THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY,

INCLUDING

ZOOLOGY, BOTANY, AND GEOLOGY.

(BEING A CONTINUATION OF THE 'ANNALS' COMBINED WITH LOUDON AND CHARLESWORTH'S 'MAGAZINE OF NATURAL HISTORY.')

CONDUCTED BY

CHARLES C. BABINGTON, Esq., M.A., F.R.S., F.L.S., F.G.S.,
JOHN EDWARD GRAY, Ph.D., F.R.S., F.L.S., F.Z.S. &c.,
WILLIAM S. DALLAS, F.L.S.,

AND

WILLIAM FRANCIS, Ph.D., F.L.S.

VOL. IX.—FOURTH SERIES.

LONDON:

PRINTED AND PUBLISHED BY TAYLOR AND FRANCIS.

SOLD BY LONGMANS, GREEN, READER, AND DYER; SIMPKIN, MARSHALL, AND CO.;
KENT AND CO.; BAILLIÈRE, REGENT STREET, AND PARIS:
MACLACHLAN AND STEWART, EDINBURGH:
HODGES AND SMITH, DUBLIN: AND ASHER, BERLIN.

1872.

"Omnes res creatæ sunt divinæ sapientiæ et potentiæ testes, divitiæ felicitatis humanæ:—ex harum usu *bonitas* Creatoris; ex pulchritudine *sapientia* Domini; ex œconomiâ in conservatione, proportione, renovatione, *potentia* majestatis elucet. Earum itaque indagatio ab hominibus sibi relictis semper æstimata; à verè eruditis et sapientibus semper exculta; malè doctis et barbaris semper nimica fuit."—LINNÆUS.

"Quel que soit le principe de la vie animale, il ne faut qu'ouvrir les yeux pour voir qu'elle est le chef-d'œuvre de la Toute-puissance, et le but auquel se rapportent toutes ses opérations."—BRUCKNER, *Théorie du Système Animal*, Leyden, 1767.

. . . . The sylvan powers
Obey our summons; from their deepest dells
The Dryads come, and throw their garlands wild
And odorous branches at our feet; the Nymphs
That press with nimble step the mountain-thyme
And purple heath-flower come not empty-handed,
But scatter round ten thousand forms minute
Of velvet moss or lichen, torn from rock
Or rifted oak or cavern deep: the Naiads too
Quit their loved native stream, from whose smooth face
They crop the lily, and each sedge and rush
That drinks the rippling tide: the frozen poles,
Where peril waits the bold adventurer's tread,
The burning sands of Borneo and Cayenne,
All, all to us unlock their secret stores
And pay their cheerful tribute.

J. TAYLOR, *Norwich*, 1818.

ALERE FLAMMAM.

CONTENTS OF VOL. IX.

[FOURTH SERIES.]

NUMBER XLIX.

NUMBER LII.

NUMBER LIII.

PLATES IN VOL. IX.

THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[FOURTH SERIES.]

"................. per litora spargite muscum,
Naiades, et circùm vitreos considite fontes:
Pollice virgineo teneros hìc carpite flores:
Floribus et pictum, divæ, replete canistrum.
At vos, o Nymphæ Craterides, ite sub undas;
Ite, recurvato variata corallia trunco
Vellite muscosis e rupibus, et mihi conchas
Ferte, Deæ pelagi, et pingui conchylia succo."
N. Parthenii Giannettasii Ecl. 1.

No. 49. JANUARY 1872.

I.—*On the Abyssal Theory of Light, the Protozoic-Absorption Theory, and the Azoic-Mud Theory, propounded in the Reports of H.M.S. 'Porcupine,'* 1869 *and* 1870. By W. C. M'Intosh.

In recording the following remarks I must disclaim any intention to cast reflections on the scientific energy or the experience of marine animals of the three excellent naturalists who were chosen by the Royal Society to represent British zoologists in these expeditions. Such would certainly be unworthy, more especially as I had the pleasure of receiving (through the intervention of Mr. Jeffreys) part of the collection of Annelids (all from a depth of less than 500 fathoms) in the first expedition, and the whole of the Annelida of the second. Having made this necessary acknowledgment, I must also admit that certain parts of the reports of my friends struck me at once, on hearing the first read and on perusing the second, as being slightly at variance with my own views on such subjects. Some of the latter, however, are points on which more than one opinion may be held; and the following remarks *, therefore, are intended to be tentative rather than dogmatical.

* These were included for the most part in a paper read before the Royal Society of Edinburgh, on the 1st of May, 1871.

1. *The Abyssal Theory of Light.*

The distinguished dredgers in the expeditions were struck by the luminosity of many of the animals procured from great depths in the Atlantic, such as Alcyonarian Zoophytes, Brittle-stars, and Annelids. In some places, indeed, the mud itself was full of luminous specks*. In their Report on the Dredgings of 1869†, they broach the idea that the abyssal regions might depend solely for their light upon the phosphorescence of their inhabitants, and that this luminosity in the dark abysses of the sea fulfils, in regard to the great object of the supply of food, the functions performed in the upper world by the light of day. In other words, the phosphorescence of an animal would, on the one hand, enable it to see its prey, and, on the other, would discover it to its enemies‡. Moreover, according to the report, since the young of certain starfishes are much more luminous than the adults, it is probable that this is part of the general plan which provides an enormous excess of the young of many species, apparently as a supply of food, their wholesale destruction being necessary for the due restriction of the multiplication of the species, while the breeding individuals, on the other hand, are provided with special appliances for escape or defence.

Now, without entering on the present occasion into the literature of the subject (a labour which has been so ably accomplished by Ehrenberg, De Quatrefages, and other authors), it will be seen, on referring to a single passage in the article on this subject (Todd's Cyclopædia) by the late accomplished Dr. Coldstream, that marine zoologists have long been familiar with such notions. "Considering," says Dr. Coldstream, "that in the ocean there is absolute darkness at the depth of 800 or 1000 feet (133–166 fathoms), at least that at such depths the light of the sun ceases to be transmitted, Macculloch has suggested that, in marine animals, their luminousness may be 'a substitute for the light of the sun,' and may be the means of enabling them to discover one another as well as their prey. He remarks, 'It seems to be particularly brilliant in those inferior animals which, from their astonishing powers of reproduction, and from a state of feeling apparently little superior to that of vegetables, appear to have been in a

* We shall suppose that due precautions were taken to prevent the entrance of the myriads of surface-forms.

† Proc. Royal Soc. No. 121 (1870), pp. 431, 432.

‡ Thus a young *Hyas araneus* having dense tufts of *Obelia geniculata* waving from its carapace and limbs, must, on the one hand, like an Indian beauty with her fire-flies, be the cynosure of all (predatory) eyes, and, on the other, be enabled to throw such a flood of light on the food-question as to distance many rivals.

great measure created for the supply and food of the more perfect kinds.' "

Phosphorescence, however, is a feature so broadly and diversely distributed amongst marine animals, not only abyssal, but pelagic and littoral, that, on a careful view of the subject, some objections to such a theory present themselves.

On land the idea that the phosphorescence of certain insects (*Lampyris*, *Elater*, &c.) may guide them to their prey, was early promulgated by entomologists (*e. g.* Kirby and Spence). Further, since the light in *Lampyris* is usually most brilliant in the female, it has been connected with sexual characteristics, especially as these females are wingless; but it must be remembered that both larva, pupa, and male are likewise luminous. The provision, besides, continues after the reproductive season. The luminous myriopods, again, show that the presence or absence of wings has little to do with the matter. Kirby and Spence have also observed that certain insects can control their phosphorescence, in order, as they suppose, to escape being captured by nocturnal birds. On the whole, we can scarcely predicate of such animals, any more than the botanists can with regard to the Fungi, that their luminosity subserves them for the light of day.

Amongst the inhabitants of the ocean, phosphorescence appears in all the invertebrate subkingdoms, from Protozoa to Annulosa. Certain infusorial animalcules (*Ceratium*, *Peridinium*, *Synchæta*) and the well-known *Noctiluca* are luminous. Of Cœlenterata there are Hydroid Zoophytes, true Medusæ, and Alcyonaria; while *Pyrosoma* and, it may be, others are similarly provided among the mollusks. In the Annulosa, again, there are Brittle-stars, *Planariæ*, Annelids, and Crustacea.

If, as the report says, luminosity subserves the purpose of guiding animals to their prey, or of causing them to be preyed upon (an unfortunate result), or even of illuminating the abysses of the ocean, we should find traces of a general resemblance in habits, structure, or physiology, which would at least indicate the bearings of a provision so important. Thus, for instance, we should look for a similar state of matters in the dark caves of Illyria and Dalmatia, or in those of Kentucky.

On surveying the marine animals possessed of this property of phosphorescence, they are found to live under circumstances so varied that it is truly difficult, not to say hazardous, to attribute the function assigned in the report to the phenomenon. Thus *Noctiluca miliaris* occurs in such swarms as to give the whole surface of the ocean a sparkling appearance. Mere blowing on the surface of sea-water taken at random in July off many of our shores where Laminariæ abound, produces phosphorescence from a vast number of minute medusa-buds. The same takes place most strikingly in vessels in which specimens of *Obelia geniculata* attached to tangle-blades are immersed. On touching the seaweed, a large number of such luminous points appear on the zoophytes, the stems most irritated sending off beautiful flashes, which glitter like a faintly dotted line of fire, the points not being harshly separated, but blending into each other; while the shock imparted by the instrument detaches the minute medusa-buds, which scintillate from the parent stem upwards to the surface of the water. Dr. Allman would therefore have found this a much more interesting species for his observations than *O. dichotoma* *. The immense abundance of these minute phosphorescent organisms (medusa-buds) in some parts of the Zetlandic seas may explain the following fact, reported to me by Mr. Gatherer, the intelligent naturalist of Fort Charlotte, Lerwick. During the prevalence of a south-easterly gale, the late Dr. Cowie, of Lerwick, was riding at night along Deal's (or Dale's) Voe, when, happening to touch his beard, he found both it and his fingers gleam with phosphorescent points; and the same ensued on rubbing his sleeve. The gale had probably swept the spray and thousands of its minute inhabitants landwards, and showered them on the person of the rider.

If *Thaumantias*, or any other phosphorescent Medusa, which, when swimming freely, has its disk-margin shining like a dotted fiery ring of great beauty, be taken from the water and rubbed on a woollen surface, such as a carpet, a considerable luminous area is produced, showing that the entire mass of the animal has this property when thus violently irritated; moreover the surface just mentioned, as well as the fingers, remain in a gleaming condition for some time. I am aware that this view slightly differs from that of so distinguished and so cautious an observer as my friend Mr. Busk, who, along with Dr. Allman and probably Panceri, confines the seat of light to the marginal tentacular bulbs; but I cannot conscientiously say otherwise†. If *Beroë* be treated in the same rough manner, it is found to be less phosphorescent, and the luminosity of the area disappears sooner. It did not signify, in any case observed by me (*Beroë* excepted, as I did not examine it especially on this point), whether the examination were made at

* This author (Proc. Roy. Soc. Edinb. vol. iv. p. 519) is of opinion that *Beroë* and other Ctenophora are among the chief sources of the phosphorescence of the sea in our latitudes.

† The state of matters in *Aphlebina*, where the light gleams along the simple tentacular processes, supports this view.

night or by day in a darkened room or recess; and this feature of itself would raise a doubt as to such having any connexion physiologically with the capture of prey or of being conspicuous to marauders.

The free gonozooids of many of the Hydroid zoophytes, therefore, and the true Medusæ are pelagic and phosphorescent animals, whose active life is passed at or near the surface of the water, so that they can scarcely be included under the head of abyssal inhabitants, though some descend during quiescence to the bottom. We have no proof that the luminosity of such forms occurs only at night; for, as before mentioned, I have found various species, like the annelids and the Coleopterous larva recently described by Dr. H. Burmeister*, exhibit this property as vividly during the day as during the night, if taken into a suitable place for observation, and without any previous seclusion in darkness as described by Dr. Allman in *Beroë*. Medusæ, besides, do not, so far as I know, form a common food of other marine animals in our seas (their most notable enemies, perhaps, in this respect being each other), and their habits and structure do not point to their exercising the luminosity for the sake of seizing their prey. Moreover there does not seem to exist the provision mentioned in the report, whereby, in virtue of their lessened phosphorescence, the breeding individuals are preserved. There is nothing in the history of *Pennatula* or *Pavonaria* which would lead us to infer such interpretations of their luminosity; and though the former sometimes occurs in the stomach of the cod, it must be borne in mind that inconspicuous mollusks and annelids are at least as common, not to mention stones and iron nails.

Phosphorescence could be of little service to the brilliant *Pyrosoma* in capturing prey; and, to balance the fancy that this was given for the sake of attracting plunderers, we have the fact that the allied and equally palatable Salpæ of the British waters are not luminous.

It is asserted that the young of the starfishes emit more light than the adults in order that they may the more readily court destruction; but it may be asked, are the young of the Hydroid Zoophytes, of *Beroë*, or the young Annelida more luminous than the adults? Apparently not; and in some cases rather the reverse. Further, we may inquire as to the facts bearing on this question in those starfishes which are not phosphorescent. The structure of the group and their habits in feeding, again, show that such illumination could only be of service to their enemies. But we have no reliable data to

* Proc. Linn. Soc. (Zool.), vol. xi. no. 54, p. 419.

demonstrate that one marine species which is luminous is more preyed on than another which is not.

Some interesting features are presented by the Annelids. *Chætopterus norvegicus*, for instance, is a most beautifully phosphorescent form, bright flashes being emitted from the posterior feet; but the most vivid luminosity is at a point on the dorsum between the lateral wings of the tenth segment. Here the copious mucus exuded by the animal can be drawn out as bluish-purple fire of great intensity, which, besides, now and then gleams along the edges of the wing-like processes, at once illuminating the surrounding water and eliciting the admiration of the observer. A very characteristic odour, somewhat resembling that produced by phosphorus in combustion, is given out by the animal during such experiments. The common *Harmothoë imbricata*, again, discharges bright greenish scintillations from the point of attachment of each dorsal scale; and thus, under irritation, the flashes are arranged in pairs along the body, or in a double moniliform line. The separated scales, also, continue to gleam for some time, chiefly at the surfaces of attachment. If severely pinched, the worm wriggles through the water, emitting sparks of green light from the bases of the feet. The same phenomenon is readily produced in a fragment either of the anterior or posterior end of the body. The large *Polynoë scolopendrina* and a Zetlandic *Eunoa* are similarly phosporescent, the light proceeding from the dorsal surface of the bases of the feet. A *Eusyllis* common under stones and on the blades of tangles is also highly luminous. Under irritation, a fine green light is emitted from the ventral aspect of each foot. The scintillations seem to issue from many minute pores at each space, flash along both sides of the worm posterior to the point of irritation, and then disappear, a faint trace only being visible for a few seconds. On one occasion, after a severe pinch, the animal remained luminous behind the injured part for nearly half a minute, while the surface of granular light on each segment was larger than usual; and in some instances those of opposite sides were connected on the ventral aspect by a few phosphorescent points. Moreover, for some time after, mere shaking of the vessel caused a repetition of the brilliant flashes. The body behind the irritated point had a decidedly paler pinkish hue (under a lens) immediately after the emission of the luminosity. When at rest, a spark appeared here and there at intervals. As in all such marine forms, immersion in spirit elicited the luminosity, a moniliform band of greenish phosphorescence (brightest at the tail) being instantly produced on each side: at the end of five minutes the body was still faintly luminous, while from the injured points the soft parts protruded. A pale *Aphlebina* (*Polycirrus*), very generally distributed, is so phosphorescent that, on simply blowing on the water of the dissecting-trough or other shallow vessel in which it lies, the most vivid pale bluish luminosity gleams for a moment along every one of the mobile tentacles, which are often elegantly disposed in a stellate manner.

Now, with the exception of *Harmothoë imbricata* and *Eunoa*, all the luminous annelids above-mentioned are inhabitants of tubes of greater or less density. *Chætopterus* lives under stones between tide-marks, amongst old shells and stones in deep water, or sunk in sand and gravel at low water in tubes resembling thick parchment covered with pebbles, shells, and seaweeds. *Polynoë scolopendrina* frequents the tubes of the speckled *Terebella nebulosa*; indeed I have never found it anywhere else than in these or similar galleries. The latter species is not luminous, while the former is; yet both are placed under the same circumstances, and, of the two, perhaps *P. scolopendrina* has less need for such extraneous aid in procuring nourishment. Many of the Polynoidæ which have similar habits are not phosphorescent, while the succeeding form, which greatly resembles *Terebella* in habits and structure, is luminous. With such a varied history, the only theory that seems feasible is one which would endow the *Polynoë* with the property of attracting prey for the benefit of *Terebella* or itself —a somewhat analogous part to that ascribed by the fancy of the older naturalists to the pea-crab in the horse-mussel! The yellow *Aphlebina*, again, a close ally of *Terebella*, is beautifully phosphorescent. This and the two foregoing are comparatively safe from the attacks of marauding fishes or crabs, the two former in tubes immersed in sand or under stones, and the latter in obscure chinks and fissures of muddy rocks, boulders, and old shells. It will not do to affirm that they are protected because they are luminous, since many species which are not so have exactly the same habits and shelter, while other phosphorescent annelids are without such a safeguard. Lastly, *Eusyllis* occurs in swarms in delicate tubes on Laminarian blades covered with *Obelia*, as well as under ascidians on stones between tide-marks. The effect produced in its former situation may sometimes be seen on a gigantic scale on the West Sands at St. Andrews, after a heavy storm has tossed on shore a bank of tangles and other seaweeds about a mile long. Throughout this extent, wherever the people are engaged at night in securing the valuable mass as manure, countless myriads of minute glittering points cover the seaweeds, carts, and weapons. Whether the phosphorescence be due to the zoophytes, the annelids, or both, does not signify for our argument. Both are found between tide-marks, and in immense quantities in the Laminarian region immediately beyond, where there is abundance of light. Neither, therefore, supposing it were able to profit by that gift, requires its luminosity to aid it in its search for nourishment; nor do the Nudibranchs which prey on the zoophyte, or the devourers of the annelid, stand in need of this artificial guide to their respective means of support.

The abyssal theory of light thus gains little succour from the Annelids.

