed that the cell-walls become thicker, the contents less granular, while the whole filament increases in diameter, and that then the contents are segmenting (Pl. LVIII. fig. 18 *a*). After a time the parent-cell walls dissolve away, and the subdivisions become free (Pl. LVIII. fig. 18 *b*). From this point the description applied to those cells which were free before division corresponds so exactly as not to need repetition (Pl. LVIII. fig. 18 *c*). By this means, as by the other, large portions of bark of trees are covered with the Chlorococcus-like bodies, which multiply also indefinitely.

But in some filaments there is a still more unsuspected change, namely, in the production of cells of *Glœocapsa*. The segmentation proceeds within the filament, as in the instance just quoted; but the divisions become invested in a gelatinous envelope, while the parent-cell wall breaks up. These Glœocapsa-like bodies then become free, and continue the segmenting process as in *Glœocapsa*. This I have shown on Pl. LVIII. fig. 19 *a*. It is a condition by no means rare in the winter months: considerable masses of these bodies are to be found so produced.

I have frequently seen *Glœocapsa polydermatica* (Kützing), &c., formed, as well as other so-called species. After frequent segmentation, the cells are imbedded in an indefinite mass of gelatinous substance.

But there is a variety of this "*Glœocapsa*-formation" frequently met with (Pl. LVIII. fig. 20 *d d*).

The cells of a filament in one or in every part at once begin the process of quaternary segmentation, as before noticed, at first regularly, but shortly after irregularly; besides this, a certain amount of free-cell formation goes on within the divisions (mother cells); so that it is difficult to say which kind of cell-formation predominates (Pl. LVIII. fig. 20 *a a*). In this manner large irregular masses of segmentary cells are produced, like some of those resulting from segmentation of the so-called Palmellaceæ (Pl. LVIII. fig. 20 *b b*). The cells set free from them are either *Chlorococcus*-like cells of variable size (Pl. LVIII. fig. 20 *c c*), or they are like *Glœocapsa*, undergoing segmentation in their variable manner (Pl. LVIII. fig. 20 *d d*).

These changes can be readily observed in the colder months. They frequently, by distortions in all directions, produce a mass whose origin might be very doubtful to determine, were it not generally possible to find some small part retaining the original filamentous condition (Pl. LVIII. fig. 20 *a a*).

Up to this point of the observations I have made, with the exception of that just noticed, the efforts made by the confervoid filaments towards multiplication have been carried out upon the plan of the "parietal cell-formation" of Nägeli, and that principally upon the quaternary mode.

The next series of remarks will show the results of "*free-cell formation*" (Nägeli), or "*free cytogenesis*" (Pringsheim), as it occurs in these filaments.

As far as my observations extend, there are *two varieties* of this mode of cell-formation in this portion of the Mosses.

1. The *first* is by the gathering together of the whole contents into one or more oval masses, which become covered by a cell-wall thrown around each portion; and by the segmentation of these while still within the parent cell (Pl. LVIII. fig. 21 *a*, *b*, *c*). In both instances these masses are released by the destruction of the parent-cell wall. That they again divide when set free, probably many times, is all that I have been as yet able to discover, beyond the amœboid change to be alluded to below. This I have observed best in those cells which have lived in water—a position probably favouring this mode. That these portions of contents can segment, and continue to do so, seems to me to militate entirely against the opinion that the whole process is not a healthy one.

There is another point in connexion with these new cells, namely, that their contents become of a red or reddish-brown colour, in manner similar to the change so frequently observed among Algæ that I need not particularize it here.

But the most remarkable feature in their history is that upon which I have already dwelt in a paper on vegetable amœboid bodies (Mic. Journ., April 1862), and therefore need not do more than call attention to the point, namely, that these cells gradually lose their colour, with the exception of a few reddish granules. When this change is complete, they *possess the power of moving about* as do *Amœbæ* (Pl. LVIII. fig. 22 *a*, *b*). After they have continued to do so a certain time, they reassume the ovoid form, and are clothed with very delicate cilia, in a constant state of vibration (Pl. LVIII. fig. 22 *c*). For further remarks on this curious change, and its connexion with similar occurrences in the Algæ, I must refer to the paper above quoted.

2. The *second* mode of free-cell formation is as follows :—

The cells in the stem and leaves of the Mosses contain, as is well known, a varying number of granules of a homogeneous green colour, which are called by Nägeli and others "chlorophyll-utricles." They are generally connected with each other by means of delicate colourless threads of endoplast. These utricles or granules are also found in the confervoid filaments, in variable quantity, sometimes, as in rapid growth, widely separated, sometimes, as in slow growth, closely pressed together.

In either case these chlorophyll-masses have the power of throwing around themselves a cell-wall, of growing, of forming in their centre a nucleus, and of segmenting, and also of *forming an independent cell* capable of undergoing further changes presently to be pointed out.

Now Nägeli has already pointed out that they possess an outer membrane, and has shown that they multiply by subdivision*. The fact, however, of their having a new membrane has been denied by Caspary†, Mohl and Gris, and by the author of the article on Chlorophyll, in the 'Micrographic Dictionary,' who, on the other hand, admits of the

* Ray Society, 1849, pp. 176–178.

† Die Hydrillæ, Pringsheim's Jahrb. d. Wiss. Botanik, i. p. 399.

possibility of their segmenting. It is hoped that the following observations may tend to throw some light upon the question, and to reconcile the conflicting evidence of these great observers, upon which I shall more particularly dwell in reviewing the points of interest in this paper.

During the years 1859–60 I grew Moss under glass. The various branches threw out numberless confervoid filaments, some of which approached the radicular rather than the confervoid type. However, it was in both that I observed that each of the bodies which corresponded to the "chlorophyll-utricles" of other parts possessed the power of enlarging. This is drawn in Pl. LVIII. fig. 23 *a*. In Pl. LVIII. fig. 23 *b* are shown two portions of filaments, with the chlorophyll-granules just beginning to show consistence on their exterior. This was best noticed in those which were escaping from a broken cell. At *c* is shown a number of these cells in various degrees of growth; and it was easy, by comparing the contents of the various cells, to see that the smaller possessed the same origin as the larger.

As they increased, they showed a more distinct outline; and it was clear that, whatever doubts might attach itself to the existence of a membrane on the exterior of the chlorophyll-utricles of the leaves and ordinary confervoid filaments, these contents were enclosed by a delicate envelope: and as they further enlarged, a nucleus appeared in the centre. After a time, the parent cell broke up, and these once chlorophyll-utricles, but now distinct cells, became free.

In the undisturbed condition in which they existed, and being held together by the gum-like character of the residue of the parent-cell wall, they of course did not spread far; and as the filaments had attached themselves to the sides of the glass, I had an excellent opportunity of watching their subsequent progress.

After increasing gradually in an oval form, they arrived to about the $\frac{1}{1700}$ inch in size, when they began to segment into two, or three, or four divisions, or even into more (Pl. LVIII. fig. 22 *d*), a nucleus appearing in each division.

When the resulting cells were two or three, they were almost always oval, the line of separation taking place obliquely in the oval parent cell (Pl. LVIII. fig. 23 *d*). When, however, the secondary cells were more than that, then they formed around a common axis. At this period the cell-wall of the parent cell (once chlorophyll-utricle) was very marked.

After they had remained some months in a state of nearly complete quiescence, I placed some of these segmenting cells into water on a slide, and, covering them with ordinary thin glass, I put them in the sun for about an hour. To my great surprise, *I found the whole water alive with zoospores.* There were thousands in the square inch, in a most active state. Further examination showed that the segments had been released by the bursting of the parent-cell wall, and had now become these zoospores. After a time they came to rest, and altogether lost their activity. I preserved the slide for some time, but I could not determine anything very definite as to their after-life, beyond that they came to rest, lost their cilia, and again subdivided.

These zoospores were of light-green colour; they differed slightly in size, and were principally oval; some, however (and these were the larger), were round. They possessed two cilia, and their contents were granular (Pl. LVIII. fig. 23 *e*). The smaller measured about $\frac{1}{1800}$ by $\frac{1}{3500}$th of an inch.

Thus far I have dealt with the confervoid filaments and their gonidia. I shall now point out two other methods by which independent cells are set free from Mosses, possessing the power of segmentation, and doubtless of reproducing the parent Moss, although I have not been able to trace them back again to the parent.

It has been mentioned above, that in the thallogenous plants the power of producing gonidia is diffused through almost any part of the thallus, but that in the Mosses it is more localized. Yet it is not entirely confined to the confervoid filaments.

I have frequently noticed that *Glœocapsa*-like cells are produced from the contents of the cells of the older leaves, which, situated at the base of the stem, towards autumn and during winter and spring have become brown. These leaves are not wholly dead. It is their cell-walls only which, having become brown, give them the appearance of dead tissue; but the contents as yet retain their vitality and green colour within. Their condition is precisely similar to that of the cells of the filaments described above, whose walls have become dyed of a brown colour. After a time the old cell-wall dissolves away, and then it becomes evident that the contents have assumed the form of, or rather have become a *Glœocapsa*, which certainly undergoes segmentation freely. I have shown a portion of some of these leaves in this state in Pl. LVIII. fig. 24; a portion of the margin has lost its dark cell-wall, and has already produced *Glœocapsa* (Pl. LVIII. fig. 24 *a*). I have seen considerable masses of *Glœocapsa* produced in this manner.

Another very curious mode of forming free cells, capable of segmentation, is the following.

The axis springs up in the usual way, and proceeds to form leaves. The cells, however, which should in the ordinary way unite to form their lamina, in this case do not cohere, but either *run parallel to or branch away* somewhat from each other (Pl. LVIII. fig. 19). The terminal cell of each of these pseudo-leaves possesses the power of separating from the others (as the terminal cell of the filaments did, see Pl. LVII. fig. 10). In the instance from which I give this description, it might be noticed that the freed cell was more or less of a pointed oval form, one side being, however, much straighter than the other (Pl. LVIII. fig. 19 *c*), and having somewhat the appearance of the frustule of *Isthmia nervosa*. Each of these cells might be noticed to have already begun to divide by binary division before their separation.

Large numbers of these cells were shed, and disseminated readily. Many for the time remained in contact with the structure from which they sprang, and gave the whole the appearance of little yellow dots on the ground whence they arose. I cannot tell to what Moss it belonged, but there were numerous examples of it. From the same stem confervoid filaments arose, and some (*a*) were giving rise to *Glœocapsa*, as before mentioned.

In Pl. LVIII. fig. 25, I have shown a condition of the axis of one of the *Jungermanniæ* from Jamaica, precisely like that of the Moss shown at Pl. LVIII. fig. 19. I observed it in plenty in a hot-house, where the plant grew in abundance. The whole had very much the appearance of an Alga, and was a very beautiful object, from the transparency of the cells. Every terminal cell seemed ready to separate, or had already done so. Each was divided by a septum into two portions; after separation, the cells began to increase, and the contents became darker, more homogeneous, and ultimately they possessed the appearance of a *Chlorococcus*, and underwent subdivision.