It is stated in the report that, since fishes feed principally at night, the phosphorescence of the larvæ on the surface, for instance, is an example of a provision for feeding the herring. The stomachs of cod, haddock, whiting, flounders, and other fishes, however, give no such result in regard to luminous annelids. Even if such were the case in the herring, it would not be a solid basis on which to found the abyssal theory of light.

On the whole, then, the present state of our knowledge does not warrant the supposition that luminosity is given to marine animals for the purpose of preying or being preyed upon; moreover, that the abysses of the ocean are not better supplied with this provision than the littoral region and the shallow Laminarian zone—indeed much less than the surface of the sea itself. It may yet be a question, according to some observers, whether the phosphorescence may not in some cases act a part exactly the reverse of alluring, and so tend to preserve the species from attack. A speculation to this effect could be as easily established as the foregoing. The theory has much of the visionary character of Œrsted's scheme as to the occurrence of marine animals in variously coloured strata corresponding to the solar spectrum; and some other explanation must be advanced as to the presence of well-formed eyes in certain animals at great depths in the sea.

2. *The Protozoic-Absorption Theory.*

In regard to the speculation that marine Rhizopoda have the power of absorbing, after the manner of the Entozoa, the organic matter which certain analyses of oceanic water showed to exist therein, some reflections suggest themselves.

In the first place, there does not appear to be any serious difficulty in accounting for the supply of nourishment to the abyssal Rhizopoda, since the whole ocean lies at their command. Minute organisms and minute organic particles of all kinds surely abound, and currents, however slow, must bring a constant supply for even a larger population of such microscopic animals than has yet been discovered*. Besides, the minute jellies and disintegrating particles of their fellows of the deep are not unpalatable, and probably in many cases are preferable to "diffused protoplasm" imbibed by their surfaces.

If the reporters had prefixed to their theory†, which is clearly a modification of Dr. Wallich's ‡, a statement of a series of exact scientific experiments proving that the Protozoa in question, or other free animals, lived not upon minute organic particles, as other Rhizopoda do, but upon this invisible "protoplasm" diffused through sea-water, or if they had observed that when disintegrating particles were placed near such Rhizopoda there was no contact, but only a patient expectation till the protoplasm got diffused through sea-water, so as to enter their tissues by absorption, then there would have been a basis for their argument. Such a foundation there would have been, also, if they had stated the fact that the beautiful and highly complex *Eunice norvegica*, an annelid five inches long, provided with intricate dermal, muscular, digestive, nervous, circulatory, branchial, and other systems, can be preserved alive in fifteen ounces of the purest (unchanged) sea-water, in a clean glass vessel §, for three years—that large Nemerteans, like *Lineus marinus*, can be kept for a longer period, and regenerate lost portions of their bodies (though their general bulk diminishes), no trace of nourishment of any kind being visible, nor any change made in the water. Further, they might have drawn upon their experiences in this respect with many other Annelids, Echinoderms, Mollusca, and Cœlenterates, and called attention to the remarkable tenacity of life in sea-water, under apparently complete absence of all nourishment; and, reviewing such facts by the light of their discovery of "decomposable organic matter," might have shown that, since animals so highly organized thus sustain life in sea-water, there must be some inherent aliment, capable of absorption, therein, and consequently that there can be no difficulty in believing that vast myriads of animals of the simplest structure live altogether on this pabulum in the ocean-bed.

The mere occurrence of some "decomposable organic matter" (to wit, "dilute protoplasm") in sea-water in general, or any sea-water in particular, it appears to me, cannot be balanced for a moment in such a case against well-ascertained facts as to the mode of nourishment in the Rhizopoda. Be-

* An interesting paper bearing on this question has recently been published by Dr. Karl Möbius, Zeitsch. w. Zool. xxi. Bd. 2. p. 294, and Ann. Nat. Hist. ser. 4. vol. viii.

† Proc. Roy. Soc. No. 121, p. 476 *et seq.*

‡ North-Atlantic Sea-bed, pt. i. p. 131.

§ A jar with a glass cover.

sides, it is well known that a large quantity of organic matter in solution ("diffused protoplasm" be it called) exists in many freshwater lochs and ponds; yet it has not been brought to light that the Rhizopodous faunæ of these ever resort to this old prescription of nutritive baths, after the fashion of the Gregarinæ and other parasites*.

Moreover it does not seem to be a sound inference to assert (and this also is a modified form of Dr. Wallich's argument) that, because the Protozoon has the power of "drawing" from the sea-water "the mineral ingredients of the skeleton it forms," it is nourished by direct absorption of the "dilute protoplasm" so conveniently dissolved in the surrounding medium. So far as our experience of such formations goes, the calcareous and siliceous spicula and the horny fibres of sponges, the tests of Foraminifera, and other such organisms are (of course with the exception of the instances in which foreign bodies are used) as much the peculiar secretions and excretions in virtue of the inherent properties of their tissues as the crystalline styles in the gastric organs of certain mollusks, the stylets in the Nemertean proboscis, and the spicula of the Echinoderms. It is no rough "drawing" of "mineral ingredients" from the sea-water which takes place at all, but a much more intricate vital process; for, just as the primitive layers in the vertebrate embryo form the respective classes of tissues, as each annelid produces its characteristic bristles, each *Synapta* its peculiar anchors and plates, each armed Nemertean its stylets, each mollusk its shell, and each coral-polyp its special mass, so the elementary tissues in the several Rhizopoda as invariably secrete or excrete their peculiar internal or external "skeletons," and that, too, in many cases, as infallibly as though each had inherited the die from its ancestor. It is true that in marine animals the surrounding medium is favourable, but this will not of itself affect the main question at issue. The same line of argument used by the reporters may be applied to every other subkingdom of animals inhabiting the ocean, from mammals to cœlenterates; yet it is highly problematical if a minute coral-polyp would rest satisfied with a meal of this "dilute protoplasm" any more than, in our opinion, a Protozoon would. The speculation does not appear to be worthy of confidence.

3. *The Azoic-Mud Theory.*

In the summary of the results of the last cruise of the

* It is a pity the solution of "protoplasm" was not a little stronger; for thereby many marine animals, such as *Arenicola*, would have been saved some trouble.

"Porcupine," Dr. Carpenter, who assumes the entire responsibility of this part of the Report*, has advanced the theory that it is the *turbidity of the bottom-water* which renders the deeper parts of the basin of the Mediterranean barren of life. "All marine animals," he says, "are dependent for the aëration of their fluids on the contact of water either with their external surface or with special (branchial) prolongations of it. Now if this water be charged with suspended particles of extreme fineness, the deposit of these particles upon the respiratory surface will interfere with the aërating process, and will tend to produce asphyxia." He further cites the case of oyster-beds, which cannot be established in situations to which fine mud is carried. He, moreover, points out the important bearing this theory of his will have in regard to the vast azoic deposits of the geologists, who, since the lapse of Prof. E. Forbes's views as to the absence of animal life at great depths, have been puzzled for a solution of the difficulty. Such a theory, of course, ought only to be built on well-ascertained facts, some of which, however, do not seem quite in agreement therewith.

Thus *Terebellæ* and *Gephyrea* in vast numbers are characteristic of muddy beaches, such as those between St. Peter Port and St. Sampson's, in Guernsey, and near Rat Island, Herm. Not only these, but many other annelids are found nowhere else than amongst mud or muddy sand, and this is often of such a nature that the sea-water which covers them must always be loaded with minute particles of mud. So distinctly is this the case, as at Lochmaddy, that the fronds of the seaweeds (both those covered and those uncovered by the tide) in quiet creeks are coated with a deposit of fine mud. Yet marine life, from sponges upwards, is nowhere more abundant than in such muddy regions. Indeed the contrast in this respect between these creeks and the rocks washed by open (not rough) water is marked.

Certain mollusks, it may be true, like very young salmon, do not thrive in muddy water, yet some of the most delicate and beautiful annelids, with the finest branchial plumes, live amongst the most tenacious chalk-mud, as it is called, which it has been my lot to encounter. Yet these annelids are so sensitive to other impurities that a very slight admixture of fresh water (although the supply be taken from the sea) is instantly fatal, as I, unfortunately, have reason to remember. The habits of the littoral annelids are also instructive in this respect. Many of the *Polynoidæ*, *Ophiodromus*, numerous *Nereidæ*, *Lumbrinereis*, the large *Marphysa sanguinea*, *Onu-*

* Proc. Roy. Soc. No. 125 (1870), p. 202.

phis (*Hyalinœcia*) *tubicola* (in deep water), *Arenicola*, several of the *Spionidæ* (e. g. *Nerine foliosa* and *Scolecolepis vulgaris*), *Cirratulus*, *Sabellaria*, many of the *Terebellidæ* and *Sabellidæ* habitually live amongst mud or ooze, often of a putrid description, while *Tubifex* and other annelids swarm in the mud of the Thames. Some of the Nemerteans, again, a group of animals with most sensitive ciliated skins, which, moreover, are supposed to subserve the purposes of respiration, live constantly amongst fine and often odoriferous mud. No branchial organs can be more delicate than those of many of the above-mentioned annelids, and no skins more tender than those of the Nemerteans; yet, according to this theory, they are placed in most unfavourable circumstances, to a very great extent more calamitous than the condition of any denizen of the muddy depths of the Mediterranean can be. They must, indeed, pass a life alternately of asphyxia and semiasphyxia. Further, the curious type *Balanoglossus*, Delle Chiaje, has an elaborate and delicately ciliated branchial apparatus, forming part of the dorsal arch of the first region of the alimentary canal, the only possible separation, as shown by Kowalewsky, being by an incurvation of the body-wall, which, of course, can hardly be complete. Now this animal lives in muddy sand, and swallows it wholesale, so that, not to speak of the currents of muddy water which otherwise bathe its respiratory organs, we have at least an occasional application of mud in mass to this important surface.

In glancing at the other divisions of the animal kingdom, also, we observe that many littoral sponges are found on extremely muddy ground, in some the terminal spicula alone being visible through the oozy coating. The siliceous sponges, again, all over the world, affect a muddy bottom. Muddy ground is a favourite haunt of zoophytes and other cœlenterates. In the sandy mud of certain parts of the West Voe of Scalloway (where, by the by, a few oysters are) *Scrobicularia* and other mollusca live and thrive; yet the stinking odour of the ooze is most penetrating, the comparatively still water probably preventing the decaying tangles and other débris from being carried off. Other mollusks, such as *Corbula gibba*, abound on a muddy bottom; and ascidians and mussels are not only powdered by the mud of their respective sites, but the latter are often almost imbedded in it. Those familiar with the habits of the common *Carcinus mœnas* would be cautious in attributing a deleterious character to mud of any description. In general, muddy ground is found to be much more productive in marine life of all kinds than where the rocks, seaweeds, and sands are pure. I need only instance, in conclusion, the muddy ground on which the horse-mussels thrive in Bressay Sound and in the Voes on the west coast of Shetland. The agglomerated masses of mussels, tangle-roots, stones, and odoriferous mud teem with marine life. Even where the margin of the sea is rendered perfectly turbid from mud (and this, too, calcareous), as at White-Cliff Bay, in the Isle of Wight, marine animals are abundant between tide-marks.

There is doubtless some reason why animals were not found by Dr. Carpenter in the dredgings referred to; but it is, on the whole, unlikely that such barrenness was due to the muddy condition of the water *per se*. Whether his alternative restraining condition, viz. "the *stagnation produced by the almost entire absence of vertical circulation*," be founded on a more secure basis, must remain, as he adds, a matter of future inquiry.

II.—*Seventh Account of new Species of Snakes in the Collection of the British Museum.* By Albert Günther, M.A., M.D., Ph.D., F.R.S.

[Plates III., IV., V., & VI.]

The following species of Ophidians have been added to the collection of the British Museum since the publication of the last paper on the same subject in this Journal (June 1868, i. pp. 413–429). The total number of species in that collection amounts now to 920, and that of the typical specimens to 366. In the following lists a part of the species are marked with an asterisk (*); of these, as well as of a few others, I have added descriptions or short remarks.

I. *List of Species which were formerly desiderata.*

Typhlops travancoricus, *Bedd.* Travancore. Capt. Beddome.
Typhlops striolatus, *Ptrs.* Khassya. T. C. Jerdon, Esq.
Typhlops exiguus, *Jan.* Belgaum. Dr. Leith.
Plectrurus sanguineus, *Bedd.* Anamallays. Capt. Beddome.
Rhinophis punctatus, *Müll.* Ceylon. T. H. K. Thwaites, Esq.
Adelphicos quadrivirgatum, *Jan.* Java. M. Boucard.
Ablabes reticulatus, *Jerdon.* Khassya. T. C. Jerdon, Esq.
Cyclophis monticola, *Jerdon.* Khassya. T. C. Jerdon, Esq.
Colophrys rhodogaster, *Cope.* Rio Chisoy. O. Salvin, Esq.
Simotes albocinctus, *Cant.* E. I. archipelago. Dr. van Lidth de Jeude.
Coronella (Liopeltis) sagittifera, *Jan.* Tucuman, Mendoza. Purchased.

*Liophis purpurans, *D. & B.* Demerara. Zool. Soc. Museum.
*Tachymenis piceivittis, *Cope.* Tehuantepec. M. Boucard.
*Spilotes fasciatus, *Ptrs.* Surinam; Hr. Kappler. Peruv. Amazons: Mr. Bartlett.
Zamenis himalayanus, *Steindachner.* Kashmere (10,000 feet). T. C. Jerdon, Esq.
*Zamenis spinalis, *Ptrs.* North China or Japan. A. Adams, Esq.
*Tretanorhinus nigroluteus, *Cope.* Panama. Zoolog. Society.
Helicops Brandtii, *Rnhrdt.* Brazil. Prof. Reinhardt.
Leptognathus pavoninus, *Cuv.* Surinam, Berbice, W. Ecuador.
*Elaps multifasciatus, *Jan.* Nicaragua and Bogota. Purchased.
Atheris chloroëchis, *Schleg.* Lagos. Purchased.

II. *List of the new Species procured and described since June* 1868.

*Geophis mœstus, *Gthr.* Costa Rica. Purchased.
*Opisthotropis ater, *Gthr.* West Africa. Purchased.
*Leptocalamus torquatus, *Gthr.* "South America." Mr. Cuming.
*Microdromus virgatus, *Gthr.* Costa Rica. Purchased.
*Ablabes gracilis, *Gthr.* Costa Rica. Purchased.
*Coronella pœcilolæmus, *Gthr.* Upper Amazons. Mr. Bartlett.
*Tachymenis bitorquata, *Gthr.* Peruv. Amazons. Mr. Bartlett.
*Simotes formosanus, *Gthr.* Formosa. R. Swinhoe, Esq.
*Zamenophis australis, *Gthr.* Cape York. Purchased.
*Zamenis ater, *Gthr.* Algeria. J. Brenchley, Esq.
*Dromicus madagascariensis, *Gthr.* Madagascar. Purchased.
*Herpetodryas tetratænia, *Gthr.* Bogota. Purchased.
*Diplotropis bilineata, *Gthr.* Costa Rica. O. Salvin, Esq.
*Hapsidophrys niger, *Gthr.* Gaboon. Purchased.
*Phylodryas psammophideus, *Gthr.* Tucuman. Purchased.
*Dendrophis salomonis, *Gthr.* Solomon Islands. G. Krefft, Esq.
Dendrophis caudolineolatus, *Gthr.* Ceylon. R. H. Barnes, Esq.
*Ahætulla diplotropis, *Gthr.* Tehuantepec. M. Boucard.
*Ahætulla modesta, *Gthr.* Rio Chisoy. O. Salvin, Esq.
*Ahætulla lagoensis, *Gthr.* Lagos. Purchased.
*Chrysopelea vicina, *Gthr.* Island of Misol. Purchased.
*Hydræthiops melanogaster, *Gthr.* Gaboon. Purchased.
Psammophis Leithii, *Gthr.* Sindh. Dr. A. H. Leith.
*Leptognathus annulatus, *Gthr.* Costa Rica. Purchased.
*Leptognathus Copei, *Gthr.* Surinam? Dr. van Lidth de Jeude.
*Leptognathus dimidiatus, *Gthr.* Mexico. Purchased.
*Leptodira semiannulata, *Gthr.* Loanda. Purchased.
*Leptodira rhombifera, *Gthr.* Rio Chisoy. O. Salvin, Esq.
Dipsas Barnesii, *Gthr.* Ceylon. R. H. Barnes, Esq.
*Dipsas approximans, *Gthr.* Upper Amazons. Mr. Bartlett.
*Hydrophis Holdsworthii, *Gthr.* Western Ceylon. E. W. H. Holdsworth, Esq.
*Rhinelaps fasciolatus, *Gthr.* West Australia. Mr. Duboulay.
*Diemenia Schlegelii, *Gthr.* Island of Misol. Purchased.

*Cacophis modestus, *Gthr.* West Australia. Mr. Duboulay.
*Pseudonaja affinis, *Gthr.* Australia. G. Krefft, Esq.
*Atractaspis micropholis, *Gthr.* Africa. St. G. Mivart, Esq.

Geophis latifrons.

Günth. Ann. & Mag. Nat. Hist. 1868, i. p. 415.

A variety of this species from the Upper Amazon is black, the trunk being encircled by about 52 narrow, nearly equidistant, white rings. The rings are only one or two scales broad, the narrower and broader being alternately arranged. Tail coloured as the trunk. The white occipital band of the typical specimen is also present in this variety, but is limited to the side of the head, and does not extend across the occipitals. Abdomen with large irregular black cross bands. Ventral shields 148.

A second variety has 11 pairs of black rings on the trunk, the rings of each pair being separated only by a narrow white line. The interspaces of the ground-colour are much wider than the rings. Ventrals 145. Upper Amazons.

Geophis lineatus, D. & B.

= *Rhabdosoma trivirgatum*, Jan, and = *Rhabdosoma punctovittatum*, Jan.

Specimens from Trinidad have been presented by L. Guppy, Esq.

Geophis mœstus.

Head rather broad, short and depressed; body and tail of moderate length. Eye small. Anterior frontals about one eighth the size of posterior. Vertical as broad as long, six-sided, with the anterior angle rather obtuse, and with the posterior somewhat pointed; its lateral edges are very short, convergent. Occipitals rounded behind, shorter than the vertical and postfrontals together. Six upper labials, the third and fourth entering the orbit; the fifth is the largest, and forms a suture with the occipital; an elongate temporal behind this suture. One postocular. The first pair of lower labials form a suture together; anterior chin-shields not quite twice as large as posterior. Scales in fifteen rows, smooth. Ventrals 148; anal entire; subcaudals 41. Coloration very similar to that of *Homalocranium mœstum*—viz. entirely black, with a broad white collar, nearly entirely occupying the occipitals and temple. Lower parts blackish.

One specimen from the elevated parts of Costa Rica, near Cartago. Total length 6½ inches; tail 1 inch.

Catostoma chalybœum (Wagl.).

A variety of this species, from the elevated country of Costa Rica near Cartago, has a series of large, subquadrangular, white spots along each side of the body. Sometimes the spots of both sides are confluent and form white cross bars. Ventrals 144. In specimens of a uniform black coloration, from Mexico, I count 130 ventral shields.

OPISTHOTROPIS (g. n. Calamarid.).

Body and tail moderately slender, posteriorly somewhat compressed; head rather narrow, not distinct from neck. A pair of anterior frontals; a single postfrontal, which is very broad. Rostral rounded. Nostrils between two nasals, directed upwards. One loreal; one ante-, two postoculars. Eye small. Scales smooth anteriorly, with faint keels towards the middle of the body, and strongly keeled behind and on the tail, in 17 rows. Anal and subcaudals double. Maxillary teeth equal in length, densely set, none grooved.

West Africa.

Opisthotropis ater. Pl. III. fig. B.

The upward direction of the nostrils reminds us in some measure of the *Homalopsidæ*; but the pholidosis is that of a Calamaroid snake. Rostral broad and low; anterior frontals about as long as broad; postfrontal thrice as broad as long, with an obtuse angle in front, but with the fronto-vertical suture straight. Vertical triangular, occupying nearly the entire width of the upper surface of the head, as broad as long. Occipitals nearly twice as long as broad, obtusely rounded behind. The nostril is small, in the upper part of the suture between the two nasals; loreal large, subquadrangular. The præorbital reaches to the upper surface of the head, but not to the vertical; the upper postocular larger than the lower. Seven labials, the fifth of which only enters the orbit; the seventh very long, as long as the single temporal shield above it. Ventrals 170; subcaudals 65. Upper parts brownish black, lighter towards and on the abdomen. Length of the head $\frac{1}{3}$ inch, of trunk 10 inches, of tail 3 inches.

West Africa.

LEPTOCALAMUS (g. n. Calamarid.).

Body and tail slender, subcylindrical; head narrow, not distinct from neck. Two pairs of frontals. Rostral rounded. Nostrils small, between two nasals. Loreal united with præocular; two postoculars. Eye small. Scales smooth, in 17 rows. Anal and subcaudals double. The posterior maxillary tooth (1—3) is large, trenchant, not grooved, separated from the others by a small interspace.

South America.

Leptocalamus torquatus. Pl. III. fig. A.

This snake might be taken at the first glance for an *Elapomorphus*, from which it is distinguished by the number of scales and the dentition. Rostral broad and low; posterior frontals about thrice the size of the anterior; vertical quadrangular, with a very obtuse angle in front, and with a right one behind; it occupies nearly the entire width of the upper surface of the head. Occipitals considerably longer than broad. obtusely rounded behind. The præocular is nearly as long as the two nasals together; two small postoculars. Seven upper labials, the third and fourth entering the orbit. Temporals 1 + 2. Ventrals 183; subcaudals $53+x$. Reddish-olive above, with a very indistinct darker vertebral line; lower parts uniform white; a broad white collar across the posterior half of the occipitals and first rows of scales.

Length of the head $\frac{1}{4}$ inch, of trunk $9\frac{1}{2}$ inches, of tail (mutilated) 3 inches.

One specimen, purchased of Mr. Cuming, said to be from "South America."

MICRODROMUS (g. n. Calamarid.).

Physiognomy and habit as in *Elapomorphus* and *Homalocranium*. Head small, depressed, not distinct from neck. Eye rather small. Upper shields of the head normal. Loreal none, replaced by the conjunction of the nasal, posterior frontal, and præocular. Nasal simple. Scales smooth, without apical groove, in fifteen rows. Anal and subcaudals double. The last maxillary tooth is the largest, separated from the others by an interspace, and smooth.

Central America.

Microdromus virgatus. Plate IV. fig. B.

Rostral shield just reaching to the upper surface of the snout; anterior frontals scarcely half the size of posterior, narrow; vertical five-sided, longer than broad; occipitals as long as the vertical and frontals together, rounded behind. One ante-, two postoculars. Seven upper labials, the third and fourth entering the orbit, the hindmost the largest. Temporals 1 + 1. The first pair of lower labials not in contact with each other. Anterior chin-shields much larger than the scale-like posterior. Ventrals 180; subcaudals 71. Upper parts greyish, with a white collar; a pair of brown bands edged with black, and two scales broad, run along the back from the collar to about the middle of the tail. A similar band along each side of the body, and sometimes a narrow blackish line along each edge of the abdomen. Lower parts uniform white. Upper labials white, with a black spot below the eye and on the rostral shield.

This snake does not appear to be uncommon in the elevated country of Costa Rica, near Cartago.

Total length 12½ inches, tail 3 inches.

Streptophorus Sebæ (D. & B.).

Having seen numerous examples of this snake collected at Cartago in Costa Rica, I regard the *Str. maculatus* of Peters (Berlin. Monatsber. 1861, p. 924), likewise from Costa Rica, as a variety. Specimens with or without spots on the abdomen, with or without black on the head and neck, occur in the same locality, the ornamental colours being subject to great individual variation.

Ablabes gracilis. Pl. III. fig. D.

Body and tail slender, subcylindrical; head narrow, not distinct from neck. A pair of narrow anterior frontals; posterior frontals confluent into one large shield. Rostral rounded. Nostrils small, between two nasals. One loreal; one anteocular and one postocular. Eye small. Scales smooth, with a single apical groove, in fifteen series. Anal and subcaudals double. The posterior maxillary teeth become gradually larger, and are smooth. Rostral shield very broad and low; anterior frontals narrow, nearly the entire upper surface of the snout being occupied by the single posterior frontal. Vertical broad and long, five-sided, with the posterior angle produced and pointed; occipitals as long as the vertical and posterior frontal together. Nasal shields small; loreal longer than deep; præocular narrow, not extending to the upper surface of the snout. Seven upper labials, the third and fourth entering the orbit. Temporals 1+1+2. The first pair of lower labials form a suture together; two pairs of chin-shields, subequal in size. Ventrals 149; subcaudals 69. Upper parts nearly uniform blackish brown, the anterior and lateral scales somewhat lighter in the centre. An indistinct narrow brownish collar. Lower parts yellowish.

One specimen from the elevated country of Costa Rica, near Cartago. Total length 12 inches, tail 3 inches.

Coronella pœcilolœmus.

This species resembles externally *Liophis reginæ* and *L. tæniurus*; but the dentition is syncranterian, the three or four posterior teeth gradually increasing in length. The head is rather narrow and elongate. The anterior frontals two-thirds the size of posterior; vertical narrow and elongate, but shorter than the occipitals, which are rounded behind. Loreal as high as long; one anteocular, not reaching the vertical; two postoculars. Eight upper labials, the fourth and fifth below the orbit. Temporals 1+2, the foremost very elongate. Six lower labials are in contact with the chin-shields. Scales in seventeen series, without pores. Ventrals 159; anal divided; subcaudals 67. Upper parts nearly uniform blackish; a faint reddish-brown streak along each side of the back of the tail and hind part of the trunk, bordered below by an indistinct blackish streak. Lower parts white chequered with black, the black spots being less numerous on the posterior part of the trunk, and disappearing entirely on the subcaudals; they are more numerous and confluent on the anterior half of the abdomen, the lower side of the head being yellowish with rounded black spots. A yellow band along the upper labials, continued on the side of the throat.

Two specimens were collected by Mr. Bartlett on the Upper Amazons. Total length 15½ inches, tail 3½ inches.

Liophis purpurans.

Ablabes purpurans, D. & B. p. 312.
Diadophis purpurans, Jan, Iconogr. livr. 15, pl. 5. fig. 5.

This snake is very closely allied to *L. cobella*, *Merremii*, &c., with regard to its general habit, pholidosis, and coloration. I would also describe the dentition rather as diacranterian than as isodont, the two posterior teeth being decidedly larger than the preceding, and separated from them by a slight yet conspicuous interspace.

Tachymenis bitorquata.

Rostral low, scarcely extending to the upper surface of the head; anterior frontals transverse, one fourth the size of posterior; vertical very broad, subtriangular, scarcely longer than broad, and somewhat shorter than the occipitals, which are obtusely rounded behind. Nostril between two nasals; loreal large; *præorbital single, widening above, and in contact with the vertical*; two postoculars. Eight upper labials, the fourth and fifth entering the orbit. Temporals 2+3. Scales in oblique rows, in nineteen series. Ventrals 195; anal entire; subcaudals 97. Each scale yellow, with a black margin;

upperside of the head black; neck with two black collars on a yellowish ground. Lower parts uniform yellowish.

A single specimen is 9½ inches long, of which the tail is 1¾ inch; it was obtained by Mr. Bartlett on the Peruvian Amazons.

Tachymenis piceivittis.

Coniophanes piceivittis, Cope, Proc. Am. Phil. Soc. 1869 (July), p. 149.
Tachymenis tæniata, Peters, Berl. Monatsber. 1869 (Decemb.), p. 876.

One specimen from Tehuantepec, purchased of M. Boucard.

Simotes formosanus.

Scales in nineteen rows. Ventrals 164; anal entire; subcaudals 54. Two præoculars, the superior of which is the larger; two postoculars. Seven upper labials, the third and fourth entering the orbit. Posterior chin-shields only half the size of the anterior. Light brownish; many scales with a black edge, these black edges forming a great number of reticulated transverse lines extending across the back and sides. Lower parts uniform yellow; a rather indistinct whitish line along each edge of the abdomen.

Mr. Swinhoe has obtained one example at Takou, Formosa. It is 22 inches long; tail 4½ inches.

Spilotes fasciatus.

Peters, Monatsber. Berl. Akad. 1869, p. 443.

Scales in twenty-three or twenty-four series, those on the back keeled. Ventrals and subcaudals 193 + 125, or 200 + 125, or 207 + 120; anal entire. Eye large. Vertical bell-shaped, with converging outer margins; occipitals not much longer than vertical. *The single præocular is either in contact with the vertical or very nearly reaches it.* Two postoculars. Eight upper labials, of which the fourth, fifth, and sixth enter the orbit; the eighth is very long, as long as the three preceding together. Loreal scarcely longer than deep. Temporals 2 + 2 + 2, or $\frac{3}{2}$. Scales elongate and much imbricate, Upper parts uniform brown in the adult; lower parts yellowish; towards the middle of the trunk the ventral shields become more and more mottled with brown; and further behind the lower parts are of the same dark colour as the upper. A young specimen is more greyish, finely mottled and clouded with brown.

Of this beautiful species we have three examples, one without locality; the second (young) is from Surinam, and the third (adult) from the Peruvian Amazons. The first is 57 inches long, the tail being 17 inches; it has the dorsal scales provided with exceedingly strong keels, whilst the keels are rather slight in the two others.

This species is allied to *Sp. pœcilonotus*, which has the præocular separated from the vertical by a considerable interspace.

Zamenophis (g. n. Colubrin.).

Body rather elongate, with angular abdomen; back flat; tail of moderate length; ventral shields 200 or more in number, obtusely keeled on the sides; head flat; eye of moderate size, with round pupil. Shields of the head normal; two præoculars. Scales smooth, in seventeen series, without pores. Anal entire; subcaudals two-rowed. The last maxillary tooth or teeth larger than, and separated by a very short interspace from the others.

North Australia.

This is a new addition to the small number of innocuous snakes of Australia. It cannot be placed among the Coronelline forms having a distinctly compressed abdomen with angular ventral shields. Among the Colubrina it approaches most nearly to *Zamenis*, as far as technical characters are concerned. But its physiognomy is very different; and the true *Zamenis* having its geographical limits so well defined, I have availed myself of the (technical) character of the entire anal shield for distinguishing this Australian snake as a new generic type.

Zamenophis australis.

Head flat, as in *Coronella*. The rostral is rounded, with the posterior angle extending on the upper surface of the head and entering between the two frontals. Anterior frontals about one third the size of posterior. Vertical pentagonal, with the lateral margins nearly parallel, and with a right angle behind, longer than broad. Occipitals narrower and rounded behind, as long as the vertical and posterior frontals together. Nostril open in the anterior nasal; loreal as large as inferior præocular; the upper præocular does not reach the vertical; two postoculars; nine upper labials, the fourth and fifth entering the orbit. Temporal shields in two longitudinal series: two elongate ones in the upper series, and three shorter ones in the lower. Two pairs of chin-shields equal in size. Scales short, polished. Ventrals 204; subcaudals 79. Upper parts uniform brownish black; lateral scales with the apex of a lighter colour; lower parts uniform brownish yellow, each ventral with a brownish spot at the lateral corner.

Cape York. Total length 24 inches; tail 5½ inches.

Zamenis ater.

Scales in seventeen rows. Habit moderately slender; eye of moderate size; loreal region not concave; two anterior and two posterior oculars. Eight upper labials, the fourth and fifth of which enter the orbit. The upper præocular not reaching the vertical. Temporals 1 + 2, the anterior long. Ventrals 142; anal double; subcaudals 60. Upper parts uniform deep black; abdomen whitish.

Three specimens, presented by J. Brenchley, Esq., are said to be from Biscra (Algeria); the largest is 26 inches long, the tail being 6 inches.

Zamenis spinalis.

Masticophis spinalis, Peters, MB. Ak. Wiss. Berlin, 1868, p. 91.

A fine specimen of this snake was contained in a collection made by Mr. A. Adams in various parts of the Chino-Japanese Region. Unfortunately no record of the exact locality where it was obtained is preserved; but so much appears to be probable, that the statement of the dealer of whom the specimen in the Berlin Museum was purchased (viz. that it came from Mexico) is not correct.

Dromicus madagascariensis. Pl. V. fig. A.

Scales in nineteen rows, smooth, without apical groove. Loreal square; one anteocular extending to the upper surface of the head, but not reaching the vertical; two postoculars. Eight upper labials, the fourth and fifth entering the orbit. Temporals 1 + 2. Ventrals 168, without keel; anal bifid; subcaudals 95. Upper parts black; on each side of the back, along the fourth and adjoining halves of the third and fifth outer series of scales, a yellowish band, which commences on the side of the neck and is continued to the extremity of the tail. The second and adjoining halves of the first and third outer series are blackish, forming a stripe which passes into a black lateral band of the tail. Abdomen whitish, anterior ventral scutes with a black spot *at the suture with the scales.* The posterior maxillary tooth is considerably larger than, but scarcely separated by an interspace from, the preceding teeth. In one specimen the frontal shields are confluent into a single pair.

Two specimens from Madagascar, purchased on distinct occasions. The larger is 22 inches long. At the first glance this species may be taken for *Herpetodryas Bernieri.*

Herpetodryas occipitalis.

Günth. Ann. & Mag. Nat. Hist. 1868, i. p. 420.

The example from which I described this species was young, and showed a varied coloration, like many other species of this genus in their young state. The adult (3 or 4 feet long) is of a uniform dull greenish-olive coloration, this colour extending over the outer fourth of the ventral shields. Middle of the ventrals uniform yellowish.

Herpetodryas tetratænia.

Scales in seventeen rows, all keeled, with the exception of the outermost. Ventrals 150, not keeled; anal bifid; subcaudals 127. Head moderate; eye rather large. Rostral just reaching the upper surface of the head; anterior frontals obtusely rounded in front, about half the size of posterior. Vertical as long as the snout, but shorter than the occipitals, which are subtruncate behind. Loreal as high as long; anteocular extending to the upper surface of the head, but not reaching the vertical; two narrow postoculars. Nine upper labials, the fourth, fifth, and sixth of which enter the orbit. Body greenish olive, with four black longitudinal bands: the bands of the *dorsal* pair occupy three series of scales outwards of the vertebral series; they commence behind the neck as a double series of spots, which are soon confluent; the scales composing its anterior half are black with a narrow white margin, and entirely black posteriorly; on the tail the two bands are confluent into a single band. The lateral band is narrower, occupying the meeting edges of the second and third outer series; it commences as a linear, subinterrupted, zigzag tract in the anterior half of the trunk, but soon becomes broader, and is continued to the end of the tail. Upper parts of the head and neck uniform greenish olive; a broad black band along the side of the head, through the eye. The colour of the side extends for some distance on the ventral shields, which have anteriorly a black transverse margin, interrupted in the middle.

One specimen from Bogota, purchased. Entire length 30 inches, tail 12 inches.

Philodryas psammophideus. Pl. IV. fig. A.

Habit slender; head narrow; eye of moderate size, with round pupil. Rostral shield as high as broad, reaching to the upper surface of the snout; anterior frontals two thirds the size of posterior. Vertical narrow, much longer than the snout, and as long as the occipitals. Loreal region not grooved; loreal shield longer than deep; anteocular extending on the upper surface of the head, but not reaching the vertical. Two postoculars. Eight upper labials, of which the third, fourth, and fifth enter the orbit. Temporals 1 + 2 + 2. Scales smooth, in nineteen rows, without pores. Ventrals 201; anal divided; subcaudals 92. Posterior maxillary tooth longest, grooved; anterior mandibulary teeth longer than the succeeding.

The coloration of this snake resembles that of a *Psammophis* or *Ragerrhis.* The ground-colour is a reddish olive; a darker band, three scales broad, runs from the occipitals along the vertebral line, and is bordered on each side by a series of black specks. A brown band through the eye to the side of the neck, where it becomes indistinct and is continued in the form of two or three darker lines. Lower parts yellow, with a series of black dots along each side of the abdomen. Upper labials yellow, the sixth with a black spot.

One specimen from Tucuman; it is 27 inches long, tail 7 inches.

DIPLOTROPIS (g. n. Dryadin.).

Body and tail slender; trunk with about 150 ventral shields, which show only very faint lateral keels. Head somewhat elongate, rounded in front, flat above; eye rather large, with round pupil; nostril between two shields. Shields of the head regular; loreal present; one anterior and two posterior oculars. Scales in fifteen series, on the anterior half of the back elongate, lanceolate, on the posterior rhombic; many with a single apical pore; *they are smooth, with the exception of those forming the series next to the vertebral series; these are provided with a strong keel, the keels forming a pair of raised lines along the middle of the back.* Anal bifid. The maxillary teeth become gradually stronger posteriorly; none are grooved.