Retrospect.—In reviewing the points of interest contained in the foregoing communication, I shall take them in the order in which they have been presented. And the first which seems to stand most prominent is,

1. The peculiar tendency of the confervoid filaments to grow for any indefinite period and extent in the same form and state, both in and out of water; so that it is not to be wondered at that they should have been considered independent vegetations. This opinion appears still more excusable when it is considered that they can reproduce themselves by any one of their cells, which sometimes, becoming free and globular, presents the appearance of a spore. How much more would it have been justified had the knowledge of their segmentation, &c., been then possessed? It gives another instance of the importance of the study of the entire life-history of all forms. We are much indebted to Kützing (whose studies have had generally an opposite tendency) for first pointing out the true nature and origin of these so-called Algæ.

At the same time, may I not ask, does it not make us question the origin of many of the Confervoids, the tracing of whose whole history we have never achieved, of whose sexual life we have no knowledge? Of how many do we know only the vegetative growth, with its formation of active (zoospores) gonidia and passive gonidia! Let us not conclude these to be finally placed, but let us follow them through by every possible way, in order to detect all their phases of existence.

The remark of Braun applies to this subject, as well as to those which follow:—"The greatest care is requisite in their determination as independent organisms; nor should this be decided unless every stage of their evolution, from beginning to end, is known" *. I can only add, *When* are we to know when we have found both or either?

2. The second thought which seems worthy of detention arises from the circumstance that, out of these confervoid filaments, two or three genera with numerous species of Algæ have been founded. *Protonema*, *Gongrosira*, and certainly some forms of *Chroolepus* are not Algæ, but the varying forms of these Moss-productions. We might well feel our faith in specific and even generic distinctions in general staggered by these and similar facts, but more particularly in respect to the Confervoideæ. We are bound to suspend our implicit trust in the certainty of their position, at least as to many whose history is as yet undetermined. It might be brought forward as an apology, that these forms were really distinct, each kind belonging to separate Mosses. In answer, I might say that a few observations would readily show that this excuse could not be sustained; for I have reason to believe that nearly all the varieties can be produced from each one of the Mosses, if placed under varying conditions.

The different forms of the confervoid filament, as I have already shown, depend on external circumstances, rather than on the species to which they belong, although it is possible that some exceptions may be found to this rule. The value of the distinctive

* Braun, on Unicellular Algæ, Mic. Journ., vol. v. p. 91.

marks between many Confervoids is very questionable, and they have doubtless led to much misconception and incorrect assumption. These plants being formed of very simple parts, their characteristics are necessarily ambiguous, and hence the difficulty of fixing their true position; and this is especially the case in those kinds which are composed of a single cell, whether belonging to those which have been designated by Braun as "true unicellular Algæ," or "pseudo-unicellular," or to those which are multicellular, but which spring at some portion of their history from a single vegetative cell (spore, gonidium, &c.).

3. The third subject to be dwelt upon has already received some attention at the commencement of this paper,—namely, that the function and development of the cells separated from the filaments are evidently analogous to those of the gonidia of Lichens and also of many Algæ, and therefore the term gonidia* may be rightly applied to them. It is the office of the filaments to produce these gonidia; or perhaps it should rather be considered that each filament, in its most marked condition, is a series of gonidia developed in a linear form, each division of which is capable of becoming a gonidium: and this mode of viewing these filaments points out the analogous condition observable in the moniliform filament of gonidia in *Collema*, each cell of which, although generally segmenting linearly on the binary plan, can at any time assume the other actively segmenting states, as has been pointed out by me in the papers above alluded to.

The position in which these filaments stand towards the rest of the plant is peculiar. Looking at them as a basis upon which the axis producing the organs of the true fructification is supported, they have at first been considered as the homologue of the prothallium of Ferns; but they really represent only a portion of that organ. They correspond, indeed, only to the few confervoid cells first generated from the spore; while the heart-shaped Marchantia-expansion of the prothallium of the Fern is to be considered as corresponding to the stem, leaves, antheridia, and archegonia in the Mosses. They differ also in the respect of producing gonidia, at least so far as is known at present, although it is quite possible (judging from analogy) to suppose that gonidia may be found to be produced from this position of the prothallium of Ferns, under certain conditions. Compared with Fungi, they seem to hold an analogous condition to the mycelium, more particularly apparent in the simpler forms of the *Hyphomycetes*; for it is questionable whether the so-called fruit of these Fungi is not rather analogous to the gonidium than to the growth which results from impregnation. It is at present uncertain whether any antheroids exist in the Fungi, and, if they do, whether the spores take any part in true fecundation.

It is very necessary to bear in mind that the confervoid filaments play a very important part, if not the most important, in the disseminating of Mosses—much more so than has been generally supposed. Considered quite independently of their powers of producing gonidia, they tend to spread the order in every direction, and cover very much larger surfaces than the species from whence they are derived could do by gamic reproduction, whereby, simultaneously as it were, large spaces, even many feet in length, are

* The distinction between "gonidium" and "spore," as marked out by Braun in 'Rejuvenescence in Nature,' is borne out here and in the Lichens much better than in the Algæ.

covered with Moss of equal-sized growth. It is also to be remembered that, amongst the Cryptogamia, it is in the Mosses that they assume the most important position. They are known at present in only three divisions, viz. in Ferns, Liverworts, and Mosses. In the two former they are confined to a very small number of short-lived cells.

But it is when they are considered in combination with their gonidia and their indefinite powers of subdivision (only comparable to the Lichens in this respect) that we can appreciate the influence they possess in multiplying the Mosses, accounting, doubtless, for their well-known abundance and wide diffusion; and this brings me to another consideration in relation to the reproduction of Mosses by their means.

I have shown above, that the cells thrown off from the filaments, as also those that remain attached, multiply by subdivision on the binary or quaternary plan principally (parietal cell-formation), and also that both within these cells when separated, as well as in those still attached, cells were formed (free-cell formation) which again continued to subdivide. By these processes and their continuation innumerable myriads of cells are produced, which possess all the appearances assumed by the results of the same efforts in the Lichen-gonidium. At first, I remarked, the contents of the cells were granular, but soon became homogeneous and without perceptible nucleus. Thus forms of segmenting cells hitherto classed as *Chlorococcus* (*Protococcus*) and *Glœocapsa* (*Hæmatococcus*) are produced undistinguishable from those so-called Algæ; so that, considering the exceeding diffusibility of the Mosses and Lichens alone, it seems to me to be almost impracticable to declare that any of these forms, as well as those I have mentioned in my paper on the gonidia of Lichens (above quoted), have an independent existence as Algæ.

On the contrary, it seems to me impossible to discriminate between the cells of the segmenting gonidia of Algæ*, of Lichens, and of Mosses; and hence I believe we shall be obliged to conclude that all the cells classed as Palmellaceæ—*Chlorococcus, Glœocapsa, Sorospora*, and some others†, with their so-called species—are but varieties of one mode of simple vegetative cell-growth, common to most of the Cryptogamia. What is the value of the differences between each kind it seems difficult to decide, but it may possibly be less than hitherto supposed.

Without digressing far into a subject not here intended to be discussed, I shall content myself with pointing out the effect such an opinion produces in unsettling our belief in the reality of the separate existence and position of the Protophytes generally, more particularly those classed by Braun as pseudo-unicellular Algæ‡. Whether it affects Braun's true unicellular Algæ requires further investigation; but it is worthy of notice that it is in the former that the forms above named are arranged.

4. The chlorophyll-utricles next arrest our attention. I have already quoted Nägeli's remark upon their segmentation, in which opinion Henfrey, in Linn. Trans. vol. xxi. pt. 2. p. 121, coincides. But in regard to their cell-wall, difference of opinion exists. The observations I have here recorded, it appears to me, tend to explain the two opinions, and especially confirm the opinion expressed by the writer of the article on Chlorophyll,

* See Pringsheim, Mic. Journ. 1862, April, p. 105.

† Probably also *Tetraspora* and *Hormospora*.

‡ Mic. Journ. 1857, p. 13.

in the 'Micrographic Dictionary,' namely, that chlorophyll-granules are probably small portions of contents coloured by chlorophyll. If we consider them to be such, and that they are capable of losing colour, or of changing it to brown or red, &c., then it is easy to conceive, and what indeed we should expect, that each granule could proceed to form a cell within the parent cell in accordance with what we know of free-cell formation; and thus the various opinions expressed upon this point are capable of being reconciled. Whether this condition extend to the chlorophyll-granules of *Nitella*, *Chara*, &c., I am not in possession of any facts to show.

5. But perhaps the most interesting fact I have met with in the course of my observations on the filaments is that of the *formation of zoospores* from these enlarged and segmenting chlorophyll-utricles. I am not aware of their having been noticed in the Cryptogamia above the Algæ, though they have been seen in the Fungi.

The evidence upon which it is based seems to me at least as conclusive as it is possible to obtain under the circumstances, unless the zoospores were seen to emerge directly from within the cell of the filament. It is possible that future observation may be able to confirm my observation in this direction; but without that, it seems that we may fairly conclude that zoospores can spring from these cells; and this is perhaps not quite so surprising a fact as it would at first sight appear, when we reflect that the formation of zoospores is purely a vegetative process and, for anything we know, may be more extensive throughout the vegetable kingdom.

I have already remarked*, with respect to the diamorphosis of *Lyngbya*, that the distinction between *Ulva* and *Prasiola* was now confined to the supposed fact that the former produced zoospores, while the latter did not. This, I objected, could not be held a sufficiently distinctive sign, on account of the truly vegetative origin of the zoospores, which are merely a variety of gonidial formation.

Zoospores seem capable of arising at various epochs in the life of a plant, and of various sizes. An interesting account, as they occur in *Hydrodictyon*, is given by Pringsheim in Mic. Journ., April 1862.

It is a very interesting feature, however, to find, that the confervoid filaments of Mosses, which in so many ways present the confervoid type, should also in this show one of the most marked and frequent phenomena of the Algæ.

6. The last point to which I shall allude is the near connexion with the Algæ which the Mosses hold in their capability of producing gonidia from any portion of their stem or leaves. The facts I have brought forward here show a very curious link existing between the Thallogens and the higher Cryptogamia, and prove that the formation of gonidia by no means ends with the Algæ.

* Mic. Journ. *suprà cit.*

Phases in the life of a Moss.

Intermediate conditions. — *Results.*

- Spore
  - Confervoid filaments .... Confervoid filaments.
  - Confervoid filaments .... So-called
    - Protonema .... Confervoid filaments.
    - Gongrosira, Chroolepus .... Chlorococcus. Glœocapsa.
  - Confervoid filaments .... Chlorococcus. Glœocapsa.
  - Confervoid filaments ....
    - Prothallium.
      - Confervoid filaments, Radicles, stem, leaves, Antheridia, archegonium ....
        - Confervoid filaments.
        - Confervoid filaments, with zoospores.
        - Chlorococcus, Glœocapsa — from any part.
        - Confervoid filaments, from any part, of variable forms of growth.
    - .... Confervoid filaments.
    - Oospore, Sporange
      - Spore.
      - Confervoid filaments — Prothallium. Sporange. Spore.
      - .... Spore.

EXPLANATION OF THE PLATES.

Plate LVII.

Fig. 1. *a*. Moss-plant, with confervoid filaments.

b. Confervoid filaments, one assuming the radicular type.

Fig. 2. Growing extremity of confervoid filament, showing the different stages towards the formation of branches.

Fig. 3. Branching filament in active growth.

Fig. 4. Branching filament (enlarged) growing under stimulus of heat and moisture, producing—

a. The "peculiar fruit" (compound gonidium) or gemma.

b, *b*, *b*. Terminal cells of a linear form, given off plentifully; some of the cells tapering almost to cilia.

c. A detached cell, giving off a branch.