Diplotropis bilineata. Pl. VI. fig. B.

Snout rather depressed. Rostral not extending on the upper surface of the head; anterior frontals obtusely rounded, not much smaller than posterior. Vertical nearly as long as the snout and as the occipitals, which are rounded behind. Loreal considerably longer than deep; anteocular extending to the upper surface of the head, but not reaching the vertical; two narrow postoculars. Labials eight, low, the fourth and fifth entering the orbit. Temporals 1 + 2. Ventrals 144. Green; the raised keels are black, forming a pair of black dorsal lines, which are indistinct on the foremost part of the body, and disappear on the tail. A very indistinct blackish horizontal streak behind the eye. Lower parts uniform light greenish.

One example was obtained by one of Mr. Salvin's collectors in Costa Rica. It has lost a considerable portion of the tail, the head and body being 29 inches long.

Hapsidophrys niger.

Similar in habit and form of the head to *H. cœruleus.* Scales keeled, much imbricate, thin and loose, in thirteen series, those of the outermost series much smaller and shorter than the others. One anterior, three posterior oculars, the latter very narrow. Eight upper labials, the fourth and fifth entering the orbit. Temporals 1+1. Ventrals 203, not keeled on the sides; anal bifid; subcaudals 140. Uniform black, except the lower jaw, which is of a smutty brown.

Gaboon. One specimen, 61 inches long, the tail being 17 inches.

Dendrophis salomonis.

Allied to *D. calligastra* and *striolata.* Scales in thirteen rows. Loreal present, sometimes confluent with the posterior frontal. Eight upper labials, the fourth and fifth entering the orbit. One præocular, not extending to the vertical; two postoculars; temporals 1 + 2 + 2. Ventrals 193 or 194, strongly keeled; subcaudals 130. Scales with a single apical pore; vertebral scales large. Yellowish, with iridescent reflexions. The membrane between the scales is black; many scales with an elongate white spot on the outer margin. A blackish ill-defined band from the nostril along the side of the head and neck. Lower parts uniform yellow, with a dark central line along the abdomen.

Solomon Islands. The larger of two examples is 32 inches long, tail 12½ inches.

Ahætulla diplotropis. Pl. VI. fig. A.

Scales in fifteen rows, smooth, with the exception of those forming the two series nearest to the vertebral series; these scales are strongly keeled, the keels forming a continuous raised black line, as in the genus *Diplotropis.* Head as in *A. liocercus.* Rostral broader than deep; vertical bell-shaped, shorter than the occipitals, which are rounded behind. Loreal twice as long as deep; præocular not reaching the vertical; two postoculars. Eight upper labials, the fourth and fifth entering the orbit. Temporals 1+2. Eye of moderate size, with round pupil. Ventrals 178–181, with a very faint lateral keel; anal 1/1; subcaudals 140. The posterior maxillary tooth is much longer than, and separated by an interspace from, the preceding teeth. Green, with a yellow line along the vertebral series. A black band commences behind the eye and runs along the side of the fore part of the trunk; it is soon broken up into irregular spots, which soon disappear entirely. Lower parts uniform yellowish.

Three examples from Tehuantepec. Length 33 inches, tail 11 inches.

Ahætulla modesta. Pl. VI. fig. C.

Scales in fifteen rows, very strongly keeled, except those in the outermost series. Ventrals 171; anal bifid; subcaudals 171. Snout depressed, not pointed. Rostral shield just reaching to the upper surface of the crown; anterior frontals subtruncated in front, about half the size of posterior. Vertical not much longer than broad, rather shorter than the snout or than the occipitals, which are truncated behind. Loreal longer than deep. Anteocular extending to the upper surface of the crown, but not reaching the vertical; two small and short postoculars. Eight upper labials, the fourth and fifth of which enter the orbit. Temporals $1+\frac{1}{1.1}$. Eye rather smaller than in the other species of this genus. Uniform greenish-olive above, light green below. A narrow black band from the eye along the suture between the labials and temporals.

One specimen was obtained by one of Mr. Salvin's collectors on the banks of the Rio Chisoy, below the town of Cubulco; it is 52 inches long, the tail being 22 inches.

Ahætulla lagoensis.

Ventral shields with distinct lateral keels, 163; anal bifid; subcaudals 150. Nine upper labials, the fourth, fifth, and sixth entering the orbit. Loreal twice as long as deep. One præocular, not reaching the vertical, two postoculars. Five lower labials are in contact with the chin-shields. Temporals 1+2. Scales with minute striæ, in fifteen series. Dentition syncranterian. Uniform green; scales without white spots.

One specimen from Lagos, purchased. Total length 35 inches; tail 13 inches.

Ahætulla heterolepidota.

Günth. Ann. & Mag. Nat. Hist. 1863, xi. p. 286.

We have received this species in two different collections made at Lagos.

Chrysopelea vicina.

Scales in seventeen rows, those on the back keeled. All the scales conspicuously shorter and less imbricate than in *Chr. rhodopleuron*, to which this species is nearly allied. Ventrals 221; subcaudals 146. Rostral shield not twice as broad as deep. Præocular in contact with the vertical. Temporals 2+2+2. Uniform brownish olive; greenish olive after the loss of the epidermis; lower parts uniform olive.

One specimen from the island of Misol. Total length 44 inches, the tail being 13 inches long.

This is not merely a local variety, as we have received the true *Chrysopelea rhodopleuron* from the same locality. By the characters given, the new species will be readily recognized.

Tropidonotus ferox.

Günth. Ann. & Mag. Nat. Hist. November 1863.

Mr. Cope (Proc. Ac. Philad. 1868, p. 309) places this as a synonym of *T. mortuarius* (Schleg.). The history of the latter name is shortly as follows:—

1. The name was originally given by Daudin (Hist. Nat. Rept. vol. vii. p. 187) to an Indian snake figured by Russell on pl. 28 and described on p. 33. This snake is a dark variety of *Tropidonotus quincunciatus*; and therefore *Coluber mortuarius* of Daudin is a synonym of this Indian species.

2. Kuhl (Beitr. z. Zool. p. 96) misapplied the name to an example in his collection, quoting Russell, but not Daudin, and apparently ignorant of the locality where his example was obtained.

3. Schlegel (Essai, p. 330) having received the example mentioned by Kuhl and misnamed by him "*Coluber mortuarius*," adopts this erroneous nomenclature, adding to the confusion by giving incorrect references to the works of Russell and Daudin. However, he describes Kuhl's specimen in a perfectly lucid manner*.

It is now evident that the specimen from Kuhl's collection is identical with the West-African species to which I first gave a distinct name, viz. *Tropidonotus ferox.*

Tretanorhinus nigroluteus.

Tretanorhinus nigroluteus, Cope, Proc. Ac. Nat. Sc. Philad. 1861, p. 298.
Helicops Agassizii, Jan, Iconogr. livr. xxviii. pl. 2. fig. 1.

(Nicaragua), Panama; purchased of the Zoological Society of London. Abdomen and two outer series of scales bright

* The species is figured by Jan under the same name, livr. xxviii. pl. 1. fig. 2.

scarlet during life. Ventrals 151 (136); anal 1/1; subcaudals 68.

Hydræthiops (g. n. Natric. vel Homalops.).

Body stout, cylindrical; form of the head as in *Homalopsis.* A single anterior and two posterior frontals. *Nostrils on the upper surface of the snout,* narrow slits between two nasals. Scales keeled, short, in twenty-three series; anal and subcaudals divided. Loreal present. Maxillary teeth in an uninterrupted series, slightly increasing in length posteriorly, numerous and closely set; none grooved.

This is another form intermediate between the *Natricidæ* and *Homalopsidæ.* Having entirely the physiognomy of the latter, it differs by its dentition. From *Atretium* and *Limnophis* it is distinguished by the position and form of the nostrils, from *Tretanorhinus* and *Neusterophis* by the single anterior frontal.

Hydræthiops melanogaster. Pl. III. fig. G.

The single anterior frontal is an isosceles triangle, touching the rostral; posterior frontals small, but rather larger than the anterior. Vertical not twice as long as broad, with parallel outer edges, and with a right angle behind; occipitals as long as the vertical and posterior frontals together, rounded behind. Loreal large, longer than deep, with the lower posterior angle rather produced. One præocular, extending to the upper surface of the head, but not reaching the vertical. Two postoculars, the lower of which is small. Nine or ten (eleven) upper labials, the fourth and fifth or the fifth and sixth entering the orbit. Temporals 1 + 2 + 3, the anterior in contact with the upper postocular. Chin-shields two pairs, the anterior longer than, and produced between, the posterior. Cleft of the mouth bent upwards behind; a groove behind the eye between the labials and temporals. Eye small. Ventrals 153; anal 1/1; subcaudals 43. Upper and lower parts of a uniform shining black; a reddish or yellowish band runs along the side of the head and trunk, along the three or two outer series of scales, becoming narrower behind.

Gaboon.

The largest of four examples is 24 inches long, tail 4 inches.

West Africa appears to be much richer in freshwater snakes than was formerly believed. We now know

1. *Tropidonotus ferox,* from Fernando Po.
2. *Neusterophis lævissima* (exact locality unknown).
3. *Limnophis bicolor,* from Angola.
4. *Hydræthiops melanogaster,* from the Gaboon.

Euophrys modestus (Gthr.).

Specimens of this snake have been obtained from Paraguay and Buenos Ayres. It is not a Chinese species.

LEPTOGNATHUS.

The snakes of this genus feed chiefly on slugs, like the Indian species of the family of *Amblycephalidæ.*

Mr. Cope has given a very lucid synopsis of the species of this genus (Proc. Philad. Acad. 1868, p. 107), by which their determination is much facilitated. I think he has attached too great a value to the arrangement of the shields between the eye and nostril and the number of labial shields; but the limits of variation, which differ almost in every species, can only be ascertained by the examination of numerous examples.

Leptognathus Mikanii (Schleg.).

The British Museum possesses several examples from Western Ecuador, one of which agrees perfectly with *Leptognathus oreas* of Mr. Cope (Proc. Philad. Acad. 1868, pp. 108, 109), whilst the others lead up (with regard to pholidosis) to the typical eastern form. All these western specimens, however, have the abdomen extensively mottled and chequered with black. None of the other structural characters which were supposed to be distinctive being constant, I refer these specimens, with *L. oreas*, to *L. Mikanii*. One of our Ecuador specimens approaches a prettily coloured variety from Tehuantepec, from which the following notes are taken.

Posterior frontals large, not entering the orbit. Vertical as broad as long, with an obtuse angle behind. Loreal entering the orbit; another well-developed anteocular above it; two postoculars. Eight upper labials, the fourth and fifth entering the orbit. Temporals 2+3(2)+3. Three pairs of chin-shields subequal in size, as broad as long; a pair of lower labials form a suture together in front of the chin-shields. Ventrals 188; anal entire; subcaudals ca. 85. Yellowish, with numerous narrow black cross bands, 44 on the trunk and 23 on the tail, as broad as the interspaces of the ground-colour; each more or less completely divided into two by a yellow transverse line, which is broader within the anterior black bands than within the posterior. The bands do not extend on the belly, which is chequered with black. Upper parts of the head black, finely mottled with yellow.

The specimen is 12 inches long, tail 3 inches.

Leptognathus annulatus.

Scales smooth, in fifteen rows, the vertebral scales being enlarged, hexagonal. Habit slender; neck very thin; head broad and short. Eye of moderate size, with vertical pupil. Anterior frontals short and small; posterior frontals large, extending down on the sides of the snout, and forming the antero-superior part of the orbit. Vertical with nearly parallel outer edges, and with a right angle behind, shorter than the occipitals. Loreal broadly entering the orbit; a small separate præocular below. Two postoculars. Seven or eight upper labials, the fourth and fifth or the fifth and sixth entering the orbit. Temporals 1+2+3. The first pair of lower labials not in contact with each other. Four pairs of chin-shields, the anterior pair the smallest, the second the largest, much longer than broad. Ventrals 164; anal entire; subcaudals 113. Upper parts light brownish powdered with darker, lower yellowish mottled with brown. Body and tail encircled by black rings, which are shorter than the head, but wider than the interspaces; there are about forty of these rings on the trunk. Head irregularly spotted with brown.

One specimen from the elevated country of Costa Rica, near Cartago. Total length $17\frac{1}{2}$, tail 6 inches.

Leptognathus Copei.

Scales smooth, in fifteen rows, those of the vertebral series scarcely twice as large as those of the adjoining series. Habit very slender and compressed; neck exceedingly thin; head very short and thick; eye large. One loreal, higher than long; two narrow præ- and two postoculars. Ten or eleven upper labials, the fourth, fifth, sixth, and seventh, or the fifth, sixth, and seventh, entering the orbit. Ten lower labials, the first pair in contact with each other. Three pairs of chin-shields, the anterior of which is the largest, but not much longer than broad. Temporals 1+2. Ventrals 218; anal entire; subcaudals ca. 140. Ground-colour light reddish grey, with fifteen large rounded brown spots, each with a black and yellow margin; the anterior extend round the whole trunk; the following are interrupted along the median line of the abdomen, and the middle and posterior also along the vertebral line, so that each forms a pair of large rounded lateral spots. Each interspace of the ground-colour with a small, ovate, lateral brown spot, at least in the posterior half of the body. Snout white; forehead and crown of the head dark brown, this colour forming a ring round the head, below the eye, and across the chin. A large round white spot on each side of the occipital region.

A male was obtained from the collection of the late Dr. van Lidth de Jeude; it is probably from Surinam, and is 26½ inches long, the tail being 9 inches.

Leptognathus dimidiatus.

Scales smooth, in fifteen rows, those of the vertebral series not enlarged. Body much compressed, neck slender, head broad and short. Eye rather large, with vertical pupil. Anterior frontals short and small; posterior frontals large, extending down on the sides of the snout, and forming the antero-superior part of the orbit. Vertical with nearly parallel outer edges, and with a right angle behind, shorter than the occipitals. Loreal confluent with the single præocular; two postoculars. Eight upper labials, the fifth and sixth entering the orbit. Temporals 1+2+3. Three pairs of chin-shields, the anterior the largest, crescent-shaped, much longer than broad; the middle shorter, but still longer than broad; the posterior of about the same size as the middle, and divergent. An azygos scale-like shield between the front chin-shields and the minute median labial. The first pair of lower labials are not joined together by a suture, being separated by the azygos shield; the five following lower labials are in contact with the anterior chin-shields. Ventrals 186; anal entire; subcaudals 98. Body and tail with broad black rings separated by whitish interspaces much narrower than the rings; there are 25 black rings on the trunk and 16 on the tail. The white interspaces are again each subdivided by a narrow black transverse line. Upper parts of the head black, with small whitish spots irregularly placed; a pair of large whitish spots on the neck, forming a kind of collar. Anterior chin-shields black.

An adult female from Mexico (purchased) is 17 inches long, tail 5 inches.

Leptodira semiannulata.

Scales smooth, in nineteen series. Ventrals 227; anal entire; subcaudals $27+x$ (about one half of the tail is lost). Head broad and depressed. Anterior frontals very small; loreal rather longer than deep; anteocular single, not reaching the vertical; two postoculars. Eight upper labials, the third, fourth, and fifth entering the orbit. Temporals 2+3+3. Chin-shields very small. The posterior maxillary tooth long and grooved. Yellowish olive; back with about 32 brownish-black transverse spots or bands, rather irregular in shape, and separated by interspaces broader than the spots. The first band occupies the neck, the head being entirely immaculate. Lower parts whitish.

One specimen from Loanda, purchased; the snout has suffered considerably by bad preservation. Length without tail (which is mutilated) 24 inches.

Leptodira rhombifera.

Scales smooth, in twenty-five series. Ventrals 170; anal 1/1; subcaudals 75. Head rather broad and depressed; anterior frontals very small; anteocular reaching or nearly reaching the vertical; two postoculars. Loreal rather longer than deep. Eight upper labials, the fourth and fifth being below the eye. Temporals 1 + 2. Pupil of the eye vertical. The posterior maxillary tooth long and grooved. Brownish; trunk with about 26 large subrhombic dark-brown spots edged with black. Yellowish cross bands, brightest on the median line, separate these rhombic spots from one another. Upper part of the head brown, powdered with black. A black stripe with a yellowish margin on each side connects the crown of the head with the first rhombic spot. Abdomen yellowish; subcaudals powdered with brown.

One specimen was obtained on the banks of the Rio Chisoy, near the town of Cubulco, by one of Mr. Salvin's collectors. It is 23 inches long, tail 5 inches.

Dipsas approximans.

This snake may be taken at the first glance for a *Leptodira*, being in coloration similar to *L. annulata* and the species allied to it; but it is more slender than any species of that genus, though less so than a typical *Dipsas*.

Scales in nineteen rows, those of the vertebral series distinctly the largest, and especially on the hinder part of the body, where they are hexagonal; they are provided with a pore at the tip. Ventrals 190; anal divided; subcaudals 94. Form of the head and upper shields as in *L. annulata*. Loreal square; the single anteocular nearly reaches the vertical; two postoculars. Eight upper labial shields, the third, fourth, and fifth of which enter the orbit. Temporals 1 + 2 + 3. Eye of moderate size, with vertical pupil. Posterior maxillary grooved; of the anterior teeth, only those of the mandible are somewhat elongate. Brownish, with an undulated (zigzag) dark brown band along the back. Head dark brown, with an obscure streak from the eye towards the angle of the mouth. Lower parts uniform yellowish. Sometimes the ground-colour is so dark that the dorsal band is scarcely visible. A young specimen is whitish with the dorsal band black; head brownish above and the band on the temple very distinct.

Several specimens from the Upper Amazons (Chyavetas) were obtained by Mr. Bartlett. The largest is 31 inches long, tail 9 inches.

Hydrophis stricticollis, Gthr.

Several adult examples of this species have been obtained by Mr. Theobald, on the Bassien River, Pegu. The adult have the ventral plates developed in the entire length of the body, and the bands become very indistinct in the posterior half of the trunk.

Hydrophis Holdsworthii.