Fig. 5. Branching filament, with gemmæ, showing another variety of growth.

Fig. 6. Tapering end of filaments, the result of very rapid growth.

Fig. 7. Branching filaments of nearly equal length, giving a velvety appearance to the surface on which they grow. The commencement of the red tinge visible in the cell-walls.

Fig. 8. Condition intermediate between confervoid filaments and radicles.

Fig. 9. Peculiar mode of growth of filament in water, approaching *Draparnaldia tenuis* (*Stigeoclonium tenue*, Kützing).

Fig. 10. Occasional state of a growing filament.

a. With a small colourless cyst or cell between two ordinary cells.

b. End of a filament of beaded appearance, shedding the terminal globular cells, *c.*

Fig. 11. Various appearances of portions of filaments: *a,* showing the reddish-brown colour of old cell-wall; *b,* ditto, growing; *c,* growing with rapidity; *d d,* portion of broken-up filaments.

Fig. 12. *a.* Filament with cell-contents changed to brown.

b. Single cell of same.

c. Single cell of same, showing indication of binary division: each end has ridges.

d. The ends of cells, in profile and in full.

e. Filament of same before change, tapering at the end.

Fig. 13. Mode by which the ascending axis is formed from confervoid filaments.

Fig. 14. Three branches of filaments, which have been crowded with others, so as to cause absence of colour in the lower cells. The terminal cells are separating to form gonidia.

Fig. 15. Ends of filaments.

a. Producing "gemmæ" (compound gonidia).

b. Producing single-celled gonidia. One branch is producing four cells at its extremity.

c. Cells becoming separate, of linear form, with nucleus.

Plate LVIII.

Fig. 16. Portion of a mass of filaments growing like velvet, consisting of multitudes of filaments crowding closely each other, forming a variety of resting gonidium.

a. Section of the mass.

b. Single filament.

c. Detached cells, with dark contents and reddish cell-wall.

Fig. 17. Filaments showing the cells of filaments segmenting *in situ.*

a. On the quaternary plan.

b. Ditto, and on its multiples.

c. Round a common centre.

d. Contents of some of the cells changed to reddish brown.

Fig. 18. Segmentation, *in situ,* of the contents of cells of a filament.

a. Commencement of subdivision;

b. Shedding cells of various sizes.

c. Free cells (gonidia) segmenting, without much decrease in size.

d. Ditto, ditto, after lapse of time, diminishing in size as segmentation proceeds.

Fig. 19. Ascending axis, giving off gonidia in two ways:—

a. As *Glœocapsa* from a short confervoid filament;

b. As segmenting cells from the ends of the pseudo-leaves.

c. A detached cell (enlarged), with granular contents. Short diameter about $\frac{1}{2800}$ inch.

Fig. 20. Confervoid filament changed into irregular segmenting masses, partly by parietal, partly by free cell-formation.

a a. First stage.

b b. Masses of segmenting cells separated.

c c, d d. Results of breaking-up of the former.

c c. Into Chlorococcus-like cells.

d d. Into Glœocapsa-like cells.

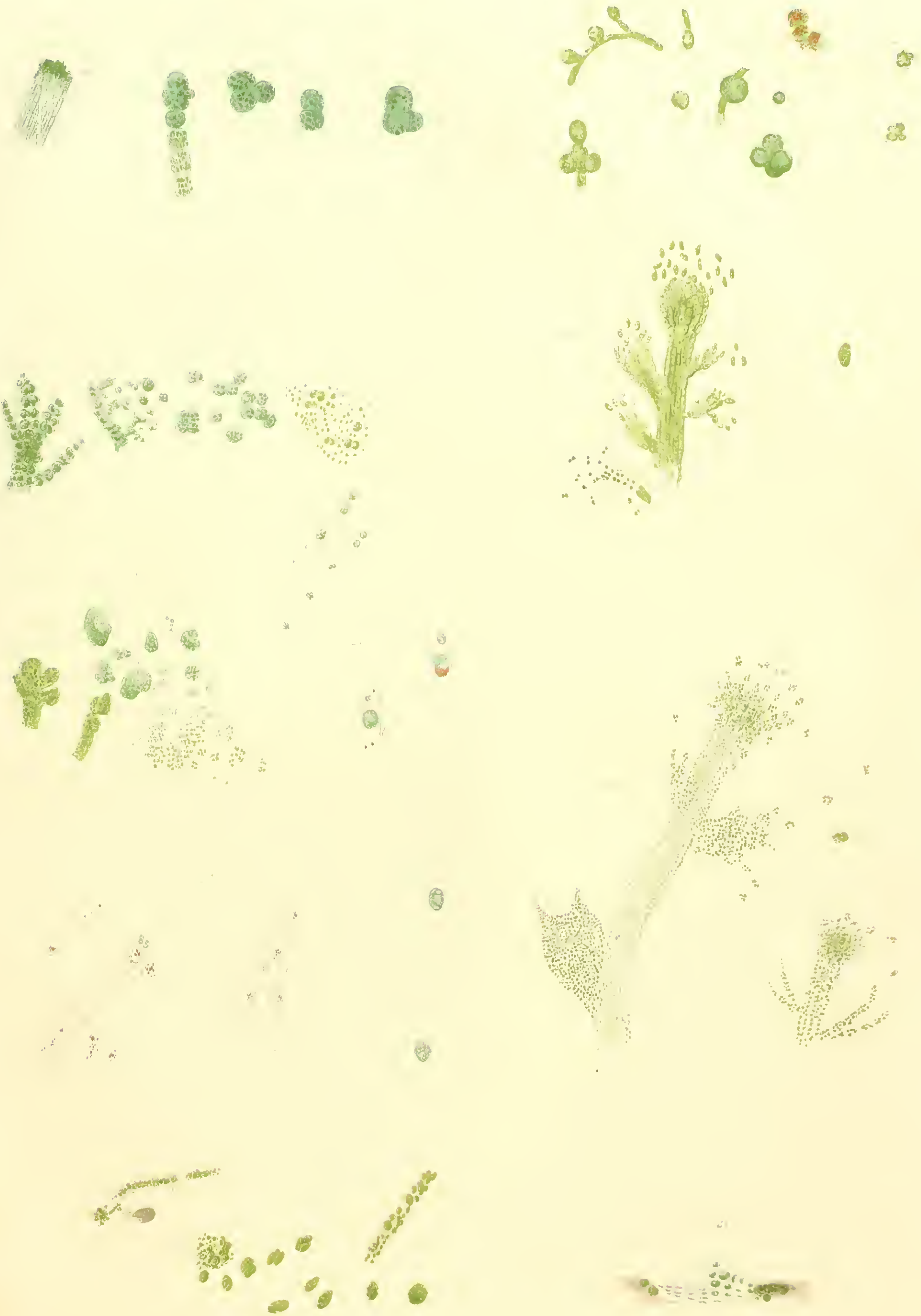
Fig. 21. Free-cell formation in confervoid filaments.

Fig. 22. Amœboid changes occasionally found in some of the same.

Fig. 23. *a*. Chlorophyll-utricles growing, and forming nuclei.
b. Incipient stage.
c. Same as *a*, dispersed from parent cell.
d. Same, having segmented.
e. Zoospores produced from the segments.

Fig. 24. Portion of edge of old leaf, contents of cells changing into *Glœocapsa* (*a*).

Fig. 25. Portion of stem and leaves of a *Jungermannia,* in a similar state to that of the Moss, fig. 19, the terminal cells of which are separating and becoming free, and segmenting (gonidia).



XXXIV. *Notes on the* Thysanura.—Part II. *By* John Lubbock, *F.R.S., F.L.S., F.G.S.*

Read June 19th, 1862.

SMYNTHURIDÆ.

THE Linnean Society has already done me the honour of publishing some notes on the much-neglected *Thysanura*. In the present paper I propose to place on record the species I have met with since, and which are twenty in number; these indeed do not, in all probability, amount to one-tenth of those which will hereafter be discovered, but it is at least something to have made a beginning.

Papirius nigromaculatus, n. s. (Pl. LIX. fig. 4). Yellow; eyes, ocelli, and a black patch on the posterior part of the back black. Large specimens are a little mottled on the back with light brown, and on each side there is a pale band, which surrounds the black patch, and then passes forwards and outwards. Legs and belly pale. Antennæ a little darker, except at the base.

Length $\frac{1}{20}$th of an inch.

Found, in spring and summer, under dead pieces of wood in Kent. Common.

In the form of its different organs, this species much resembles *P. Saundersii.* The two black spots, which I suppose to be ocelli, are more distinct.

The antennæ are very like those of that species. The mandibles have respectively five and six teeth.

The anterior legs and feet very closely resemble those of *P. Saundersii*, and the posterior feet differ slightly, if at all. The filament (*c*), however, appeared to be shorter, and the inner claw had only one tooth on the outer margin. Still *P. Saundersii* itself varies in this respect, and one specimen of the present species had a second very minute tooth.

The saltatory appendage offers no special peculiarity.

Smynthurus aureus, n. s. (Pl. LIX. fig. 1). Yellow, with black eyes. Antennæ four-jointed; basal segment shortest, terminal segment longer than the other three. Under side of body pale; saltatory appendage white. Body with a few scattered hairs, which are longer and more numerous towards the posterior extremity.

Length $\frac{1}{30}$th of an inch.

Found in the same places as the last.

Common from February to June.

The four segments of the antennæ increase in length progressively from the base to the apex, each being about twice as long as the preceding. The long apical segment has whorls of short hairs, but no distinct evidence of segmentation. The eyes are situated, as usual, on a black ground; and near the central line, a little in front of the antennæ, is a black double spot, which looks like the seat of two ocelli. At the same time I did not obtain by dissection any further evidence that these spots were really in any way connected with vision.

The two claws are simple, but they differ in form (Pl. LIX. fig. 2) from those of any other species which I have examined. The feet also are provided (perhaps to make up for the simplicity of the claws) with four or five tenent hairs.

The saltatory appendage is somewhat like that of *S. Buskii*, but less hairy, being indeed almost naked; the terminal lamellæ, however (Pl. LIX. fig. 3), are different in form. There are no tenent hairs.

I at first supposed that these specimens might be the young of some already described species; but I have never found any larger ones, and they differ in form as well as in colour from all the other representatives of the genus.

SMYNTHURUS FUSCUS, Lat. This species, which is probably the same as that mentioned by Templeton under the name of *S. ater*, is the only one hitherto recorded as occurring in England (Sam. Ent. Compend., p. 141).

PODURIDÆ.

This family comprises those species of the old genus *Podura*, in which the mouth has mandibles, and the body is elongated, with a more or less developed saltatory appendage at the posterior extremity.

Before proceeding to describe the species which have come under my notice, it may be convenient that I should give a short description of the genera into which they are distributed.

1. ORCHESELLA, Templeton. Segments of the body unequal in size, more or less thickly clothed by clubbed hairs. Antennæ long, six-jointed. Eyes six in number on each side, arranged in the form of an S.

The structure of the antennæ makes this genus very easy to recognize.

2. DEGEERIA, Nicolet. Segments of the body unequal in size, more or less thickly clothed by clubbed hairs, and sometimes also provided with scales. Antennæ longer than the head and thorax, filiform, four-jointed. Eyes eight in number, on each side of the head.