Allied to *H. pachycercus*. Head and body of moderate width and length; back very broad. Shields on the upper surface of the head regular. Two pairs of chin-shields, both of which are in contact with each other. Two or three postoculars. The third upper labial is not in contact with the nasal, but enters the orbit; the fourth labial below the orbit. The first upper temporal is longer than high. Scales not imbricate; each with a very prominent spine. Thirty-one series of scales round the neck, forty-five round the highest part of the body. Ventral shields 326 in number, with a pair of spinous tubercles, the anterior twice as broad as the scales of the adjoining series, the posterior less broad. Four præanal shields subequal in size. Body with thirty black bands across the back, extending but a short way down the sides; they are broadest in the middle, tapering on each side. An indistinct dark spot in the median line between the posterior cross bands. Tail with five similar cross bands.

A male example, 33 inches long, was captured by E. W. H. Holdsworth, Esq., on the Aripo Pearl-banks, on the western coast of Ceylon.

Brachyurophis semifasciata.

Günther, Ann. & Mag. Nat. Hist. 1863, xi. p. 21, pl. 3, and 1865, xv. p. 97.

We have recently received two other (young) examples from Perth, West Australia.

Rhinelaps (g. n. Elapid.).

Body stout, cylindrical, covered with short polished scales in seventeen series; tail short. Head not distinct from the neck, with the snout flat and trenchant. Eye small, with round pupil. Posterior frontal replacing the loreal, in contact with two labials; one anterior, two posterior oculars. Nasal subdivided by the nostril. Anal bifid; subcaudals two-rowed. The poison-tooth placed rather far backwards; no other teeth behind it.

It is with some reluctance that I propose a distinct generic name for this snake; but the dentition and the arrangement of the shields between the eye and nostril have hitherto been used as generic characters, and in one or the other of these two points *Rhinelaps* differs from the other Australian genera.

Rhinelaps fasciolatus. Pl. V. fig. B.

Rostral shield broad, depressed, trenchant in front, extending on the upper surface of the snout. The anterior frontals are only half as large as the posterior, which are in contact with the second and third labials. Vertical six-sided, as much produced in front as behind, as long as the occipitals, which are rounded behind. Nasal single, but nearly entirely divided into two by the nostril, which is subanterior. Anteocular large, in contact with, or nearly reaching, the vertical; two postoculars. Six upper labials, the first very small, the sixth not much larger than the fifth. Temporals 1+1. Ventrals 161; subcaudals 26. Body light reddish, with a great number of narrow, slightly undulated, brownish-black, transverse bars across the back; they are narrower than the interspaces between them, and nearly all are broken up into transverse series of spots. Head white, with a large black patch covering the interocular space and occipitals, and separated by a narrow interspace from a broad black collar, which, again, is followed by a narrower black cross bar. Lower parts uniform white.

One specimen was found by Mr. Duboulay at Perth, West Australia; it is $13\frac{1}{2}$ inches long, tail $1\frac{1}{3}$ inch.

Diemenia Mülleri (Schleg.).

Schlegel has evidently confounded two species under the name of *Elaps Mülleri*. He states that the two original examples were from S. Müller's collection made in New Guinea; and both are figured in 'Verh. Nat. Gesch. Nederl. overz. Bez. Rept.' pl. 9. figs. 1 & 2. The one (fig. 1) has 176 ventrals and 32 caudals, and the other (fig. 2) only 148 ventrals and 24 caudals. A third specimen, brought by Quoy and Gaimard from Rawak, had 166 ventrals and 36 caudals.

I am not able at present to form an opinion about the last example; but, having received specimens agreeing with those collected by Müller, I feel convinced that they are distinct.

I retain the name given by Schlegel for the species figured on pl. 9. fig. 1. The specimen in the British Museum is from North Ceram, and agrees in every respect with the figure referred to: it has 178 ventral shields and 34 subcaudals—numbers nearly identical with those of the typical example.

For the second species I propose the name of

Diemenia Schlegelii.

This is a conspicuously shorter species, having only (148, Schlegel,) 149 or 155 ventral shields, and (24, Schlegel,) 24 or 21 subcaudals. The shields of the head are very much the same as in the other species. Temporals 2+2+3, the lower of the first series being intercalated between the last two labials, and not in contact with the postoculars. Scales in fifteen rows. The lower parts are more or less dotted with brown; and the lateral bands of the head are indistinct, if present.

Of this species we have two examples from the island of Misol.

Cacophis modesta. Pl. III. fig. C.

Scales smooth, in seventeen series. Head of moderate width and length, not depressed. Rostral shield somewhat projecting (as in *Liophis conirostris*), higher than broad. Anterior frontals one third or one fourth the size of posterior. Vertical five-sided, much longer than broad; occipitals as long as vertical and postfrontals together, rounded behind. Nasal simple, pierced in the middle by the nostril, in contact with the single præocular. Two postoculars. Six upper labials, the sixth as long as the two preceding together. Temporals 1+2+3, the foremost in contact with the occipital, lower postocular, and two posterior labials. Eye of moderate size, with round pupil. Ventrals and subcaudals 154+48, 157+49, 165+42. Anal bifid. Upper parts uniform greenish olive, the lower whitish. In one specimen a darker collar, edged with yellowish in front and behind, is distinctly visible; this specimen has also greyish spots on the abdomen. Anteocular generally yellow.

This species has the appearance of a *Diemenia*, from which genus it differs by its pholidosis. We have obtained three examples from Western and North-western Australia; the largest is 16 inches long, the tail being 3 inches. One was obtained at Perth by Mr. Duboulay.

Pseudonaja affinis. Pl. IV. fig. C.

This snake is readily distinguished from *P. nuchalis* by a greater number of scales, which are arranged in *nineteen* series. The rostral shield is much produced backwards above, but less so than in its congener. Vertical, two thirds as broad as long. Nostril wide, the division of the nasal being indicated below the nostril only; one præ-, two postoculars. Six upper labials, the sixth the largest, as long as the fourth and fifth together. Temporals 1+2+3, the anterior the largest, the others scale-like. Ventrals 216; anal bifid; subcaudals ca. 70. Uniform brown above; a few scales, irregularly scattered, are black. Ventral shields yellowish, with a blackish margin.

The British Museum received one example from Mr. Krefft, without indication of the exact locality; it is 54 inches long, tail 9 inches.

Elaps multifasciatus (Jan).

I am not quite certain whether, by using this name, I have correctly determined two specimens—one from Nicaragua (Chontales), and the other from Bogota. Our specimens have only 239 ventral shields, whilst Jan states 278. One of the principal characters of our specimens is that the anteocular is in contact with the nasal; and, unfortunately, the figure given by Jan is so indistinctly drawn, that the arrangement of the shields of the snout cannot be made out.

Atractaspis corpulentus (Hallowell). Pl. III. fig. F.

Having recently received an *Atractaspis* from the Gaboon (that is, the locality where Hallowell's original specimen was obtained), I find that it agrees so well with Hallowell's description that I cannot entertain a doubt about its identification. I find at the same time that I was mistaken in referring a specimen noticed in Ann. & Mag. Nat. Hist. 1866, xviii. p. 29 to this species, and that that specimen belongs to another (sixth) species, which is not yet named. The characters of the true *A. corpulentus* are as follows:—

Black above, blackish below. Body stout. Ventrals 179 (–182, Hallowell); subcaudals (25, Hallowell, –)27. Scales in twenty-five series. Normally two pairs of frontals. One præ-, one postocular. Five upper labials, the third and fourth entering the orbit. Temporals 1+3, the anterior very large, in contact with the occipital, postocular, fourth and fifth labials. The first pair of lower labials in contact with each other; the pair of chin-shields following these labials form part of the labial margin; the succeeding lower labial rather shorter than the opposite third and fourth upper labials.

Atractaspis micropholis. Pl. III. fig. E.

Atractaspis corpulentus, Günth. in Ann. & Mag. Nat. Hist. 1866, xviii. p. 29, *nec* Hallowell.

Black above, lighter below. Body stout. Ventrals 210; subcaudals 29. Scales in twenty-five series. Two pairs of frontals. One præ- and one postocular. Six upper labials, the third and fourth of which enter the orbit, and are much larger than the anterior and posterior pairs. Temporals 1 or 2+3, all small, scale-like, the anterior in contact with the postocular, fourth and fifth labials, but not with the occipital. Lower labials small, the anterior in contact with each other in front of the chin-shields, which do not enter the labial margin.

The single specimen known is 13 inches long, the tail being one inch. It is not known from which part of Africa it was obtained.

III.—*A List of Species of the Genus* Planaxis, *with Descriptions of eleven new Species.* By Edgar A. Smith, Zoological Department, British Museum.

The genus *Planaxis* was founded by Lamarck in 1822, in the 'Hist. des Anim. sans Vert.' vol. vii. p. 50, to include a group of shells generally of a somewhat ovate-conical form, more or less transversely sulcated, and having for the generic character the columella provided with a callosity at the upper part, abruptly truncated at the base, and forming with the outer lip a small basal channel.

Only two species (which I now unite) were known to Lamarck; but since then the number has greatly increased, and now forty-four distinct forms have been described, and unfortunately several of them more than once by various authors under different names, as will be observed from the following list.

1. *Planaxis sulcatus.* B.M.

A dark fuscous-coloured species, sparingly dotted with squarish white spots, strongly spirally ribbed and lirate within the outer lip.

Buccinum sulcatum, Born, Mus. Vindob. p. 258, pl. 10. f. 5, 6.
Planaxis buccinoides, Deshayes, Anim. s. Vert. ed. 2, vol. ix. p. 237.

Var. *a.* Shell elongate, acuminate; spiral ribs ornamented with equal-sized black and white squarish spots.

Planaxis sulcata, Lamarck, *l. c.* p. 236.

Var. *b.* Shell shorter; black spots flowing into irregular longitudinal stripes.

Buccinum pyramidale, Gmelin, Syst. Nat. p. 3488.
Planaxis undulata, Lamarck, *l. c.* p. 236.

Hab. Australia, Philippines, Mauritius, S. Africa.

Born, in the Mus. Vindobon., first described and figured a species of *Planaxis* under the name of *Buccinum sulcatum*. Deshayes subsequently characterized the same species with the name *P. buccinoides* (Anim. s. Vert. ed. 2, vol. ix. p. 237), at the time quoting Born's figure.

Lamarck, in the Anim. s. Vert. vii. p. 51, described two species, *P. sulcata* and *P. undulata*.

I have carefully compared the figures he quotes as representing these species, and also those referred to by Deshayes in the second edition of the above work; and having also examined a numerous series of specimens, I can arrive at no other conclusions than these, viz.:—1, that his *P. sulcata* is a variety of Born's shell (*P. buccinoides*, Desh.) with an elongate acuminate spire, with the whorls ornamented with black and white squarish spots about equal in size; and, 2, that his *P. undulata* is a shorter, more obtuse form of the same species, with the dark spots flowing into one another, and thus forming irregular undulating longitudinal stripes.

2. *Planaxis encausticus.*

P. testa solida; spira brevis, valde erosa; anfr. 6?; ultimus magnus, ad peripheriam obtusatim angulatus, sordide albus, zonis duabus obscuris lurido-fuscis cinctus, altera supra, altera peripheriam infra, et infra suturam macularum nigrescentium serie ornatus, superficie partibus alteris irregulariter brunneo punctatus, transversim superne obsolete, basi validiore angustissime sulcatus, incrementi lineis obliquis striatus; apertura magna, spiram longe superans, testæ longitudinis $\frac{3}{5}$ æquans; columella leviter curvata, callo postico magno albo-brunneo; canalis basalis parum profundus; labrum margine integro, tenui, nigro-fuscum, superne medioque albo maculatum, intus pallidiore, 8- albido-liratum.

Long. 20 mill., diam. 12. Coll. Sylvanus Hanley.

Hab. Aracan (*Theobald*).

Of the form, solidity, and size of the short variety of *P. sulcatus*. It may be known by these peculiarities:—1, the smoothness of the body-whorl, which has the appearance of being overlaid with a thin white enamel; 2, the sulci are extremely narrow, merely impressed striæ; 3, the periphery is left white between two obscure lurid-fuscous bands; 4, the basal channel is very shallow and partly filled up by a callous deposit. The oblique lines of growth are the vestiges of a thin epidermis.

3. *Planaxis Savignyi.* B.M.

Planaxis Savignyi, Deshayes, Mag. de Zool. 1844, pl. 109.

Hab. Red Sea.

This species has much of the general appearance of *P. sulcata*; but the difference of colour and style of painting may be sufficient to separate it.

4. *Planaxis crassispira.* B.M.

P. testa perelongato-ovata; spira crassa; anfr. 6, planiusculi, spiraliter valide costati; costæ planæ, albæ, nigro-brunneo punctatæ, in anfr. ultimo 16; interstitia luteola; in anfr. ult. zonæ 2 purpurascentes, superior nigro-maculata, altera supra et altera infra peripheriam albam; apertura perparva; labrum intus fuscum, medio albo-maculatum, margine tenui et crenulato, subito incrassatum et intus 9-liratum; columella curvata et callo postico munita.

Long. 18 mill., diam. $8\frac{1}{2}$.

Hab. —— ?

The breadth of the upper whorls is very marked compared with that of other species. The aperture also is conspicuously small.

5. *Planaxis brevis.*

Planaxis brevis, Quoy, Voy. Astrolabe, vol. ii. p. 488, pl. 33. figs. 30–32.

Hab. Guam and New Guinea.

6. *Planaxis breviculus.* B.M.

Planaxis breviculus, Desh. Mag. de Zool. 1844, pl. 108; Issel, Mem. Accad. Torin. xxiii. pl. 1. figs. 5 & 6.

Hab. —— ? Var. Persian Gulf (*Col. Pelly*).

The British-Museum collection contains a very dark bluish-black variety from the Persian Gulf, covered with an olive-brown epidermis. The liræ within the mouth are very fine indeed. The young form of this variety approaches *P. Menkeanus*, Dkr.

7. *Planaxis Menkeanus.*

Planaxis Menkeanus, Dunker, Malak. Blätt. 1861, p. 41.

Hab. Red Sea.

8. *Planaxis planicostatus.* B.M.

Planaxis planicostata, Sowerby, Append. Tankerville Cat. p. 13, 1825; Reeve, Element. Conch. pl. B. fig. 17.
Buccinum planaxis, Wood, Index Test. Suppl. p. 12, pl. 4. fig. 15 *a*, 1828.
Planaxis canaliculata, Duval, Rev. Zool. 1840, p. 107.
—— *circinata*, Lesson, Rev. Zool. 1842, p. 187.

Hab. Galapagos Islands and Panama.

9. *Planaxis obscurus.* B.M.

Planaxis obscura, A. Adams, Proc. Zool. Soc. 1851, p. 271.

Hab. —— ?

It is a question whether this species should not be placed as a variety of *P. planicostatus*; but it would be hazardous to do so until more specimens are at hand and the locality known. The chief difference consists in the narrowness of the sulci, and the mouth being of a uniform brown colour. The epidermis is similar.

10. *Planaxis nucleus.* B.M.

Purpura nucleus, Lamarck, Anim. s. Vert. vol. vii. p. 249, ed. 2, vol. x. p. 88.
Planaxis semisulcata, Sowerby, Gen. Rec. & Foss. Shells, pl. 70. fig. 3.

Hab. West Indies, Jamaica.

11. *Planaxis nicobaricus.*

Planaxis nicobaricus, Zelebor, Verhandl. zool.-bot. Gesellsch. Wien, 1866, vol. xvi. p. 910; Frauenfeld, Reise Novara, Mollusk. p. 9, pl. 2. fig. 12.

Hab. Nicobar Islands.

12. *Planaxis nigritellus.* B.M.

Planaxis nigritella, Forbes, Proc. Zool. Soc. 1850, Dec. p. 273, pl. 11. fig. 6.
—— *acutus*, Menke, Zeitschrift f. Mal. Nov. 1850, p. 169.
—— *obsoletus*, Menke, *l. c.* p. 170.

Hab. Mazatlan.

The name *acutus* was employed by Krauss for a Cape species two years previous to Menke. This, together with the reasons given by P. P. Carpenter in the ' Mazatlan Catalogue,' p. 364, are sufficient to establish the retention of Forbes's species.

13. *Planaxis acutus.* B.M.

Planaxis acuta, Krauss, Südafrik. Moll. p. 103, t. 6. fig. 2.

Hab. Natal.

14. *Planaxis castaneus.* B.M.

P. testa solida, elongato-conica, castanea; spira elongata, apice acuminato; anfr. 6, convexiusculi, spiraliter striati (in anfr. ultimo striæ circiter 20, basi validissimæ), incrementi lineis obliquis parum conspicuis; apertura parva, ovata, spiram non æquans, intus pallide fusca; labrum margine tenui, subito incrassatum,

intus 7- albido-denticulatum; columella modice arcuata, basi expansa, rimam parvam fere tegens, callo postico parvo, cum labro canalem indistinctum formans.
Long. 10½ mill., diam. 5.

Hab. —— ?

This is a very solid, small species, with the whorls transversely striated; the striæ at the base of the body-whorl are much deeper than those encircling the rest of the shell, and produce the appearance of spiral ribs. The first stria below the sutural line is rather distant from it, thus giving the whorls the aspect of having an infrasutural raised belt.

15. *Planaxis Hanleyi.*

P. testa elongato-ovata, omnino brunnea; spira convexo-conica; anfr. 7, parum convexi, primi 3–4 politi, cæteri leviter spiraliter anguste sulcati, incrementi lineis obliquis ornati; anfr. ult. permagnus, basi sulcis validissimis; apertura magna; columella superne callosa cum labro incisuram distinctam formans; labrum tenuiusculum, patulum, intus tenuiter liratum.
Long. 12 mill., diam. 5½. Coll. S. Hanley.
Var. Testa columellæ callo postico producto cum labro incisuram, ut in *Pupina*, formante. Coll. S. Hanley.

Hab. Sandwich Islands.

I feel much pleasure in dedicating this species to Mr. Sylvanus Hanley, who has very kindly allowed me access to his vast collection.

It is much larger than *P. atropurpureus*, *P. niger*, or *P. abbreviatus*, but belongs to the same group.

Its principal characteristics are the strong basal sulcations of the body-whorl, the well-marked posterior channel, and the patulate outer lip. As is the case in several of the species of the genus, the first stria below the suture is rather distant, thus producing the appearance of an infrasutural raised belt.

The loop-like sinus in the variety reminds one very much of the incision in the genus *Pupina*.