3. TEMPLETONIA, n. g. Segments of the body subequal, clothed by clubbed hairs, and provided with scales. Antennæ longer than the head and thorax, five-jointed, with a small basal segment, and with the terminal portion ringed.

4. ISOTOMA, Bourlet (*Desoria*, Nicolet). Four anterior abdominal segments subequal, two posterior small; body clothed with simple hairs, and without scales. Antennæ four-jointed, longer than the head; segments subequal. Eyes seven in number on each side, arranged in the form of an S.

5. MACROTOMA, Bourlet (*Tomocerus*, Nicolet). Abdominal segments unequal, with

simple hairs and scales. Antennæ very long, four-jointed, the two terminal segments ringed. Eyes seven in number on each side.

6. Lepidocyrtus, Bourlet (*Cyphoderus*, Nicolet). Abdominal segments unequal, with simple hairs and scales. Antennæ long, four-jointed. Eyes eight in number on each side.

7. Podura. Abdominal segments subequal; hairs simple, no scales. Antennæ four-jointed, shorter than the head. Eyes eight in number on each side. Saltatory appendage of moderate length.

8. Achorutes, Templeton. Abdominal segments subequal. Antennæ short, four-jointed. Eyes eight in number on each side. Saltatory appendage quite short.

These two latter genera, or subgenera, differ only in the form and size of the caudal appendage, a point, however, of special importance in this group of animals. Templeton, indeed, calls the fork "obsolete;" but it is present, though small. We thus pass naturally to the *Lipuridæ*, in which it is altogether absent. This small family contains as yet only two genera, *Lipura* (Burmeister), in which the mouth is composed of the same parts as those in the preceding genera, and *Anoura* (Gervais), in which the mandibles and maxillæ disappear.

Orchesella.

Orchesella filicornis, Temp. My specimens were not so green as those of Templeton, and in the colouring of the antennæ they agreed more closely with his figure than with his description. The two small basal segments and the small fourth segment were black; the third had the basal half brown, the apical white; the fifth, on the contrary, was palest at the base; the two terminal segments were pale, but not greenish. Body black, more or less weakened by greenish brown; the mesothorax has two pale oval spaces converging in front, and leaving a triangular central space, and the margins dark; the metathorax and first abdominal segment have also on each side a pale band, which are, as it were, continuations of those on the mesothorax. Posterior half of second abdominal segment white, with a greenish tinge. Third abdominal segment very dark, especially in front, and with a lunate greenish patch at the centre of the posterior margin. Fourth abdominal segment with a white lateral spot at the posterior margin. Legs annulated with light and dark brown.

The abdominal hairs are, in Templeton's figure, curved backwards; in my specimens they stood out straight.

Length $\frac{1}{7}$th of an inch.

Common throughout the year, under logs of wood.

Orchesella fastuosa, Nicolet. M. Nicolet's description of this species is as follows:—"Corps cylindrique; moitié supérieure du second article des antennes, quatrième segment du corps et deux bouquets de poils à l'extrémité postérieure du sixième d'un blanc très-pur. Les deux segmens thoraciques bruns, avex quatre taches obliques et une ligne médiane d'un beau jaune clair au premier, et d'un jaune foncé au second segment. Premier segment de l'abdomen brun, avec trois taches et une bordure postérieure jaune foncé. Cinquième et septième segmens d'un noir foncé. Tête très-noire, ainsi que le premier, la moitié inférieure du second et le troisième article des antennes. Les suivants sont bruns et gris. Pattes brunes à la cuisse, grises à la jambe et annulées de jaune. Queue d'un brun pâle."

In my specimens, the fourth segment of the body was greenish, and darkened gradually in front. The thoracic markings were less distinct: the patches were yellowish; the anterior pair, however, with white hairs. The first abdominal segment is but obscurely marked with yellow, and the yellow band along the back is scarcely perceptible.

My specimens, therefore, do not exactly agree with Nicolet's description, and are, indeed, in several respects intermediate between the *O. fastuosa* of Templeton and *O. cincta* of Nicolet. The white patch on each side of the sixth segment of the body, which, though sometimes very faint, was always recognizable, induces me to identify them with *O. fastuosa*; but I should be by no means surprised should that species eventually be considered as being merely a variety, perhaps geographical, of *O. cincta*. I am also very much disposed to regard *O. filicornis* as a pale variety of the same species: I have found almost all of the intermediate links.

It occurs with the preceding.

Orchesella rufescens, Linn.

The markings of my specimens of this pretty species do not exactly agree with those described by Bourlet. My specimens were yellowish, with reddish-brown markings. The principal one was a brown band, which began at the anterior end of the mesothorax on each side, not far from the middle line, and passed backwards and slightly outwards over the four following segments, dying away at the third abdominal; the fourth and fifth abdominal segments are somewhat darker than the others.

The first, third, fourth, and basal half of the second antennary segments are light reddish brown; the rest of the antenna is paler. Eyes black.

The body is rather narrow, and much less hairy than in the other English species.

I only found three or four specimens of this pretty species. They occurred with the preceding, in spring.

Orchesella pilosa, n. s. (Pl. LIX. figs. 5, 6, 7.) Yellowish grey, sometimes with a tinge of green; the body mottled, and the legs annulated with brown or black. Basal segment of the antennæ pale; second, third, and fourth brown or black, but generally pale at the two extremities; the two terminal segments pale, tinged with brown. Eyes on a black patch. Head and thorax with numerous clubbed hairs; abdomen more sparingly covered. No scales.

Length $\frac{1}{5}$th of an inch.

Common in Kent, throughout the year, under logs of wood.

I at first supposed that this species was the *O. villosa* (Nicolet); but the coloring of the legs and antennæ is altogether different. Nicolet also describes his species as having scales, which are "incolores, irrégulières et striées."

The labrum is somewhat broader at the base than at the free extremity, which ends in three not very well-marked lobes on each side; there is also a curved row of teeth, which, however, do not meet in the middle, nor project beyond the edge.

The mandibles (Pl. LIX. fig. 6) are powerful, and have respectively four and five teeth, which are strong, though not very sharp. In general form, and in the position and arrangement of the molar surface, they are formed on the type common to the *Poduridæ.*

The maxillæ also resemble in general outline those of the allied species. At their extremity is a row of five processes. The three outer ones have the form of strong teeth; the two inner ones are pointed, tongue-shaped processes, serrated on their inner margin. At the side of these are two other lobes: one of these is long, narrow, pointed, and generally lies, as it were, across the top of the organ; it is serrated at its free extremity on the inner edge. The other lobe is large, and ends in a tooth pointing inwards; the outer border is arched, the inner straight. It is, however, by no means easy to make out these different processes in a satisfactory manner.

The appendage, which for the present I will call the palpus, is quadrate, but rounded off at the angles, and tapers slightly towards the apex. The apical margin is somewhat concave. The palpus has on one side a small process, which terminates in a stout bristle. At the base of the process is another stout seta, in addition to which the organ bears three smaller hairs.

The second pair of maxillæ are membranous, have the apical margin excavated, with a tooth at the inner angle.

The eyes are arranged as usual in the genus, and are pretty even in size. The antenna, which is inserted just in front of the "quadrilateral," must somewhat obstruct the field of view.

The foot (Pl. LIX. fig. 5) of the anterior leg possesses, as usual, a tenent hair and two strong claws. The larger claw has a strong spine on the outer margin near the base, and two smaller ones on the inner margin, which are situated at almost equal distances from one another and from the two extremities. Near the tip is sometimes an indication of the third spine which we find in *O. cincta.*

The small claw is lanceolate and simple. Near the base, however, and on the inner margin, is the rudiment of a tooth; but in many cases it is very difficult to perceive.

All the three legs are alike, so far as the constitution of the foot is concerned.

The caudal appendages end in a claw (Pl. LIX. fig. 7), which is curved downwards and has on the under surface a strong tooth. To see this properly, however, the organ must be seen from the side.

In this species I have found *Gregarinas.* They were of two forms, either round or elliptic. The latter appeared to be generally, if not always, united in pairs.

Degeeria.

Degeeria nigromaculata (*Podura nigromaculata*, Temp.). Body fusiform, pale greenish yellow or stone-colour. Head rounded, with a black fascia anteriorly, including the eyes. The posterior ends of the second, fourth, and fifth segments with a more or less triangular black patch on each side of the middle line; posterior margin of the fifth segment black; posterior half of the sixth segment with a black patch, which is broad and more or less divided in front; posterior half of the seventh segment black; posterior segment brown. Along the sides are black patches, expanded sometimes into an almost continuous black band.

Length $\frac{1}{15}$th to $\frac{1}{10}$th of an inch.

Under logs of wood in Kent, throughout the year.

In other specimens the markings on the second and fourth segments are scarcely visible. The anterior part of the body is paler, the posterior part yellower, and the markings of a richer brown.

The antenna is, in reality, five-jointed; but the basal segment is very small. The apical segment is not distinctly ringed, as is the case in the following genus.

The mandibles have four or five teeth.

The tarsus is provided with a tenent hair and two claws, as usual. The large claw has two teeth on the under side. The small claw is unarmed.

Degeeria nivalis, Nicolet. Nicolet's description of this genus is as follows:—"Tête et corps d'un gris-jaunâtre; ce dernier oblong, avec une bande transversale noire au bord postérieur de chaque segment et une ligne également transversale de tâches irrégulières et de même couleur presque au milieu du sixième. Une petite tache noire en forme d'ancre sur la tête. Yeux noirs. Les deux premiers articles des antennes sont jaunes, les deux derniers gris foncé. Sixième segment du corps aussi long que les trois qui le précèdent pris ensemble. Pattes jaunes, et queue entièrement blanche."

He also describes two varieties.

My specimens, however, while agreeing in the general distribution of colour, did not exactly agree with any of these. The body, at the sixth abdominal segment, was as broad as in front; the black patch on the head was sometimes absent; the transverse dark line was often incomplete in the centre on the first and second abdominal segments, and the same was the case with the anterior band of the fourth; the fifth was dark behind; the antennæ were grey; and, finally, the anterior half of the head had a dark border. The species of this genus vary, however, a good deal in the distribution of the markings, and I am therefore unwilling to describe mine as new, especially as, in some respects, they appear to be intermediate between *D. nivalis* and *D. nigromaculata*.

The saltatory appendage scarcely reaches to the ventral tube.

Length $\frac{1}{13}$th of an inch.

Found in some numbers during April and May, under logs of wood.

Degeeria cincta, n. s. Body fusiform, dark brown; posterior part of head and of mesothorax, as well as the anterior portion of the fourth abdominal and the two posterior abdominal segments pale yellowish.

The antennæ have the two first segments pale at the base, dark at the apex, third segment dark, apical rather lighter. Legs yellowish; saltatory appendage white.

This species most nearly approaches the *D. platani* of Nicolet, but may be at once distinguished by the colour of the first abdominal segment, which in the latter species is pale.

It has no scales. Each leg has a tenent hair; and the large claw is provided with two teeth. It occurs on the bark of trees, and under logs of wood.

Length $\frac{1}{20}$th of an inch.

Found during spring and summer, in Kent and Lancashire.