16. *Planaxis similis.*

P. testa elongato-ovata, omnino brunnea, spira conica; anfr. 7, planiusculi; primi 3–4 politi, cæteri valide spiraliter sulcati, incrementi lineis obliquis ornati; anfr. ultimi sulci 17 ad basim paululum validiores; apertura parva, angusta; columella callo postico parvo, cum labro incisuram parvam formante; labrum crassum, haud dilatatum, intus 15-liratum.
Long. 11½ mill., diam. 5½. Coll. Sylvanus Hanley.

Hab. Sandwich Islands.

Although in many respects similar to *P. Hanleyi*, I think the strong uniform sulcations, the narrow non-dilatate aperture, and the very thick outer lip are sufficient distinctions to separate the two forms.

It is also somewhat similar to *P. castaneus*, from which it is distinguished by stronger but less numerous spiral sulcations; and the lirations are twice as numerous within the lip, which is thick at the margin, and not acute as in *P. castaneus*.

17. *Planaxis niger.* B.M.

Planaxis nigra, Quoy, Voy. Astrolabe, p. 49, pl. 33. figs. 22–24.

Hab. New Ireland.

18. *Planaxis atropurpureus.* B.M.

Planaxis atropurpurea, Récluz, Revue Zool. 1843, p. 261.
—— *Albersii*, Dunker, Novit. Conchol. Suppl. ii. p. 16, pl. 2. figs. 35–37.

Hab. South Seas (*Récluz*); Loanda (*Dkr.*).

19. *Planaxis labiosus.* B.M.

Planaxis labiosa, A. Adams, Proc. Zool. Soc. 1851, p. 272.
—— *plumbea*, Pease, Proc. Zool. Soc. 1861, p. 244.
—— *Bronni*, Dunker, Malak. Blätt. 1862, p. 41.

Hab. Sandwich Islands.

20. *Planaxis tæniatus.*

Planaxis tæniatus, Philippi, Zeitschrift für Malak. 1848, p. 165.

Hab. —— ?

21. *Planaxis Gouldii.*

Planaxis cingulata, Gould, Proc. Bost. Soc. Nat. Hist. vol. vii. Dec. 1860; Otia Conch. p. 140.

Hab. Ousima (*Gould*).

The name *cingulata* having been applied ten years previously to another species by A. Adams, I here change it to that of *Gouldii*.

22. *Planaxis cingulatus.* B.M.

Planaxis cingulata, A. Adams, Proc. Zool. Soc. 1851, p. 271.

Hab. China Seas.

23. *Planaxis eboreus.* B.M.

P. testa parva, alba, ovato-acuminata, apice piceo; anfr. 8, convexiusculi, valide spiraliter sulcati; costæ inter sulcos dimidiatæ, in anfr. ultimo 14, basi minimæ; apertura ovata; labrum margine

tenui, acuto, et maculis 5 brunneis notatum, intus incrassatum, 8-denticulatum; columella arcuata, callo postico parvo.
Long. 6 mill., diam. 3.

Hab. West Indies, St. Thomas and St. Vincent.

An ivory-white species without other marking than a brown apex and a few brown dots on the exterior of the outer lip. The chief peculiarity of this shell, however, consists in the spiral ribs being divided into two equal parts by an impressed line, thus giving them a concave appearance.

24. *Planaxis suturalis.*

P. testa parva, alba; spira turrita, elongata, apice acuminato; sutura subcanaliculata; anfr. 8, planiusculi, spiraliter sulcati; anfr. ult. sulcis 11 cinctus, ad peripheriam obtusatim angulatus, basi contractus, cum columella caudam brevem formans; apertura ovata, spira longe brevior; columella arcuata, callo postico parvo non tuberculari; canalis basalis profundus; labrum crassum, intus 10-denticulatum.
Long. $6\frac{1}{2}$ mill., diam. 3. Coll. Sylvanus Hanley.

Hab. Chinese seas.

A very pretty species, at once distinguished from *P. eboreus* by its turreted spire, deep suture, and the spiral ribs being flat, and not bipartite.

25. *Planaxis striatulus.* B.M.

Planaxis striatulus, Philippi, Zeitschrift für Malak. 1851, p. 91.

Hab. ——?

26. *Planaxis ater.* B.M.

Planaxis atra, Pease, American Journ. Conch. vol. v. p. 72, pl. 8. fig. 4.

Hab. Marquesas Islands.

27. *Planaxis abbreviatus.* B.M.

Planaxis abbreviata, Pease, Proc. Zool. Soc. 1865, p. 515; American Journ. Conch. iv. p. 101, pl. 12. fig. 16.

Hab. Sandwich Islands.

28. *Planaxis incisus.*

Planaxis incisus, Philippi, Zeitschrift für Malak. 1851, p. 92.

Hab. ——?

This appears to approach *P. abbreviatus* in several of its characters. The size, colour, character of the incision above, and number of the liræ within the aperture are similar.

29. *Planaxis lineatus.* B.M.

Buccinum lineatum, Da Costa, Brit. Conchol. p. 130, pl. 8. fig. 5; Dillwyn, Cat. vol. ii. p. 626. no. 91; Wood, Ind. Test. pl. 23. fig. 92.
Buccinum pediculare, Lamarck, Anim. s. Vert. vol. vii. p. 275; Kiener, Coq. Viv. p. 72. no. 71, pl. 25.
Planaxis lineata, Duval, Rev. Zool. 1840, p. 107; Jay, Cat. Shells, ed. 4, 1850.

Hab. West Indies, St. Vincent and Jamaica.

30. *Planaxis succinctus.* B.M.

Planaxis succincta, A. Adams, Proc. Zool. Soc. 1851, p. 272.

Hab. West Indies.

The difference between this species and *lineatus*, Da Costa, is very slight, consisting chiefly in its having the spire more acuminate and the spiral brown lines finer and fewer in number upon a pale yellow ground, instead of white as in *lineatus*.

31. *Planaxis Hermannseni.*

Planaxis Hermannseni, Dunker, Novit. Conchol. Suppl. ii. p. 16, pl. 2. figs. 33, 34.

Hab. Benguela, west coast of Africa.

Dunker observes that it is allied to *P. lineatus*, Da Costa, but distinguished by its larger size and more inflated last whorl. Also approaches *P. striatulus*, Philippi.

32. *Planaxis virgatus.* B.M.

P. testa elongata, acuminata, lutea, lineis spiralibus paucis et virgis obliquis irregularibus rufo-fuscis ornata; anfr. 8, parum convexi; primi 4 et ultimus basi transversim valide sulcati, cæteri læves vel indistincte striati; apertura anguste ovata; labrum margine acuto, intus incrassatum, denticulatum; columella postice haud callosa.
Long. 8 mill., diam. 4.

Hab. Fiji Islands, New Caledonia.

This species somewhat approaches *P. ineptus*, Gould. It differs, however, in its much larger size, oblique brown irregular stripes, and the entire absence of a posterior callosity. The last whorl is a little contracted at the lower part, thus forming a short cauda.

33. *Planaxis variabilis.* B.M.

P. testa parva, elongato-acuminata, alba, lineis spiralibus numerosis pallido-rufis cincta; anfr. 8, planiusculi, apice et basi valide, medio leviter spiraliter sulcati; apertura parva, spira paululum brevior; columella basi brunneo tincta, callo postico nullo; labrum crassum, intus denticulatum.
Long. 6 mill., diam. 3.

Var. *angulata.* Testa anfr. superne oblique angulatis, lineis obliquis rufescentibus ornatis. Coll. Sylvanus Hanley.

Hab. Fiji Islands. Var. Chinese seas.

This species differs from *P. virgatus*, its nearest ally, in its much smaller size, greater solidity, and the narrow conical form.

34. *Planaxis longispira.*

P. testa elongata, angusta, albida, linea paululum suturam supra et in anfr. ult. lineis duabus rufis cincta, altera supra, altera peripheriam infra; spira elongato-conica; anfr. 8 ?, læves, politi, apice ? (deficiente) basique anguste sulcati, suturam infra zona pellucida cincti; apertura parva, spira longe brevior; columella arcuata, brunneo tincta, cum labro callo tenui juncta; labrum crassiusculum, intus denticulatum.

Long. 7 mill., diam. 3. Coll. Sylvanus Hanley.

Hab. Chinese seas (*Collingwood*).

Known by its very long acuminate spire, the smoothness of the whorls, and the two spiral reddish lines encircling the body-whorl.

35. *Planaxis tenuis.*

P. testa elongata, angusta, tenuis, polita, semipellucida, alba, linea paululum suturam supra, et in anfr. ult. lineis tribus pallido-rufis cincta; spira convexo-conica, sutura distincta; anfr. 8–9 convexiusculi, spiraliter levissime sulcati, apicem basimque versus validiores, suturam infra zona sordido-vitrea cincti; anfr. ult. angustus, elongatus, ad peripheriam rotundus; columella callo postico nullo; labrum tenuiusculum, intus haud denticulatum.

Long. , diam. . Coll. Sylvanus Hanley.

Hab. ——?

Resembling a variety of *P. virgatus* in colour; but it is thin, semipellucid, with the spire less conical and more convex, the body-whorl narrow and rounded at the periphery, and the outer lip thin and not denticulate; and the infrasutural vitreous band at once separates it.

36. *Planaxis ineptus.* B.M.

Planaxis inepta, Gould, Proc. Bost. Soc. Nat. Hist. vol. vii. Dec. 1860; Otia Conch. p. 140.

Hab. Kikaia Bay (*Gould*).

37. *Planaxis lineolatus.* B.M.

Planaxis lineolata, Gould, Otia Conch. p. 60.

Hab. Wilson's Island (*Gould*), near the Sandwich Islands.

38. *Planaxis zonatus.* B.M.

Planaxis zonata, A. Adams, Proc. Zool. Soc. 1851, p. 271.

Hab. Calapan, Philippine Islands.

39. *Planaxis fasciatus.*

Planaxis fasciata, Pease, American Journ. Conch. vol. iv. 1868, p. 102, pl. 12. fig. 7.

Hab. Paumotus.

40. *Planaxis areolatus.*

Planaxis areolatus, Lesson, Rev. Zool. 1842, p. 187.

Hab. Tahiti.

41. *Planaxis buccineus.*

Planaxis buccinea, A. Adams, Proc. Zool. Soc. 1851, p. 272.

Hab. West Indies.

42. *Planaxis* (*Hinea*) *brasilianus.* B.M.

Buccinum brasilianum, Lamarck, Anim. s. Vert. vol. vii. p. 272; Kiener, Coq. Viv. p. 70. no. 69, pl. 17. fig. 59.
Planaxis mollis, Sowerby, Genera of Shells, 1820–24, fig. 2.
Buccinum lævigatum, Wood, Ind. Test. Suppl. pl. 4. fig. 29, 1828.

Var. *a.* Smaller and slightly angulated at the periphery. B.M.

Planaxis fulva, A. Adams, Proc. Zool. Soc. 1851, p. 271.

? Var. *b.* Dwarfed form. B.M.

Planaxis pigra, Forbes, Proc. Zool. Soc. 1850, p. 273, pl. 11. fig. 5.

Hab. Brazil [?] (*Lamarck*), Australia.

I have very carefully studied the typical specimens of *P. fulva* in the Cumingian collection; and the only characters I can detect in which they differ from *P. brasilianus* are their smaller size and the very slight angulation at the periphery.

I place *P. pigra* as a variety with a note of interrogation. Although of much smaller size than full-grown examples of *P. brasilianus*, there being in the National Collection a large series of the latter the gradual links between them can be traced; and, allowing for difference of habitat, it may be but a dwarfed form.

43. *Planaxis imbricatum*, Lamk.

from the island of Chiloe, mentioned by Lesson in the 'Revue Zoologique,' 1842, p. 187.

44. *Planaxis niger*, Lesson,

included in Messrs. H. and A. Adams's list of the species of the genus in their 'Genera of Recent Mollusca,' vol. i. p. 322.

I am unable to find where the above two species have been described. Can the former be *Monoceros imbricatum*, Lamk., from the above locality? and can the latter be a mistake for *nigra*, Quoy?

In the sixth volume of the 'Zoological Record,' p. 549, Von Martens mentions a species of *Planaxis* "from the Gulf of Akaba, shortly described by Issel, Malac. Mar. Ross. p. 196."

Subgenus Holcostoma.

Holcostoma piligerum. B.M.

Planaxis piliger, Philippi, Zeitschrift für Malak. 1848, p. 164.
Holcostoma setigerum, A. Adams, Proc. Zool. Soc. 1853, p. 174, pl. 20. fig. 5.

Hab. Mauritius.

Subgenus Quoyia, Gray, Proc. Zool. Soc. 1847, p. 138.

Quoyia decollata.

Planaxis decollata, Quoy & Gaimard, Voy. Astrolabe, vol. ii. p. 489, pl. 33. figs. 33, 34.
Quoyia decollata, Gray, Proc. Zool. Soc. 1847, p. 138. no. 59.

Hab. New Guinea (*Q. & G.*), Philippines (*Cuming*).

IV.—*Description of a new Species of* Porzana *from the Himalayas.* By Arthur, Viscount Walden, P.Z.S.

Porzana bicolor, n. sp.

Chin greyish white, passing into pure grey on the throat; entire head, throat, neck, breast, abdomen, flanks, and thigh-coverts ashy grey; nape, back, uropygium, shoulder-coverts, and scapulars ferruginous olive; tail, upper and lower tail-coverts dark slate-colour, almost black; quills above ash-coloured, washed with light brown, underneath pale brown; under wing-coverts pale brown tinged with ashy; shoulder edge white, quill-shafts underneath white; bill black at the tip, dark green at base. Wing 4·50 inches; tarsus 1·50; middle toe 1·50; hallux 0·37, nails not included; bill from gape 1·12, from forehead 0·87.

This well marked and handsome rail was shot at Rungbee, Darjeeling.

V.—*Contributions to the Study of the Entomostraca.* By George Stewardson Brady, C.M.Z.S., and David Robertson, F.G.S.

No. VI. *On the Distribution of the British Ostracoda.*

[Plates I. & II.]

We propose in the present paper to give (1) descriptions of a few new or imperfectly known species, (2) catalogues of some recent gatherings which present points of interest, and (3) a summary of our present information as to the distribution of the known British species of Ostracoda. Upwards of three years have now elapsed since the publication of the "Monograph of the Recent British Ostracoda" in the 'Transactions of the Linnean Society;' and during that time, by the assiduous working of old fields, and the occasional investigation of new ones, many new species have been added to our list, and much valuable knowledge has been gained as regards geographical and bathymetrical distribution. But the papers * in which these results have been published being much scattered, and perhaps sometimes inaccessible, it seems desirable to present them here in a condensed form.

Of the one hundred and ninety-nine species now known as inhabitants of the British Islands and their adjacent seas, some six or seven may be said to stand on a rather precarious basis, having been admitted on the strength of one or two specimens only, perhaps "waif and stray," or for some other reason being imperfectly understood. In this category may be mentioned *Cypris elliptica*, *C. Joanna*, *Argillœcia cylindrica*, *Cythere borealis*, *C. mirabilis*, *C. marginata*, *Cytheridea inæqualis*, and possibly a few others. The whole may be broadly grouped under two heads, comprising the inhabitants respectively of the sea and of fresh water. But among the purely marine forms it is of interest to note that some are strictly littoral (A) in habitat, while others almost exclusively affect considerable depths of water; there is, again, a small but well-defined group, the members of which are scarcely ever to be found (setting aside acci-

* The papers here summarized are as follows:—"A Monograph of the Recent British Ostracoda," Trans. Linn. Soc. 1868. "Last Report of Dredging amongst the Shetland Islands" (by the Rev. A. M. Norman), Brit. Assoc. Report, 1868. "Notes of a Week's Dredging in the West of Ireland," Ann. & Mag. Nat. Hist. 1869. "On the Ostracoda and Foraminifera of Tidal Rivers," *ibid.* 1870. "The Crustacean Fauna of Salt Marshes," Nat. Hist. Trans. North. & Durham, 1868. "On Entomostraca taken chiefly in Northumberland and Durham, in 1869," *ibid.* 1870. "A Review of the Cypridinidæ of the European Seas," Proc. Zool. Soc. 1871.

dental interlopers) except in decidedly brackish water (B), and yet again another, which we may regard as an offshoot from the brackish group, and whose members (C) seem to luxuriate chiefly, though not perhaps entirely, in waters which, though fresh, are subject in some slight degree to tidal influence; and in cases where these occur apart from the conditions here noted, we should be disposed to conclude either that such occurrence is accidental and perhaps not permanent, or that the local conditions have been materially changed at some not very remote epoch.

The following lists embrace the typical members of the last-named groups:—

Group A (littoral).

Cythere badia, *Norman.*
—— rubida, *Brady.*
—— albomaculata, *Baird.*
Xestoleberis aurantia (*Baird*).
Cytherura nigrescens (*Baird*).
—— cellulosa (*Norman*).
Paradoxostoma variabile (*Baird*).
—— pulchellum, *G. O. Sars.*
—— Fischeri, *G. O. Sars.*
—— obliquum, *G. O. Sars.*
—— hibernicum, *Brady.*

Group B (brackish or estuarine).

Cypris prasina, *Fischer.*
—— salina, *Brady.*
Cypridopsis aculeata (*Lilljeborg*).
Potamocypris fulva, *Brady.*
Cythere castanea, *G. O. Sars.*
Cythere porcellanea, *Brady.*
—— gibbosa, *B. & R.*
—— Robertsoni, *Brady.*
Cytheridea torosa (*Jones*).
Loxoconcha elliptica, *Brady.*
—— pusilla, *B. & R.*
Cytherura Robertsoni, *Brady.*

Group C (subbrackish).

Cypris incongruens, *Ramdohr.*
Cypridopsis obesa, *B. & R.*
Goniocypris mitra, *B. & R.*
Metacypris cordata, *B. & R.*
Candona compressa, *Koch.*
—— candida, *var.* tumida, *B. & R.*
Cythere fuscata, *Brady.*
Limnicythere Sancti Patricii, *B. & R.*
Darwinella Stevensoni, *B. & R.*

As regards geographical distribution, the chief fact which we are at present able to point out is the admixture, at the northern extremity of our area, of a distinct glacial or arctic fauna, characterized by such species as *Cythere borealis*, *C. concinna*, *C. costata*, *C. emarginata*, *C. leioderma*, *C. mirabilis*, *Cytheridea Sorbyana*, *C. papillosa*, and *C. punctillata*; while, on the other hand, our southern and south-western shores harbour certain species which do not seem to thrive so well in more northern latitudes, and which are conspicuously absent from our eastern coast: in this list may be mentioned *Bairdia inflata*, *B. acanthigera*, and *Cythere emaciata*. Two species which are common in most other districts (*Cythere villosa* and *Loxoconcha impressa*) are also of rare occurrence on the eastern coast, the place of the latter being occupied to a large extent by *L. guttata*, and of the former by *C. lutea* and perhaps *C. albomaculata*.