Degeeria Platani, Nicolet. M. Nicolet's description of this species is as follows:—"Corps écailleux, à reflet argenté, un peu plus fusiforme que celui du précédent, à tête plus petite et plus allongée, ayant les angles postérieurs arrondis. Poils noirs. Tête et premier segment thoracique d'un jaune-orange assez foncé, et bordés antérieurement de noir; second segment noir. Premier segment abdominal d'un jaune-orange-pâle; les deux suivants noirs, et séparés par une ligne transversale très-fine du même jaune et bordant le segment antérieur. Le quatrième segment, également orange-pâle, porte une large tache irrégulière noire sur son milieu, et une ligne transversale de même couleur à son bord postérieur. Anus et bord postérieur de l'antépénultième segment également noirs. Antennes, pattes, dessous du corps et queue d'un jaune-pâle très-léger, les premières un peu plus foncées et annelées de noir ou de gris; souvent un anneau noir à l'extrémité des cuisses postérieures.

"Longueur environ 2 millimètres. Se trouve sous les écorces du *Platanus orientalis*; assez commun en été; vit solitaire."

I found my specimens in June, on the bark of beech, in company with *Psocus*, &c.

Templetonia, n. g.

Body long, cylindrical, provided with clubbed hairs like those of *Degeeria* and *Orchesella*, and also with scales. Segments eight in number, subequal. Head direct, or nearly so. Antennæ longer than the head, five-jointed; the basal segment short, the three following subequal, the apical ringed. Basal part of the saltatory appendage more than half as long as the two terminal lamellæ.

This genus is proposed for the reception of Templeton's *Podura nitida*, which is not very rare in Kent. The structure of the antennæ is alone sufficient to distinguish it from all the other *Poduridæ*. They have five segments, of which the first is quite short, the three following are cylindrical and subequal, while the terminal is ringed and shows, therefore, some approximation to a character hitherto peculiar to *Macrotoma*. It differs also from *Isotoma* in the peculiar form of the hairs, in the presence of scales, and in the form of the saltatory appendage, while agreeing with it in the general form of the body. On the other hand, while agreeing with *Degeeria* in the tegumentary appendages, it differs in the form of the body-segments. At the same time, it is more nearly allied to *Degeeria* and *Isotoma* than to the other allied genera, though in the position of the head it makes some approach to *Lepidocyrtus*, and in the termination of the antennæ to *Macrotoma*. On the whole, therefore, this genus presents us with a most interesting combination of characters.

Templetonia nitida (*Podura nitida*, Templeton). Templeton's description of this species (*l. c.* p. 94) is as follows:—"Body obovate, smooth, shining; head globular, a little produced anteriorly; eyes reddish brown. Thoracic and abdominal rings pale, with innumerable reddish-brown streaks and spots, especially basally, and two or three strong hairs in the middle; a collar of similar hairs encircling the neck, and minute ones over the whole body. Antennæ and legs pellucid.

"Length ·09 inch. Common at Cranmore, in the grove."

This species I have found in Kent, several times during the spring, though never in any great numbers. When alive, they were silvery white, so that at first sight they might easily be mistaken for specimens of *L. argentatus*; when, however, they had been for some few days in spirits of wine, the reddish spots mentioned by Templeton made their appearance.

Isotoma.

Isotoma fuliginosa (*Podura fuliginosa*, Templeton). Templeton's description of this species is as follows:—"Body subcylindric, greenish black. Head subtriangular. Antennæ not much longer than the head; joints nearly equal. *First thoracic ring* much larger than the succeeding; third abdominal also very large; a black line down the middle of the back. Legs short, tapering, pale greenish.

"Length ·05 inch.

"A few specimens at Cranmore, under the bark of a rotten tree."

My specimens did not exactly agree with this description. Mr. Templeton seems to me to have misunderstood the structure of the thorax, as the mesothorax is larger than the following segment, and the prothorax is scarcely visible from above. The abdominal segments in my specimens were less unequal; they had bluish lights; the antennæ were dark; and there was no black line down the middle of the back. The length of the head was only $\frac{7}{800}$ths, while that of the antennæ was $\frac{12}{800}$ths, or nearly double; but this proportion does not differ much from that shown in Templeton's figure. The first and third segments of the antennæ also are rather shorter than the second and fourth. The saltatory appendage was white; but I hesitate, in spite of these differences, to form a new species, looking rather upon my specimens as a dark variety. The feet had sometimes one, sometimes several, tenent hairs. The caudal fork was short, and did not reach nearly to the ventral tube.

January to April.

I did not find them very often, but generally in considerable numbers.

Isotoma Anglicana, n. s. (Pl. LIX. fig. 8.) Colour purplish greenish brown. Eyes on a black patch. Under side of head and thorax the same tint as the back, but slightly paler. Anterior abdominal segments browner; saltatory appendage gradually passing into white towards the extremities. A few scattered pale spots, and one or two pale lines, along the side. Basal segment of the antenna rather shorter than the other three, which are nearly equal in length. Body covered with short hairs and some longer setæ, especially on the thorax and the posterior abdominal segments.

Length $\frac{1}{8}$th of an inch.

Found during winter and spring, under logs of wood.

Some specimens, however, are paler and more reddish brown, wanting, apparently, the dark green; others are more green, from a deficiency of brown.

Can this be the *Podura viridis* of Linnæus? According to Bourlet, this is a variable species, with somewhat the same range of colour as in my specimens, which, on the other hand, were hairy and marked by a few spots; while Bourlet says, "Peu de villosités," and "sans tache." The *I. pallida* of Nicolet, which he considers as synonymous with *I. viridis*, has the eyes much lighter.

The body is about two and a half times as long as the antennæ. The mandibles have respectively four and five teeth. The maxillæ are short and stout.

The three feet are similar; they have no tenent hair; the large claw has an external tooth, and two small ones on the inner edge. The small claw has a single tooth on the outer margin.

The saltatory appendage reaches forward as far as the ventral tube.

Isotoma lineata, n. s. (Pl. LIX. fig. 9.) Colour dirty green, with a dark band running down the back, and a spot of the same colour on the head. Eyes situated on a black patch. Under side of body somewhat paler; saltatory appendage nearly white. First abdominal segment decidedly narrower than the two preceding segments. Basal segment of the antenna rather shorter than the other three, which are nearly equal in length. Body covered with short hairs, and with one or two longer ones towards the posterior extremity.

Length $\frac{1}{10}$th of an inch.

Found throughout the year, under logs of wood in Kent.

This is perhaps the *I. Nicoletii* of Gervais (Aptères, pl. 50. fig. 12). In that case the figure given by the eminent French entomologist is a very bad one, since the legs and antennæ are much too long in proportion, and the body is represented as having ten segments. This latter characteristic, however, must be a mistake. From *I. riparia*, Nic., it differs not only in colour, but also in the presence of the long scattered hairs.

The body is about two and a half times as long as the antennæ, which also (Pl. LIX. fig. 9) are rather stout in proportion.

The mandibles have respectively four and five teeth.

The maxillæ seemed to me to have seven processes—an inner single one, and on the outer side two rows, each consisting of three. The outer processes are the largest.

The tarsi of the three pairs of feet are similar.

There is no tenent hair; the outer claw (Pl. LIX. fig. 10) is unarmed on the inner side; the small claw has a peculiar notch, rather than tooth, on the upper side. The saltatory appendage, when turned forwards, reaches to the ventral tube.

I have also some specimens of another species of *Isotoma*, which in many respects resembles the *I. virescens* of Nicolet.

In colour it is much like *Orchesella pilosa*, having dark markings on a greenish-grey ground, and black eye-patches. The legs are light grey, the antennæ a shade darker.

The hairs are quite short and inconspicuous. The basal segment of the antennæ is shorter than the others, and the third is shorter, though scarcely so, than the second and fourth. The filaments are about half as long again as the basal part of the caudal appendage.

I found this pretty little species, on a hot summer's afternoon, running about in great numbers on a gravel walk.

Macrotoma.

Macrotoma plumbea. (Pl. LIX. figs. 11–14.) Colour, with scales, leaden; without them, yellow, with pale lateral markings on the mesothorax. Antennæ longer than the body. Anterior abdominal segment a little narrower than those on each side of it; fourth abdominal segment cylindrical, but more curved at the posterior margin than in Nicolet's figure. There is also a pale narrow line running down the back to the hinder end of the third abdominal segment. *Legs hairy and scaly throughout*, at least except the tarsus.

One of the mandibles has five teeth, the other four.

The three pairs of feet are very similar to one another, though in my specimens the extremity of the small claw seemed to be more elongated in the posterior foot (Pl. LIX. fig. 13) than in the other two. The tarsus is, as usual, provided with a tenent hair and two unequal claws. The tenent hair is large and strong. The larger, outer claw has three equidistant spines on the under margin. The lesser claw has a very small spine on the outer margin.

The two branches of the caudal appendage have on their upper side, near the base, a row of about nine small, simple, black spines, the hindermost of which is affixed rather further from the side than the others (Pl. LIX. fig. 11). The largest spine is $\frac{2}{1000}$ths of an inch in length, the diameter of the branch being at that place $\frac{7}{1000}$ths of an inch.

Macrotoma minor, n. s. (Pl. LIX. fig. 15.) Like the preceding in general outline and colour; it is, however, smaller. The antennæ are shorter than the body, which, *without* the scales, is of a dull leaden colour. The anterior segment has the usual pale, oblong, elongated markings. The large claw at the extremity of the tarsus has six minute teeth on the under side. The black spines on the second segment of the saltatory appendage are much larger than in *M. plumbea*, and some have lateral projections.

Under logs of wood, with *M. plumbea*, throughout the year. This species seems very indifferent to cold; I found it common all through the winter, even during sharp frosts.

The largest specimens are as much as $\frac{1}{5}$th of an inch in length; but the majority are smaller.

The first abdominal segment is shorter than the two on each side. The mandibles have, respectively, four and five teeth. The processes at the end of the maxillæ are not exactly like those of *M. plumbea*.

The anterior feet have, besides the usual tenent hair, on the under side of the large claw, five or six small teeth; the lesser claw is lanceolate in form, but with the lower margin straighter than the upper one, and has a single, very minute tooth on the upper side. The second and third pairs of feet much resemble the first; but the small spine on the lesser claw of the third pair is rudimentary or altogether absent. On the basal part of the caudal appendage are, as in *M. plumbea*, nine black spines. In that species, however, they are simple and short, while in the present they are much longer. The four first form a somewhat curved line; the remaining five are arranged in a straight row, and have small processes at the side; the apical spine and the penultimate are the largest.

The form and arrangement of these spines, and the structure of the feet, satisfactorily distinguish this species from the preceding. If in *M. minor*, which is smaller than *M. plumbea*, these caudal spines had been smaller than in that species, and the spines on the feet had been less numerous, we might well have supposed that these differences depended on age, and were therefore of no value as specific characters. I was, indeed, for a long time disposed to consider *M. minor* as being merely the young stage of the larger *M. plumbea*; but the large specimens are comparatively so rare, that, for this reason alone, such an opinion seemed to me untenable. This is, I think, confirmed by the structure of the feet and of the caudal appendage.

With the specimens above described are others which are narrower, and, without the scales, of a yellow colour. When placed in spirits, also, these two forms behave differently; the first swell, and the intersegmental membranes are more or less exposed, while the other variety retain their original form. The structure of the antennæ, the feet, and the caudal appendages is, however, so similar in the two forms, that I do not feel justified in separating them specifically.

Lepidocyrtus.

Lepidocyrtus argentatus, Bourlet ? (Pl. LIX. figs. 16, 17.) Body cylindrical, the third segment decidedly narrower than the second and fourth; silvery, with brilliant metallic reflexions. Eyes situate on a black patch. Antennæ and legs grey, the latter paler than the former; basal segment of antenna short, second and third equal, and about two-thirds as long as the apical. Caudal appendage pale, reaching to the ventral tube. Thorax with a tuft of short hairs in front; posterior segments of abdomen with long, scattered setæ, some of which are waved.

Length $\frac{1}{12}$th of an inch

Occurs all through the winter, from November, and perhaps earlier, to April, under logs of wood in Kent.

The mandibles have respectively four and five teeth. The labrum is pear-shaped. The feet have each a single tenent hair of the usual form. The large claw has two small teeth on its under side. The small claw is lanceolate. The first abdominal segment is decidedly narrower than those on each side of it.

It may well be doubted whether this is really the *L. argentatus* of Bourlet, his description being very brief and unsatisfactory. He says, "Thorace minus elato, corpore squamis argenteis," adding, in French, "Même taille que le précédent, thorax moins relevé et tête moins inclinée que chez le (*Lepidocyrtus*) *curvicollis*, corps revêtu en entier d'écailles d'un blanc argenté reflétant quelquefois une légère teinte cuivreuse; pubescence blanche, assez longue." He gives, however, no statement of the degree in which the thorax of *L. curvicollis* projects over the head. So that, in fact, my reasons for identifying my specimens with those of M. Bourlet are reduced to the silvery tint and the pubescence. Unsatisfactory as this is, I thought it better than to burden science with a new name, perhaps unnecessarily.

LIPURIDÆ.

Lipura.

Lipura ambulans (*Podura ambulans*, Linn.). White. Prothorax short, but visible from above. Body covered with short scattered hairs. Legs short. At the posterior extremity of the abdomen are two hooks, which are curved upwards. The skin is granular.

Common.

Length $\frac{1}{16}$th of an inch.

Nicolet states that in this species the spiracles are easily visible, and in pl. 4. fig. 4 he gives a figure of them, showing four pairs, situated on the back of the four first abdominal segments. I can only say that I have been unable to find any trace either of spiracles or of tracheæ.

He also describes the eyes as twenty-eight in number, fourteen on each side, arranged in two parallel rows of seven, behind the antennæ. In the specimens I examined I could not see these eyes.

Lipura corticina (*Adicranus corticinus*, Bourlet). This species much resembles *Isotoma fuliginosa*, and lives in similar situations. It is black in colour, somewhat paler on the under side. The eyes are dark. The body is covered with pubescence; and there are a few longer hairs, especially towards the posterior extremity.

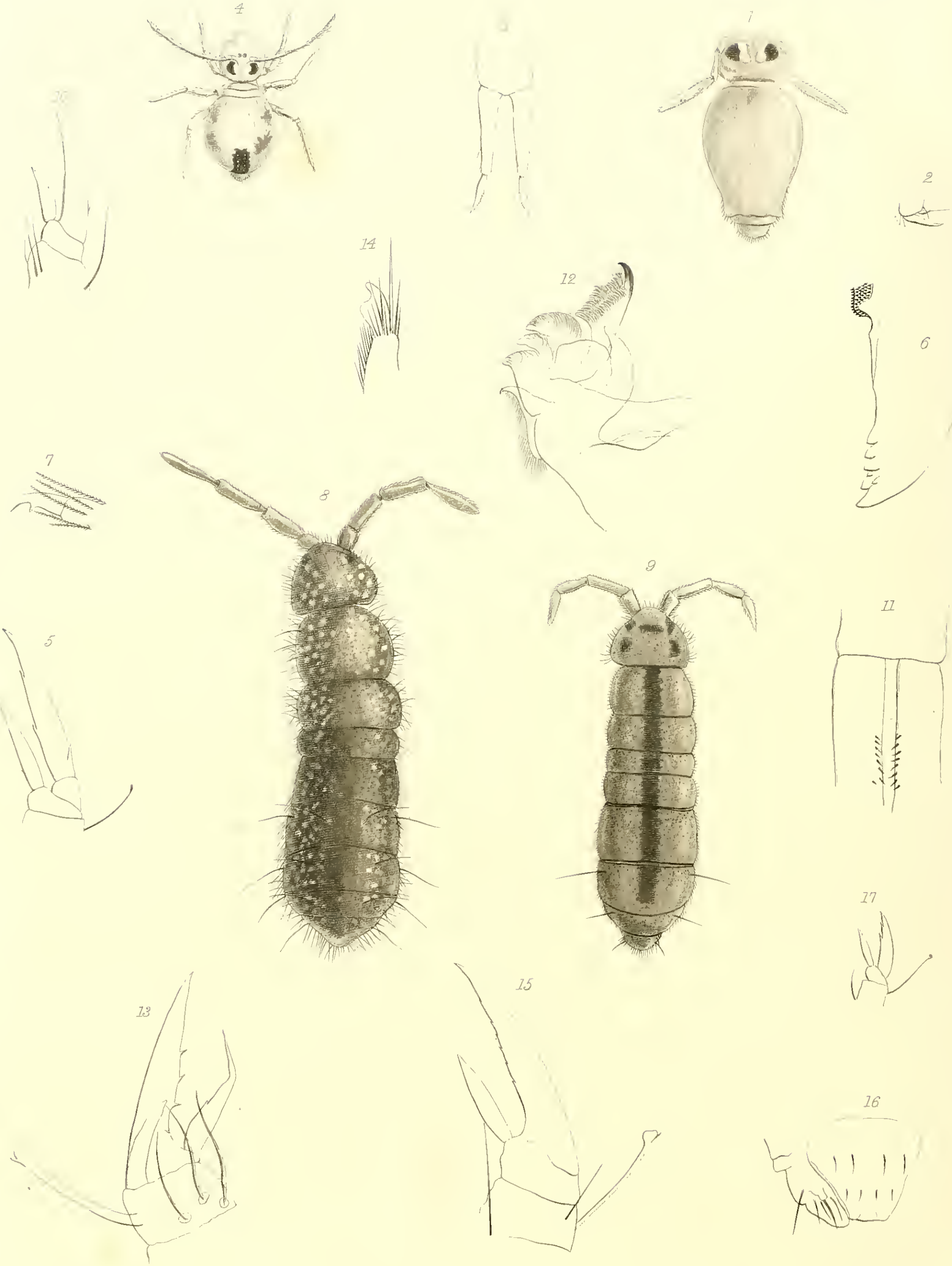
Found a few specimens in May, under bark.

Length $\frac{1}{15}$th of an inch.

Anoura.

Anoura muscorum, Templeton. "Body subcylindrical, turned posteriorly, and ending with two mammillæ, dark purplish. Head short, triangular; eyes not remote from the base of the antennæ, which are very short, and have the first joint very large, the succeeding successively diminishing in size, last acuminate. Legs pale blue. Rings with strong spiny hairs in rows along the back; hairs usually arising in pairs. Length ·07 of an inch." (*Templeton.*)

My specimens were of a dull purple, irrorated thickly over a grey ground, and with the under side paler. They were tuberculated, so as at first sight to resemble even more



J. Lubbock del.

G. Jarman sc.

strongly Nicolet's figure of *A. tuberculatus*. On the other hand, the body was shorter and thicker. The hairs were also arranged more nearly in accordance with Templeton's description, but were more numerous and less conspicuous than in his figure. The saltatory appendage is altogether absent.

In winter and spring, under prostrate boughs and logs of wood, in Kent.

ANOURA GRANARIA, Nicolet. "Omnino alba. Corpore, antennis pedibusque subtilissime granariis." (*Nicolet*, Ann. Soc. Ent. France, 1847, p. 387.)

I found a few specimens of this species near Liverpool, in the month of May.

DESCRIPTION OF THE PLATE.

PLATE LIX.

Fig. 1. *Smynthurus aureus*.
Fig. 2. „ „ Foot, × 250.
Fig. 3. „ „ Saltatory appendage, × 125.
Fig. 4. *Papirius nigromaculatus*.
Fig. 5. *Orchesella pilosa*. Foot, × 250.
Fig. 6. „ „ Tip of mandible, × 250.
Fig. 7. „ „ End of saltatory appendage, × 250.
Fig. 8. *Isotoma Anglicana*, × 30.
Fig. 9. „ *lineata*, × 30.
Fig. 10. „ „ Foot, × 250.
Fig. 11. *Macrotoma plumbea*. Base of saltatory appendage, × 60.
Fig. 12. „ „ Tip of maxilla, × 250.
Fig. 13. „ „ Foot, × 250.
Fig. 14. „ „ End of saltatory appendage, × 250.
Fig. 15. „ *minor*. Foot, × 250.
Fig. 16. *Lepidocyrtus argentatus*. Labrum and palpus, × 250.
Fig. 17. „ „ Foot, × 60.

XXXV. *On the Specific Identity of the described Forms of* Tanalia. *By* HENRY F. BLANFORD, *Esq. Communicated by* Dr. JOSEPH HOOKER, *F.R.S., F.L.S., &c.*

Read June 19th, 1862.

ANY naturalist who has looked through the list of land and fresh-water Mollusca in Sir Emerson Tennent's work on Ceylon can scarcely fail to have been struck with the large number of species there enumerated which are peculiar to the island, especially in the case of such genera as *Aulopoma*, *Cataulus*, *Tanalia*, and *Philopotamis*, the generic range of which is almost equally restricted. The area inhabited by most of these peculiar forms is, indeed, limited to less than half that of the entire island: the plains of the eastern, northern, and north-western provinces possess a fauna in a great measure identical with that of the Central and Southern Carnatic—e. g. *Helix vittata*, *H. fallaciosa*, *H. bistrialis*, *H. Tranquebarica* (type, and var. *semirugata*), *Bulimus Mavortius*, *B. punctatus*, the wide-ranging *B. pullus* and *B. gracilis*, *Cyclophorus involvulus*, and several freshwater shells; and the genera above quoted, with numerous peculiar forms of *Helix*, are restricted, with a few exceptions, to the hills of the central province and to the undulating, wet, forest-clothed country to the south and south-west. It is true that the apparently endemic character of this fauna may in some cases be rather apparent than real, owing to our ignorance of those neighbouring stations the climatal conditions of which most resemble those of South-western Ceylon. The very different physical conditions of the northern provinces, on the one hand, and of the hills and south-western parts of the island, on the other, would lead us to expect, *à priori*, the existence of a distinct and much richer Molluscan fauna in the latter; and the hills and west coast of the southern extremity of the Indian peninsula, the damp jungles of which present conditions very similar to those of Southern Ceylon, have been too little searched by conchologists to admit of anything like a fair comparison of the faunas. The little that we do know, however, of the pulmoniferous Mollusca of the Travancore Hills * and of the Anamullies † indicates an affinity with those of the Nilgiris, which are at least equally well worked out with those of Ceylon, and which include but two species (*Bulimus Nilagiricus*, Pfeiffer, and *Achatina Ceylanica*, Pfeiffer) hitherto identified as common to the hills of Ceylon, with the exception of such low-country species as range through the intermediate plains and ascend the lower slopes of the hill-ranges. It seems, therefore, improbable that future discoveries will go very far to diminish the number of forms the range of which is restricted to Southern Ceylon; and we have before us the apparently

* Benson, Ann. Mag. Nat. Hist. 1861, vol. vii. p. 81.