A glance, however, at the table appended to this paper will at once show that our knowledge of the Ostracoda of some parts of the British seas is as yet very scanty, and that there are in fact only a few districts (columns 4, 7, 8, 9) which have been examined with tolerable completeness. Much may still be done even in these better-explored provinces, while the freshwater inhabitants of most districts are at present entirely untouched.

1. The Freshwater Lakes of Mayo and Galway.

Of the almost innumerable lakes scattered through these two counties we have at different times more or less thoroughly examined twenty of the most accessible, namely those lying near the roadside between Galway and Clifden, and others within easy reach of the towns of Roundstone, Clifden, and Westport. The names of these (according to the Ordnance maps) we give as nearly as possible in their natural order, beginning with the most southerly:—Lough Aubwee, L. Corrib (at Oughterard), L. Agraffard, Park Lough (Derryneen), L. Shindilla, Loughaughnarhin, L. Ardderry, Ballinahinch L., L. Nascrahoge, L. Cam, L. Naweelaun, L. Bollard, L. Fadda, L. Doolagh, Seaville L., Cregduff L., L. Enask, L. Inagh, L. Moher, Coolbarreen L.

These lakes are uniformly of a character unfavourable to a great abundance of Entomostraca or any form of animal life, the bottoms being either stony or composed of a tough compact peat which does not easily disintegrate, and thus would appear to supply very scantily either food or shelter. Floating aquatic weeds, such as *Myriophyllum* and *Potamogeton*, occur also very sparingly; and though sedges and water-lilies are in some lakes plentiful enough, we have never found these very productive in Ostracoda. The following list embraces all the species taken by us; and not one of these occurred in any great abundance:—

Cypris lævis, *Müller*.
—— ovum (*Jurine*).
—— compressa, *Baird*.
—— striolata, *Brady*.
—— (?)tessellata, *Fischer*.
—— reptans (*Baird*).
Cypridopsis vidua (*Müller*).
—— obesa, *B. & R.*
—— villosa (*Jurine*).
Candona candida (*Müller*).
—— lactea, *Baird*.
—— diaphana, *B. & R.*
—— Kingsleii, *B. & R.*
Notodromas monachus (*Müller*).
Metacypris cordata, *B. & R.*
Limnicythere Sancti Patricii, *B. & R.*
Loxoconcha elliptica, *Brady*.
Darwinella* Stevensoni, *B. & R.*

* The generic name *Polycheles*, under which we originally described this species, being preoccupied, we now propose in its place the term *Darwinella*.

The chief point of interest here is the occurrence of several species which we have been accustomed to regard as inhabitants of brackish water only, and of some (viz. *Candona diaphana*, *C. Kingsleii*, *Metacypris cordata*, and *Darwinella Stevensoni*) which we had previously supposed to be limited to the subbrackish fens and rivers of the East-Anglian district. We have, however, but little knowledge of the contents of our inland waters; and it is quite probable that further research may very much modify our views as to distribution. Meantime it may be noted that the Irish specimens of *Metacypris* and *Darwinella* are of very poor growth and very scanty in point of numbers.

Cypris tessellata, Fischer.

The specimens which we doubtfully refer to this species, though almost exactly similar to English examples in outline, are considerably smaller, and the shell is very vaguely sculptured, exhibiting only an approach to the characteristic tessellation of the typical form. This peculiarity, however, we have previously observed in young specimens, and even to some extent in adults from certain localities; and it would not of itself have led us to doubt seriously the identity of the Irish specimens but for a concurrent difference in the postabdominal rami, which are long and slender, slightly ciliated on the inferior margin, and have the three terminal claws or setæ almost close together, the first seta being short, the second about three times as long as the first, and the third nearly twice as long as the second: the small seta usually found near the middle of the lower margin is wanting. The lakes in which these specimens occurred are Loughs Inagh and Coolbarreen.

Metacypris cordata, B. & R. Pl. II. figs. 9, 10.

Originally described from the shell only. We are now able to add a definition of the contained animal, which belongs distinctly to the family Cytheridæ.

Superior antennæ slender, six-jointed, the third, fourth, and sixth joints nearly equal in length, fifth slightly longer, last joint bearing four slender setæ, two of which are moderately long; fourth and fifth joints also bearing two or three slender apical setæ; inferior antennæ, mandible, jaw, and feet as in *Cythere*, the mandible-palp, however, short and indistinctly jointed; abdomen ending in two short curved setæ.

Hab. Lough Aubwee, near Galway.

2. East of Ireland (freshwater).

Grand Canal, Dublin.

Cypris reptans (*Baird*).
—— gibba, *Ramdohr.*
—— ovum (*Jurine*).
—— compressa, *Baird.*
Cypridopsis obesa, *B. & R.*
—— vidua (*Müller*).
Candona candida (*Müller*).
—— compressa, *Koch.*
—— lactea, *Baird.*
—— similis, *Baird.*
Limnicythere inopinata (*Baird*).
Darwinella Stevensoni, *B. & R.*

Belfast Canal.

(*Lock at junction of River Logan.*)

Cypridopsis obesa, *B. & R.*
Cythere castanea, *G. O. Sars.*
—— porcellanea, *Brady.*
—— gibbosa, *B. & R.*
—— viridis, *Müller.*
Loxoconcha impressa (*Baird*).
Cytherura Robertsoni, *Brady.*

Candona similis, Baird. Pl. I. figs. 1, 2.

Candona similis, Baird, Brit. Entom. p. 162, pl. 19. figs. 2, 2 *a*.

Carapace subelliptical, greatest height in front of the middle, and scarcely equal to half the length; extremities well rounded, the posterior much the smaller: superior margin very slightly arched, sloping gently from before backwards; inferior almost straight. Seen from above, regularly ovate, widest in the middle, thence tapering evenly to the acuminate extremities; width equal to rather more than one-third of the length. Shell thin, transparent. Length $\frac{1}{35}$ inch.

This species is known to us only from two or three specimens taken in the Grand Canal at Dublin; but these agree so completely (except as regards the coloured markings, which may have been destroyed by prolonged drying amongst mud) with Dr. Baird's description that we do not hesitate to refer them to *C. similis*. Since the foregoing sentence was written a few specimens of the same species have likewise occurred to us in the neighbourhood of Sunderland, as noted below (p. 58).

3. Northern Coast of Scotland (marine).

For several dredgings from this district, obtained during one of the surveying-expeditions of H.M.S. 'Porcupine,' we are indebted to our friend Mr. D. O. Drewett. The dredgings are from the following localities (all purely marine, and very similar in character, so that it is scarcely necessary to give separately the lists of species from each):—Dornoch Frith, 4 fathoms; Loch Erribol; three miles off Port Skerran, 30 fathoms; Kyle of Tongue, 4 fathoms; Scarpa Bay, Orkney; Scarpa Flow, 17 fathoms; ten miles off Hoy Head, 50 fathoms; Scrabster Roads, 7 fathoms. Our list includes also the contents of one dredging made by Mr. Robertson in Stromness Bay.

Pontocypris mytiloides (*Norman*).
—— trigonella, *G. O. Sars.*
Bairdia inflata (*Norman*).
Potamocypris fulva, *Brady.*
Cythere pellucida, *Baird.*
—— castanea, *G. O. Sars.*
—— porcellanea, *Brady.*
—— tenera, *Brady.*
—— crispata, *Brady.*
—— viridis, *Müller.*
—— lutea, *Müller.*
—— villosa (*G. O. Sars*).
—— albomaculata, *Baird.*
—— convexa, *Baird.*
—— cuneiformis, *Brady.*
—— finmarchica (*G. O. Sars*).
—— tuberculata (*G. O. Sars*).
—— pulchella, *Brady.*
—— angulata (*G. O. Sars*).
—— quadridentata, *Baird.*
—— emaciata, *Brady.*
—— dunelmensis (*Norman*).
—— Jonesii, *Baird.*
—— (?) acerosa, *Brady.*
Loxoconcha tamarindus (*Jones*).
—— impressa (*Baird*).
—— guttata (*Norman*).
Loxoconcha multifora (*Norman*).
Ilyobates bartonensis (*Jones*).
Xestoleberis depressa, *G. O. Sars.*
Eucythere Argus (*G. O. Sars*).
—— declivis (*Norman*).
Cytheridea elongata, *Brady.*
Cytherura nigrescens (*Baird*).
—— similis, *G. O. Sars.*
—— affinis, *G. O. Sars.*
—— undata, *G. O. Sars.*
—— striata, *G. O. Sars.*
—— flavescens, *Brady.*
—— cuneata, *Brady.*
—— angulata, *Brady.*
—— gibba (*Müller*).
—— acuticostata, *G. O. Sars.*
—— cellulosa (*Norman*).
Pseudocythere caudata, *G. O. Sars.*
Cytheropteron latissimum (*Norman*).
Bythocythere constricta, *G. O. Sars.*
Cytherideis subulata, *Brady.*
Sclerochilus contortus (*Norman*).
Paradoxostoma variabile (*Baird*).
—— abbreviatum, *G. O. Sars.*
—— flexuosum, *Brady.*
—— ensiforme, *Brady.*
—— orcadense, n. sp.

Paradoxostoma orcadense, n. sp. Pl. I. figs. 5–7.

Carapace, as seen from the side, elongated, subreniform or subtriangular, highest near the middle, lower in front than behind; height much less than half the length; extremities rounded, the anterior being the narrower: superior margin sloping gently forwards almost in a right line from its highest point, but well arched behind; inferior sinuated in the middle. Seen from above, ovato-cuneate, widest near the posterior extremity; width equal to nearly one third of the length, subacuminate in front, rounded behind. Animal unknown. Length $\frac{1}{45}$ inch.

Hab. Stromness Bay, Orkney; sandy bottom.

4. South Wales and Bristol Channel.

Canal and Dykes on Cardiff Moor.

Cypris reptans (*Baird*).
—— prasina, *Fischer.*
—— gibba, *Ramdohr.*
—— compressa, *Baird.*
Cypridopsis vidua (*Müller*).
—— obesa, *B. & R.*
—— aculeata (*Lilljeborg*).
Potamocypris fulva, *Brady.*
Candona candida (*Müller*).
—— albicans, *Brady.*
—— lactea, *Baird.*
—— hyalina (?), *B. & R.*
Limnicythere inopinata (*Baird*).
Cytheridea torosa, *Jones* (var. *teres*).
Darwinella Stevensoni, *B. & R.*

Off Penarth Head (muddy bottom).

Cypris compressa, *Baird.*
—— gibba (*Ramdohr*).
—— cambrica, nov. sp.
Cypridopsis obesa, *B. & R.*
Candona albicans, *Brady.*
Potamocypris fulva, *Brady.*
Pontocypris mytiloides (*Norman*).
Argillœcia angustata (*Brady*).
Cythere castanea, *G. O. Sars.*
—— porcellanea, *Brady.*
—— tenera, *Brady.*
—— Jeffreysii, *Brady.*
—— viridis, *Müller.*
—— villosa (*G. O. Sars*).
Limnicythere inopinata (*Baird*).
Xestoleberis aurantia (*Baird*).
Loxoconcha granulata, *G. O. Sars.*
—— guttata (*Norman*).
—— tamarindus (*Jones*).
Cytherura nigrescens (*Baird*).
—— striata, *G. O. Sars.*
—— cuneata, *Brady.*
—— quadrata, *Norman.*
—— acuticostata, *G. O. Sars.*
—— cellulosa (*Norman*).
Cytheropteron punctatum, *Brady.*
Cytherideis subulata, *Brady.*
Paradoxostoma variabile (*Baird*).
—— abbreviatum, *G. O. Sars.*
—— ensiforme, *Brady.*
—— flexuosum, *Brady.*

Ilfracombe, off Lantern Hill (3-8 fathoms).

Cythere albomaculata, *Baird.*
—— lutea, *Müller.*
—— villosa (*G. O. Sars*).
—— convexa, *Baird.*
—— crispata, *Brady.*
—— viridis, *Müller.*
—— cuneiformis, *Brady.*
—— pellucida, *Baird.*
—— castanea, *G. O. Sars.*
—— tenera, *Brady.*
—— Robertsoni, *Brady.*
—— finmarchica (*G. O. Sars*).
—— semipunctata, *Brady.*
—— pulchella, *Brady.*
—— emaciata, *Brady.*
Cytheridea elongata, *Brady.*
Eucythere Argus (*G. O. Sars*).
Loxoconcha impressa (*Baird*).
Loxoconcha tamarindus (*Jones*).
—— guttata (*Norman*).
—— multifora (*Norman*).
Xestoleberis aurantia (*Baird*).
Cytherura flavescens, *Brady.*
—— nigrescens (*Baird*).
—— striata, *G. O. Sars.*
Cytheropteron pyramidale, *Brady.*
Bythocythere constricta, *G. O. Sars.*
Cytherideis subulata, *Brady.*
Sclerochilus contortus (*Norman*).
Paradoxostoma variabile (*Baird*).
—— abbreviatum, *G. O. Sars.*
—— ensiforme, *Brady.*
—— obliquum, *G. O. Sars.*
—— hibernicum, *Brady.*
Asterope teres (*Norman*).

The gatherings from Cardiff Canal and Dykes appear to show some slight admixture of salt water, while, on the other hand, that from Penarth Head contains several Cypridæ, which we must suppose to have been derived from some neighbouring freshwater outlet; it is scarcely likely that *Cypris compressa*, *C. gibba*, *Cypridopsis obesa*, *Candona albicans*, or *Limnicythere inopinata* are permanently established in a living condition in absolutely salt water, though the shells of several of these show that they must have been either living or only recently dead when captured. We should have been disposed to class *Cypris cambrica* in the same list; but the former being unknown as a freshwater species, and bearing at the same time a strong resemblance to "*Cytheridea*" *zetlandica*, which was taken undoubtedly living between tide-marks, we can scarcely do otherwise than regard it for the present as a new marine form. The single specimen in our gathering is, unfortunately, only an empty shell; so that we cannot speak confidently as to its generic position.

In the Ilfracombe list the chief point of interest is the occurrence of *Cytheropteron pyramidale* (Brady), a species new to Britain, but perhaps too nearly allied to *C. latissimum* to be altogether satisfactory. The species was originally described from Norwegian examples, in No. 1 of these "Contributions." Amongst the specimens which we here assign to *Cytherideis subulata* are some of an unusually large size and of slightly more tumid and arcuate outline than the typical form; but whether these differences are sexual or varietal, or whether they constitute an altogether distinct species, we are not, owing to the emptiness of the shells, able decidedly to say. One of these is figured in Pl. I. figs. 12, 13; fig. 13, however, is unsatisfactory, the outline being too nearly ovate, and not attenuated sufficiently in front.

Cypris prasina, Fischer.

The species named by us in a previous paper ("On the Ostracoda and Foraminifera of Tidal Rivers") *C. fretensis*, appears to be properly referable to *C. prasina*, though the term, signifying a shade of green, is a misnomer as regards our specimens, which are in all cases of a dirty white.

Cypris (?) *cambrica*, n. sp. Pl. I. figs. 3, 4.

Carapace, as seen from the side, subtriangular; greatest height behind the middle, and equal to half the length; anterior extremity obtusely, posterior rather obliquely rounded: superior margin well arched, somewhat gibbous behind the middle, inferior almost straight. Seen from above, regularly ovate, with tapering acuminate extremities, widest in the middle; width considerably less than one half the length. Shell thin, semitransparent, yellowish. Length $\frac{1}{35}$ inch.

Cytherura quadrata, Norman. Pl. I. figs. 10, 11.

The specimens here noted and figured are interesting as being the only ones on record, with the exception of the original types, which were taken in Shetland by Mr. Norman. Though certainly different in proportion of length to height, this species seems to us to come, perhaps, dangerously near to *C. striata*, from which the shell differs in no other essential respect.

Paradoxostoma flexuosum, Brady. Pl. I. figs. 8, 9.

A more extensive series of specimens from various localities shows that the figures and descriptions originally given in the "Monograph of Recent British Ostracoda" require emendation. The conspicuously angular example from which the figures were drawn was probably a male, and is a much less common form than that now described.

Carapace, as seen from the side, elongated, flexuous, rather narrower in front than behind; greatest height equal to one third of the length, and situated near the middle; extremities tapering, rounded; superior margin well and evenly rounded, inferior deeply sinuated in front of the middle. Seen from above, compressed, oblong, tapering to the extremities, which are acuminate; greatest width in the middle, and equal to less than one fourth of the length. Shell thin and fragile, smooth; when viewed with a high power, it is, if in good condition, seen to be marked with very delicate and closely set longitudinal striations. Length $\frac{1}{48}$ inch.

5. Northumberland and Durham District.

*Lochend Loch, Edinburgh**.

Cypris gibba, *Ramdohr.*	Candona albicans, *Brady.*
—— reptans (*Baird*).	—— lactea, *Baird.*
—— compressa, *Baird.*	Goniocypris mitra, *B. & R.*
Candona candida (*Müller*).	Limnicythere inopinata, *Baird.*
—— compressa (*Koch*).	

Bolam Lake, Northumberland.

Cypris compressa, *Baird.*	Candona candida (*Müller*).
—— lævis, *Müller.*	Cythere albomaculata, *Baird.*
Cypridopsis vidua (*Müller*).	Limnicythere inopinata (*Baird*).

Belsay Lake, East, Northumberland.

Cypris reptans (*Baird*).	Cypris lævis, *Müller.*
—— gibba, *Ramdohr.*	Candona candida (*Müller*).
—— compressa, *Baird.*	—— lactea, *Baird.*
—— ovum (*Jurine*).	Limnicythere inopinata (*Baird*).

Pond on Boldon Flats, near Sunderland.

Cypris reptans (*Baird*).	Cypris lævis, *Müller.*
—— gibba, *Ramdohr.*	Candona candida (*Müller*).
—— compressa, *Baird.*	—— similis, *Baird.*

Seaton Burn, Northumberland, above the Sluice.