† Mr. King's collection of shells from these hills was unfortunately lost on its way to Calcutta. From his communications, however, the above inference is drawn.

anomalous case of a very limited area inhabited by several *peculiar* genera, each of which is represented by a large number of species.

During a late visit to the island, I enjoyed the opportunity of examining the rich local collection of Major Skinner, a collection which, including a large number of specimens of several of the peculiar species, afforded excellent data for determining how far the numerous forms described by recent authors were really distinct species, or merely varieties linked together by intermediate forms. Major Skinner informed me that, in the case of two of the endemic genera (*Aulopoma* and *Tanalia*), he had found it impossible to discover any constant association of characters by which one species could be satisfactorily separated from another, and that many of the described species of *Achatina* and certain *Helices* presented difficulties of the same kind, increasing as he obtained collections from a greater number of localities. Having myself, while collecting in Southern India, noticed the great variability of certain species, and that in many cases, owing to the describers not being provided with intermediate forms, varieties of the same shell had been described under different names (e. g. *Helix fallaciosa*, Férussac, *H. ruginosa*, Férussac, and *H. crassicostata*, Bens.; *H. Tranquebarica*, Fabricius, *H. semirugata*, Beck, and *H. vitellina*, Pfr.), I addressed myself during my stay in Colombo mainly to the examination of such puzzling species, with a view to trace out the connexion of varieties by the comparison of a large number of specimens, or to fix the limits of variation so far as the collection permitted. How necessary such revision has become in the case of many of our Indian shells any one who has collected over an extensive area, and endeavoured to trace out the geographic range of species, will readily acknowledge. In a subsequent paper I purpose contributing such corrections of Indian species as my own collections have enabled me to establish; in the meantime I give the results of my examination of the genus *Tanalia*, the numerous described forms of which are all peculiar to Ceylon. In another paper I shall submit a similar notice of the *Aulopomas* and certain *Cyclophori* *, *Helices*, and *Achatinas*. The *Melanias* and *Ampullarias* equally require revision; but these must be considered in connexion with Indian species, most of them having a very extensive range.

Genus Paludomus.

Subgenus Tanalia, *Gray*.

I have little to add to the description of this subgenus, given by Mr. Layard, except to notice the variability of the form of the operculum. This appendage is sometimes broadly triangular, the angles being more or less rounded, sometimes compressly elliptical; and the nucleus, usually about the centre of the dextral edge, or a little inferior, is, in one species [or variety ?], *T. violacea*, Layard, at the dextral corner of the base, and sometimes projecting below the basal edge. A monstrous form of the operculum (possibly that upon which Mr. Layard founded the subgenus *Ganga*) is not infrequent: in this, the nucleus

* Since the above was written, Mr. L. Reeve's Monograph of this genus has reached me, and I have had the satisfaction of seeing that he has therein made many of those corrections in the described species, of the necessity of which I had already convinced myself.

is central or subcentral, and the structure consequently concentric; but this modification is only met with in those cases in which there is good reason to believe that the original operculum has been lost, and a new one formed on a plan of structure common to other species of Gasteropoda in similar cases. [See Dr. Gray, Proc. Zool. Soc. 1854, p. 100.] Two specimens of opercula in my collection seem to prove this. In the first a small portion only of the original operculum has been lost, and the older part has the usual structure with a dextral nucleus, the newer part being concentric, as in the monstrous specimens above alluded to. The other case is still more conclusive. The original operculum, which has been only partly detached from the animal, and not destroyed, is of the usual structure; the newer, which has been formed beneath and finally fused on to the former, has the concentric structure extending up to where the older operculum still adhered to the animal. The concentric opercula, moreover, are always more or less uneven and irregular, which is never the case with the normal forms. There is therefore no reason to regard this structure as a specific, far less as a generic or subgeneric character.

Among the numerous forms of *Tanalia* that I have examined, but one departs so widely from the others as to admit of being regarded, even provisionally, as a distinct species, viz. that described by Mr. Layard as *T. violacea*. The characters which distinguish this from all others are the peculiar form of the operculum above noticed, and the dense violet colouring of the interior of the shell, as well as the small size of the latter. These two last characters are, indeed, variable in the other species of the genus; and did they alone distinguish *T. violacea*, I should feel great hesitation in separating it; but I have not seen in any other form an operculum similar to that of this little species, nor does the position of the nucleus in the numerous varieties of *T. aculeata* ever approach the position it occupies in *T. violacea*. Further materials may, however, show that these distinctive characters graduate off through intermediate forms.

T. aculeata, *Gmel.* sp.

The remark of Major Skinner, that it is impossible to separate the numerous forms of *Tanalia* into species or varieties with definite limits *, I found to be fully confirmed by my own experience when I examined his collection, which comprised about 3000 specimens from various localities. Typical specimens corresponding to most of the described species were easily selected; and it would have been equally easy to double the number of distinct forms by selected specimens differing as much *inter se* as most of those to which specific names have been given; but when any attempt was made to classify the collection, such typical forms were found to graduate into each other; and in those cases in which the collection did not furnish forms strictly intermediate, the characters of the types were such as were shown to be very variable by other series, so that I could not doubt that further materials would eventually be found to supply the missing links.

When, subsequently, I collected living specimens in the Mahavelli Ganga, the Kelany Ganga, and some other streams, and when I examined other collections classed according

* *T. violacea* must be excepted in this and the following remarks.

to locality, I found that specimens from the same stream, and collected on the same spot, were in all cases somewhat variable, and sometimes exhibited a considerable range of variation—moreover that, however great this range, the local series presented a perfect gradation between the extreme forms. Thus, in the Kelany Ganga, between Kitoolgalle and Yatteantotte, while the majority of the specimens were of the form *T. Tennentii*, frequently with the colour and markings of *T. picta*, some few occurred of the var. *T. undulata* (having, however, spiny instead of nodular ribs); and linking these together were specimens of the type *T. Gardneri* with depressed and exserted spires, and *T. undulata* of the normal form, with other intermediate forms of minor gradation. In the Mahavelli Ganga, where all my specimens were collected within the space of a few yards, the shells exhibited but a small range of *form* and *sculpture*, including the varieties *T. picta*, *T. dromedaria*, and *T. neritoides*; but the *size* of fully grown specimens ranged from $9\frac{1}{2}$ lines to 15 lines in height, and from 10 lines to $14\frac{1}{2}$ lines in the major diameter. A series of measurements of specimens from this collection is given at p. 609. Minor variations of ribbing and colour were also observable.

Finding thus that the species is evidently a very variable one, I selected, from Major Skinner's and from my own more limited collection, series exhibiting the ranges of variation in the following characters:—

1. Ornament of sculpture,
2. Colouring,
3. Exsertion of the spire,
4. Size of specimens,

on each of which a few words are necessary.

Some other characters are also variable, such as the form of the operculum (see *antè*, p. 605) and the excavation of the upper part of the whorl; but the above are more important, and to them I shall confine my remarks, contenting myself with the passing assurance that the two last mentioned are far too inconstant in their relations to other variations to allow of their being admitted for an instant as specific distinctions.

1. *Sculpture.*

The varieties *T. Tennentii* or *T. dromedaria* and *T. Skinneri* or *T. erinacea* exhibit respectively the extreme varieties of sculpture. Between these types I have a series of twelve intermediate forms *, illustrating the gradual appearance and development of ribs, and the breaking up of these ribs into nodules, which finally in the two last-mentioned forms are exaggerated into scale-like spines †.

Even in the smoothest specimens (Fig. 1, *T. Tennentii*) faint indications of the spiral ribs may be noticed, as well as striæ of growth: the most common variety is perhaps that which has distinct but not highly developed subequal ribs (Fig. 2). As these become

* Six of these are given in the accompanying Plate, Series I.

† The ribs of the shell of *Tanalia* correspond with a series of indentations on the edge of the external lip of the peristome, in which, when the animal is extruded, rest the fringes of the dorsal fold of the mantle. The number and relative size of the ribs and notches correspond with those of the filaments.

more strongly marked (Fig. 3, *T. Gardneri*), the alternate ribs are more developed, and those intervening narrow and filiform. In the next stages, the alternate ribs, or in some specimens all the ribs, become undulated (Fig. 4), then nodular, the nodules being first small and close (Fig. 5), and afterwards more distant and prominent (Fig. 6, *T. loricata*), from which the passage into *T. Skinneri* and *T. erinacea* consists in, first, some of the spines, and finally all, remaining unfilled and in the form of scales as they first appear at the edge of the shell. The varieties *T. ærea*, *T. Layardi*, *T. Reevei*, and *T. funiculata* differ from *T. Gardneri* chiefly in the elevation of the spire and the greater and regular development of the striæ of growth. These forms (as has been remarked by Mr. Layard in the case of the two first mentioned) pass into *T. undulata*, and this again into *T. loricata*, with an elevated spire.

2. *Colouring.*

When taken from the water, most specimens are more or less covered with adhering Algæ, which require soap and water and a stiff brush for their removal. When thus cleaned, the epidermis is seen to be of a rich brown colour, varying from a pale yellow brown to a tint bordering on black. Beneath this, the proper colouring of the shell is always perceptible in young specimens, and frequently also in old. It is very clearly seen in the variety *picta*, which has a thin epidermis, and in which it assumes the form of waved transverse bands varying in closeness and regularity, being sometimes so irregular as to simulate a reticulate marbling. The variety *T. Tennentii*, from Ambegammoa, is frequently marked in a similar manner. This is the commonest type of colouring in all varieties; the only modification of it I have observed is that in which the transverse bands become more or less interrupted, but regularly (as in *P. chilinoides*), so as to form spiral bands of zigzags. This is chiefly observable towards the aperture of full-grown specimens, the young part of the shell having the normal colouring. I have met also with a few cases in which the shell was colourless near the aperture.

The painting of the peristome varies but little. The inner lip is coloured purplish brown; and the tint sometimes extends round the outer lip also: it is the colour of the callous deposit which strengthens the aperture of full-grown shells. Very frequently a series of brown dots also ornaments the edge of the outer lip, being the tips of the zigzag markings appearing beneath the callus. In old specimens this callus, the internal part of which is white or brown, or white blotched with brown, extends far into the shell, obscuring its zigzag markings. These remarks apply to all forms of *Tanalia* here included under *T. aculeata*.

3. *Form of Whorls, and Exsertion of the Spire.*

The form of the whorl varies but little throughout the species: it is always obliquely flattened above, and in some specimens (var. *dromedaria*, e. g.) this feature is exaggerated into a slight excavation of the whorl near the suture. The ribbed and nodulose varieties differ in this respect as much as the smooth forms. The dilatation, or, in other words, the ratio of increase in the growth, of the whorls varies also in all varieties. The form of the spire is very inconstant: it is sometimes as much exserted as in a typical *Paludina* (e. g.

P. Bengalensis), at other times almost entirely concealed. Between these extreme modifications every intermediate degree of exsertion may be met with; and in specimens collected on the same spot (so far as my own experience goes) some variation is always perceptible in this respect. The smaller varieties have, as a rule, the highest spires; at least I have seen no Paludiniform examples of the larger forms; and the nodulose varieties are less variable in the spire than those with simpler ornamentation, though even the most spiny forms exhibit considerable differences.

In some specimens of a nearly smooth variety from a feeder of the Kelany Ganga between Ambegammoa and Kitoolgalle, the upper whorls are exposed to considerably below the swell of the whorl; but from the same spot I have specimens in which the suture coincides with the middle of the upper whorl, and others of intermediate degrees of inclination.

Some specimens which I received from the Orobokka, in the Southern Province, exhibit a similar degree of variability.

The following comparative measurements, in inches and lines, of specimens of spiny, ribbed, and large and small smooth forms exhibit the extremes of variation I have met with.

		Extreme height.		Diameter.		Ratio of diam. to spire = 100.
		in.	lin.	in.	lin.	
Spiny varieties	Highest spire	1	6½	1	3½	80
	Intermediate	1	3	1	1½	90
	Lowest spire	1	5½	1	4½	94
Ribbed varieties	Highest spire	1	2	1	0	85
	Intermediate	1	3½	1	2	90
	Lowest spire	1	3	1	3	100
Large smooth variety	Highest spire	1	2	1	0	85
	Intermediate	1	2½	1	2	96
	Lowest spire	1	1	1	1	100
Small smooth variety, from Kitoolgalle	Highest spire	1	0	0	9	75
	Intermediate	0	11	0	9	81
	Lowest spire	1	0	0	11	91

The above measurements can only be taken as roughly indicative of the exsertion of the spire, as the ratio of height to diameter varies also with the dilatation of the shell, and the former is but little affected by a slight exposure of the upper surface of the whorls. Series III. *a* and III. *b* of the Plate illustrate the variability of the spire in large smooth, and ribbed forms, respectively.

4. *Size of the Shell.*

In no respect do specimens of *Tanalia* vary more than in size. In this character, again, all the varieties (classed according to sculpture) exhibit a great range of difference, as is shown by the following four series of measurements. The specimens of the first are from the Mahavelli Ganga, illustrating the variability of full-grown shells from the same stream; those of the other three series are respectively spiny, ribbed, and smooth or faintly ribbed forms, selected from various localities. (The measurements are in inches and lines.)

		1.		2.		3.		4.		5.		6.		7.		8.		9.	
		in.	lin.	in.	lin.	in.	lin.	in.	lin.	in.	lin.	in.	lin.	in.	lin.	in.	lin.	in.	lin.
No. 1.	Height	0	9½	0	10½	1	0	1	0	1	2½	1	3						
	Diameter	0	10	0	10	0	11	1	0	1	1½	1	2½						
No. 2.	Height	0	8½	0	9½	0	11	1	1	1	3	1	6½	1	5½	1	9		
	Diameter	0	8	0	9½	0	11½	1	1	1	2	1	3½	1	4	1	7		
No. 3.	Height	0	8	0	9	0	10	0	11½	1	1	1	3	1	5½				
	Diameter	0	7½	0	8½	0	9	0	10½	1	0½	1	2½	1	4				
No. 4.	Height	0	5	0	7	0	8	0	8½	0	10½	0	11½	1	2	1	5	1	8
	Diameter	0	5	0	6½	0	7½	0	8	0	9½	0	11	1	1½	1	5	1	7½

Summary.

To sum up the evidence above given:

1st. When we class specimens according to any selected character (such as sculpture), we find them variable in all the others, especially in form and size; and if we attempt to multiply species still further, *e. g.* taking two selected characters as the basis of our classification, we still find them variable in the remaining characters.

2nd. Whatever character or characters we select as the grounds of classification, the differences observable when but a small number of specimens are compared, are eliminated by specimens of intermediate characters when we attempt to apply such classification to a large number from various localities.

3rd. Specimens collected on the same spot are always variable to some extent, and sometimes greatly so, the variation being sometimes confined to one character, sometimes affecting all.

4th. Forms with average characters are the most numerous,—those with extreme modifications of character, such as greatly extruded spires, spiny ornaments, or of extremely small or large dimensions, being comparatively rare.

From the above considerations but one deduction can be drawn, viz. that the numerous described forms of *Tanalia* (excepting, possibly, *T. violacea*) are varieties of one species. I have in these remarks confined my observations to the shell; but it is upon the characters of the shell, and these alone, that specific distinctions have been founded. So far as I have had opportunities of observing the animal in the living state, it varies but little. The colour is slaty blue on the back and muzzle, brown towards the edges, and a pale cinereous grey or flesh-tint on the creeping-disk, the variation being dependent on the relative individual abundance of orange-pigment granules. The dorsal fold of the mantle is fringed as in the genus *Melania*, from which indeed *Tanalia*, *Paludomus*, and *Philopotamis* differ so little, that it appears to me that all should rather be regarded as sections of the genus *Melania* than as distinct genera. The structure of the operculum, upon which alone their generic distinction depends, is variable both in *Philopotamis* and *Tanalia*, and is, as we have seen, also variable in the species and varieties of *Tanalia*. Indeed, accepting the views of Mr. Darwin, we might regard the group as affording an instance of variable structure in an organ usually constant, the tendency to vary having survived generic and specific differentiation and obtaining to some extent in coexistent forms of the same species.

Reverting to the subject upon which I remarked at the commencement of this paper, viz. the endemic character of the land and freshwater molluscan fauna of Southern Ceylon, it appears that in the case of *Tanalia*, as also without doubt in that of *Aulopoma* (two of the peculiar genera), the number of species is really far less than has been represented, that of the former genus being (possibly two) probably but one, that of the latter one only. Of *Philopotamis* I have met with three species; and two others have been described by authors, but are probably only varieties. Of *Cataulus* there appear to be five or six and possibly more species; but this genus is not strictly endemic, having a single described representative in the Nicobar Islands. Both *Philopotamis* and *Cataulus* still require more strict investigation than the limited materials at my disposal have enabled me to give them.

The following is a list of the described species which I have identified as varieties of *T. aculeata*:—

Paludomus loricatus, Reeve, Conch. Icon. 1.
P. undatus, Reeve, Conch. Icon. 2.
P. neritoides, Reeve, Conch. Icon. 3.
P. Gardneri, Reeve, Conch. Icon. 9.
P. pictus, Reeve, Conch. Icon. 10.
P. Tennentii, Reeve, Conch. Icon. 12.
P. funiculatus, Reeve, Conch. Icon. 13.
P. erinaceus, Reeve, P.Z.S. 1852, p. 127.
P. æreus, Reeve, P.Z.S. 1852, p. 127.
P. Layardi, Reeve, P.Z.S. 1852, p. 127.
P. dilatatus, Reeve, P.Z.S. 1852, p. 127.
P. rudis, Reeve, P.Z.S. 1852, p. 127.
Tanalia Reevei, Layard, Ann. Mag. N. H. 1855, vol. xvi. p. 138.
Tanalia similis, Layard, Ann. Mag. N. H. 1855, vol. xvi. p. 138.
Philopotamis Thwaitesi, Layard, Ann. Mag. N. H. 1855, vol. xvi. p. 139.
Paludomus Cumingianus, Dohrn, P.Z.S. 1857, p. 124.
P. distinguendus, Dohrn, P.Z.S. 1857, p. 124.
P. dromedarius, Dohrn, P.Z.S. 1857, p. 124.
P. nodulosus, Dohrn, P.Z.S. 1857, p. 124.
P. Skinneri, Dohrn, P.Z.S. 1857, p. 124.
P. solidus, Dohrn, P.Z.S. 1857, p. 124.
P. sphæricus, Dohrn, P.Z.S. 1857, p. 124.
P. Swainsoni, Dohrn, P.Z.S. 1857, p. 124.
P. torrenticola, Dohrn, P.Z.S. 1858, p. 536.

EXPLANATION OF PLATE.

Plate LX.

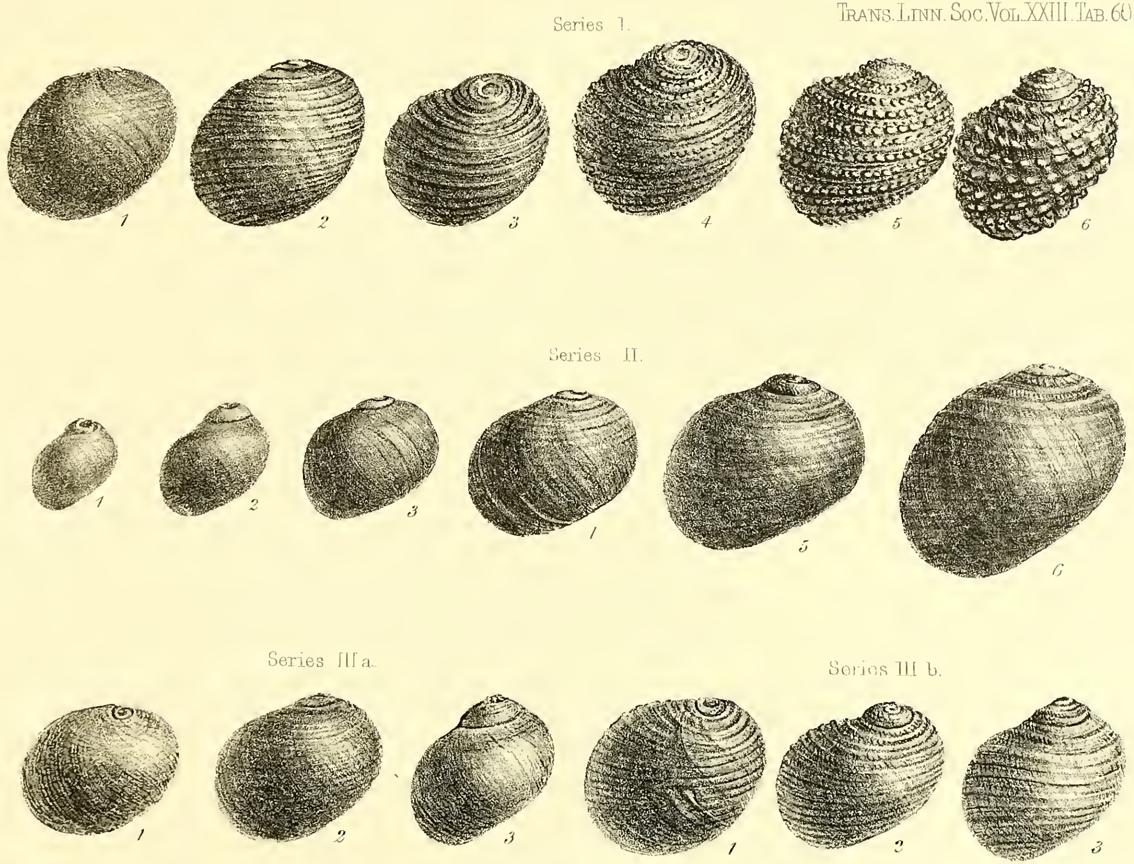
Series I. figs. 1–6. A series of six specimens of *Tanalia aculeata*, Gmel., to illustrate gradation of ornament.

Series II. figs. 1–6. A series of six specimens of the smooth variety of the same species, to illustrate gradation of size.

Series III. *a*. figs. 1–3. A series of three specimens of the smooth variety of the same species.

Series III. *b*. figs. 1–3. A similar series of the ribbed variety, to illustrate gradation of the height of the spire.

The figures are all lithographed from a photograph representing the specimens of their natural size.



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