Cypris reptans (*Baird*).	Cythere gibbosa, *B. & R.*
—— gibba, *Ramdohr.*	Limnicythere inopinata (*Baird*).
—— prasina, *Fischer.*	Cytheridea torosa (*Jones*), *var.* teres.
Candona candida (*Müller*).	Loxoconcha elliptica, *Brady.*
Cythere castanea, *G. O. Sars.*	Cytherura Robertsoni, *Brady.*
—— porcellanea, *Brady.*	

* This locality, though not coming with geographical accuracy under our fifth heading, may be regarded as belonging to the same zoological province.

Seaton Burn, below the Sluice.

Cypris gibba, *Ramdohr.*
—— prasina, *Fischer.*
Cythere pellucida, *Baird.*
—— castanea, *G. O. Sars.*
—— porcellanea, *Brady.*
—— tenera, *Brady.*
—— viridis, *Müller.*
—— albomaculata, *Baird.*
—— gibbosa, *B. & R.*
—— Robertsoni, *Brady.*
—— cuneiformis, *Brady.*
—— angulata (*G. O. Sars*).
—— villosa (*G. O. Sars*).
—— semipunctata, *Brady.*
Limnicythere inopinata (*Baird*).
Cytheridea torosa (*Jones*), *var.* teres.
Loxoconcha elliptica, *Brady.*
Cytherura nigrescens (*Baird*).
—— striata, *G. O. Sars.*
—— angulata, *Brady.*
—— Robertsoni, *Brady.*
—— cellulosa (*Norman*).
—— clathrata, *G. O. Sars.*
Cytherideis subulata, *Brady.*
Paradoxostoma variabile (*Baird*).
—— ensiforme, *Brady.*
—— Fischeri, *G. O. Sars.*
—— hibernicum, *Brady.*

North of Whitley, on muddy sand-covered rocks, between tide-marks.

Pontocypris mytiloides (*Norman*).
Cythere albomaculata, *Baird.*
—— lutea, *Müller.*
—— viridis, *Müller.*
—— pellucida, *Baird.*
—— castanea, *G. O. Sars.*
—— tenera, *Brady.*
—— Robertsoni, *Brady.*
—— villosa (*G. O. Sars*).
—— cuneiformis, *Brady.*
Loxoconcha tamarindus (*Jones*).
Xestoleberis aurantia (*Baird*).
Cytherura nigrescens (*Baird*).
—— angulata, *Brady.*
—— cuneata, *Brady.*
—— undata, *G. O. Sars.*
—— cellulosa (*Norman*).
—— clathrata, *G. O. Sars.*
Cytherideis subulata, *Brady.*
Sclerochilus contortus (*Norman*).
Paradoxostoma variabile (*Baird*).
—— ensiforme, *Brady.*
—— obliquum, *G. O. Sars.*

Seaton Carew, near Hartlepool, on muddy rocks at low-water mark.

Cythere albomaculata, *Baird.*
—— pellucida, *Baird.*
—— villosa (*G. O. Sars*).
—— borealis, *Brady.*
Cytheridea punctillata, *Brady.*
—— cornea, *B. & R.*
Loxoconcha elliptica, *Brady.*
Cytherura nigrescens (*Baird*).
—— similis, *G. O. Sars.*
—— undata, *G. O. Sars.*
—— striata, *G. O. Sars.*
Cytherura cellulosa (*Norman*).
Cytheropteron latissimum (*Norman*).
Cytherideis subulata, *Brady.*
Sclerochilus contortus (*Norman*) & *var.* abbreviatus.
Paradoxostoma abbreviatum, *G. O. Sars.*
—— ensiforme, *Brady.*
—— pulchellum, *G. O. Sars.*

Off Seaton Carew, 4 fathoms; bottom of rather muddy sand.

Cythere semipunctata, *Brady.*
—— pellucida, *Baird.*
—— castanea, *G. O. Sars.*
—— porcellanea, *Brady.*
—— viridis, *Müller.*
—— Robertsoni, *Brady.*
—— villosa (*G. O. Sars*).
Loxoconcha pusilla, *B. & R.*
—— tamarindus (*Jones*).
Xestoleberis depressa, *G. O. Sars.*
Cytherura nigrescens (*Baird*).
—— similis, *G. O. Sars.*
—— flavescens, *Brady.*
—— striata, *G. O. Sars.*
—— angulata, *Brady.*
—— cuneata, *Brady.*
—— cellulosa (*Norman*).

Cytheropteron latissimum (*Norman*).
Cytherideis subulata, *Brady*.
Sclerochilus contortus (*Norman*).
Paradoxostoma variabile (?), (*Baird*).
Paradoxostoma abbreviatum, *G. O. Sars*.
—— ensiforme, *Brady*.
—— Fischeri, *G. O. Sars*.
—— flexuosum, *Brady*.

No new species occur in the gatherings from this district; but the following interesting points may be noted. *Goniocypris mitra* has not been met with in any other locality out of the range of the "East-Anglian" or Fen-district. *Candona similis* was previously unknown to us except from the Dublin specimens described above (p. 52). The occurrence of *Cythere albomaculata* in a purely freshwater lake at Bolam is very remarkable, it being a species which in general, though very abundant in marine littoral situations, seems rather to shun any admixture of fresh water. The Bolam specimens are very poor and stunted, but there can be no doubt whatever as to their identity. *Cythere cuneiformis* we have been used to consider a deep-water species; but the specimens obtained between tide-marks at Whitley are the only living ones we have seen, and are very fine and well-conditioned. *Paradoxostoma obliquum*, from the same locality, and also living, is new to the east coast. The single specimen of *Cythere borealis* from Seaton Carew is much battered and worn, but can scarcely be referred to any other species. It has not previously been met with, except in the Arctic seas.

Cytherideis subulata, Brady. Pl. I. figs. 12, 13, and Pl. II. figs. 11–13.

The Seaton Carew shore specimens of this species are the first which we have found in the living state; and from the one or two which were available for dissection, we have been enabled to gather the following generic characters:—

Genus Cytherideis, Jones.

Superior antennæ (Pl. II. fig. 11) slender, sparingly setose; last joint short, and bearing six short terminal setæ; penultimate and antepenultimate joints each bearing a single apical seta. Mandible (fig. 12) slender and curved, divided below into about four very small indistinct teeth; palp four-jointed, its first joint bearing on the inferior margin a conical tooth-like process; third joint set along its entire length with a comb-like series of straight equal setæ; in other respects as in *Cythere*. First segment of the maxillæ (fig. 13) much stouter and larger than the rest.

The form of *C. subulata* already mentioned as occurring at Ilfracombe is figured in Pl. I. figs. 12, 13.

6. Frith of Clyde.

Kames Bay, Cumbrae; on sandy rocks near low-water mark.

Potamocypris fulva (*Brady*).
Cythere albomaculata, *Baird*.
—— lutea, *Müller*.
—— convexa, *Baird*.
—— villosa (*G. O. Sars*).
—— viridis, *Müller*.
—— angulata (*G. O. Sars*).
—— rubida, *Brady*.
—— badia, *Norman*.
—— pellucida, *Baird*.
—— pulchella, *Brady*.
—— gibbosa, *B. & R.*
Cytheridea elongata, *Brady*.
Loxoconcha impressa (*Baird*).
—— tamarindus (*Jones*).
Xestoleberis aurantia (*Baird*).
Cytherura cellulosa, *G. O. Sars*.
—— undata, *G. O. Sars*.
—— flavescens, *Brady*.
—— cuneata, *Brady*.
—— nigrescens (*Baird*).
Cytherideis subulata, *Brady*.
Paradoxostoma variabile (*Baird*).
—— hibernicum, *Brady*.

Rothesay Bay, 2–12 *fathoms*; *Roseneath, for half a mile east of Pier, mud and sand.*

* Species occurring in Rothesay gathering only.
† ,, ,, Roseneath only.

*Pontocypris mytiloides (*Norman*).
†Cythere lutea, *Müller*.
—— villosa, *G. O. Sars*.
—— pellucida, *Baird*.
†—— castanea, *G. O. Sars*.
†—— porcellanea, *Brady*.
—— tenera, *Brady*.
—— viridis, *Müller*.
†—— convexa, *Baird*.
—— Robertsoni, *Brady*.
*—— crispata, *Brady*.
—— cuneiformis, *Brady*.
—— angulata (*G. O. Sars*).
—— tuberculata (*G. O. Sars*).
—— concinna, *Jones*.
—— dunelmensis (*Norman*).
*—— antiquata (*Baird*).
—— Jonesii (*Baird*).
Cytheridea punctillata, *Brady*.
—— papillosa, *Bosquet*.
†—— elongata, *Brady*.
*—— subflavescens, *Brady*.
†Eucythere Argus (*G. O. Sars*).
—— declivis (*Norman*).
†Ilyobates bartonensis (*Jones*).
Loxoconcha impressa (*Baird*).
—— granulata, *G. O. Sars*.
—— tamarindus (*Jones*).
*—— guttata (*Norman*).
*Loxoconcha multifora (*Norman*).
†Xestoleberis depressa, *G. O. Sars*.
†Cytherura nigrescens (*Baird*).
*—— similis, *G. O. Sars*.
—— striata, *G. O. Sars*.
—— cuneata, *Brady*.
—— undata, *G. O. Sars*.
†—— angulata, *Brady*.
*—— producta, *Brady*.
*—— gibba, *Müller*.
—— acuticostata, *G. O. Sars*.
†—— cellulosa (*Norman*).
†Cytheropteron nodosum, *Brady*.
*—— inornatum, n. sp.
*—— alatum, *G. O. Sars*.
†—— angulatum, n. sp.
†Bythocythere constricta, *G. O. Sars*.
—— turgida, *G. O. Sars*.
—— simplex (*Norman*).
Sclerochilus contortus (*Norman*).
†Xiphichilus tenuissima (*Norman*).
†Paradoxostoma variabile (*Baird*).
†—— abbreviatum, *G. O. Sars*.
†—— ensiforme, *Brady*.
*—— flexuosum, *Brady*.
†Philomedes interpunctata (*Baird*).
*Asterope Mariæ (*Baird*).
*Polycope orbicularis, *G. O. Sars*.

Greenock, off the Pier, 2–6 fathoms.

Cypris compressa, *Baird.*
Cypridopsis obesa, *B. & R.*
Candona albicans, *Brady.*
Cythere pellucida, *Baird.*
—— castanea, *G. O. Sars.*
—— porcellanea, *Brady.*
—— viridis, *Müller.*
—— crispata, *Brady.*
—— lutea, *Müller.*
—— villosa (*G. O. Sars*).
—— angulata (*G. O. Sars*).
—— tuberculata, *G. O. Sars.*
—— gibbosa, *B. & R.*
Cytheridea papillosa, *Bosquet.*
—— torosa (*Jones*), *var.* teres.
Eucythere Argus (*G. O. Sars*).
Loxoconcha tamarindus (*Jones*).
—— pusilla, *B. & R.*
—— impressa (*Baird*).
—— granulata, *G. O. Sars.*
—— fragilis, *G. O. Sars.*
Cytherura nigrescens (*Baird*).
—— cuneata, *Brady.*
—— Robertsoni, *Brady.*
—— cellulosa (*Norman*).
Paradoxostoma variabile (*Baird*).

The first three species in the Greenock list were in all probability washed down from some habitat higher up stream; but the gathering is characterized by the presence of several species indicating a sensible admixture of fresh water: e. g. *Cythere castanea*, *C. porcellanea*, *C. gibbosa*, *Cytheridea torosa*, *Loxoconcha pusilla*, *L. fragilis*, and *Cytherura Robertsoni*. Some, if not all, of these may doubtless be occasionally met with in purely marine situations; but their presence together, constituting one third of all the marine species in the gathering, gives an unmistakably brackish aspect to the group.

The most noteworthy species in the Clyde lists are *Bythocythere turgida*, which occurred in greater abundance and better condition than we have previously witnessed, and three species of the genus *Cytheropteron*, two of which (*C. inornatum* and *C. angulatum*) are new to us in the recent state, though we had found the latter sparingly as a fossil in certain glacial clays. The other species (*C. alatum*, Sars) has been recorded by Mr. Norman as an inhabitant of the British Seas, on the strength of a single specimen dredged a few miles east of the Island of Balta, Shetland. We are now able to add two habitats in the Frith of Clyde, Kilchattan Bay and Rothesay Bay, both in the Island of Bute. Mr. Norman having already (last Shetland Dredging Report) quoted Sars's description of the species, it is needless here to redescribe it: we, however, give figures (Pl. II. figs. 4, 5, 6) from British examples, which will more vividly realize one of the most beautiful and remarkable of British Ostracoda. The Clyde specimens are rather smaller, and have the spinous armature of the alæ less perfectly developed than those from Norway, for examples of which we are indebted to the kindness of Dr. Sars; they also exhibit, when viewed from above, a remarkable appearance on each valve, as of a large obsolete indentation, covered in up to the edge of the valve with a thin transparent coating of shell. When closely examined, the Norwegian specimens likewise exhibit traces of this structure, but very indistinctly.

Argillœcia cylindrica, G. O. Sars.

A few specimens which appeared to be referable to this species were dredged off Greenock Pier. Further examination of the living animal, however, is needful before we can pronounce positively as to its identity.

Pontocypris hispida, G. O. Sars.

Some very fine and well-characterized examples were dredged off Cumbrae; and we have some even finer from Ventry Bay, Ireland. From a careful comparison of these with undoubted specimens of *P. mytiloides*, we think there can be no doubt that the two forms are only varieties of one and the same species. The chief distinctive characters, according to Sars, are as follows :—

P. mytiloides, dark brown, sparingly hispid, with short hairs; 8 posterior serrations.
P. hispida, yellowish, densely hispid, with long hairs; 5 posterior serrations.

Some of our examples of *P. hispida*, however, are even darker in colour than is usual with *P. mytiloides*; the degree of pubescence is subject to very great variation; and the same may be said of the number and prominence of the marginal serratures: of the anatomical differences pointed out by Sars, all we can say is that we have failed to detect any such in our specimens. Under these circumstances, we cannot hesitate to class both forms under the specific name *mytiloides*.

Cytheropteron inornatum, n. sp. Pl. II. figs. 1–3.

Carapace, as seen from the side, subrhomboidal, highest in the middle, greatest height equal to about two thirds of the length: anterior extremity narrowed, obliquely rounded; posterior produced in the middle into a very broad, subtruncate beak: superior margin well arched; inferior almost straight, slightly sinuated in front of the middle, and curved upwards behind. Seen from above, broadly triangular, the base or posterior side of the triangle produced into a very large central mucro; lateral angles almost rectangular, the sides thence tapering evenly with a very slight curve to the acuminate anterior extremity; greatest width equal to nearly four fifths of the length. End view subtriangular, with broad truncate apex, concave sides, and almost straight base. Surface of the shell perfectly smooth, or marked with a very few distant puncta, the posterior portion behind the alæ more or less rugose; lateral alæ very prominent, produced to a rectangular point. Animal unknown. Length $\frac{1}{55}$ inch.

Hab. Rothesay, Frith of Clyde.

This species approaches very nearly one which we have been accustomed to refer to *C. vespertilio** (Reuss), but differs in having a less arcuate dorsal margin, in the absence of spines at the alar angles, and in the less distinctly papillose or punctate shell: the corrugations of the posterior extremity we have not noticed in *C. vespertilio*.

Cytheropteron angulatum, n. sp. Pl. II. figs. 7, 8.

Carapace, as seen from the side, flexuous, subrhomboidal; greatest height in the middle, and equal to nearly two thirds of the length: anterior extremity rounded; posterior obliquely subtruncate, narrowed, and forming an obscurely upturned beak: superior margin boldly arched, somewhat flattened in the middle; inferior nearly straight, curving upwards towards the hinder extremity. Seen from above, subpentagonal, boat-shaped, widest in front of the middle, acuminate in front, broadly and rectangularly truncate behind; from the widest point the sides converge suddenly and almost rectilinearly forwards; behind they are markedly sinuous and less abruptly convergent; greatest width a little less than the height. The surface of the shell is exceedingly rugged, the lateral alæ not very much produced, but having, some little distance within and parallel to the margin, a strongly marked longitudinal ridge, from which several irregularly flexuous ribs stretch transversely across the valves, coalescing here and there into large rounded eminences, and having in their interspaces numerous irregularly angulated depressions. Length $\frac{1}{52}$ inch.

Hab. Roseneath, Frith of Clyde.

This very remarkable and distinct species occurs also, in the fossil state, in some of the glacial clays of the Clyde district.

7. Spitzbergen.

Cythere laticarina, *Brady*.	Cythere concinna, *Jones*.
—— emarginata, *G. O. Sars*.	—— mirabilis, *Brady*.
—— tuberculata, *G. O. Sars*.	—— dunelmensis (*Norman*).
—— globulifera, *Brady*.	Cytheridea papillosa, *Bosquet*.

* See Brady, "On Ostracoda from the Arctic Seas," Ann. & Mag. Nat. Hist. July 1868.

Cytheridea punctillata, *Brady.*
—— sorbyana, *Jones.*
Xestoleberis depressa, *G. O. Sars.*
Cytherura similis, *G. O. Sars.*
—— concentrica, *MS.*
—— undata, *G. O. Sars.*
Cytheropteron latissimum (*Norman*).
?Bythocythere turgida, *G. O. Sars.*
Sclerochilus contortus (*Norman*).
Paradoxostoma variabile (*Baird*).
Polycope orbicularis, *G. O. Sars.*

We are indebted to our friend the Rev. H. W. Crosskey, F.G.S., for the opportunity of publishing this list, which, though it does not strictly fall within the scope of the present paper, is well worthy of comparison with the British lists. It will be seen that all the species are known as inhabitants of the British seas, more particularly of those washing the north of Scotland and Shetland. Besides those given in the list, there were amongst the specimens examined only one or two unknown or of doubtful identity. These dredgings were obtained by Mr. Lamont in his Polar Expedition of 1869, and were by him obligingly handed to Mr. Crosskey.

EXPLANATION OF THE PLATES.

Plate I.

Fig. 1. *Candona similis*, seen from left side. } ×60.
Fig. 2. The same, seen from above. } ×60.
Fig. 3. *Cypris* (?) *cambrica*, seen from left side. } ×60.
Fig. 4. The same, seen from above. } ×60.
Fig. 5. *Paradoxostoma orcadense*, male (?), seen from left side. } ×84.
Fig. 6. The same, female (?), seen from left side. } ×84.
Fig. 7. The same, ditto, seen from above. } ×84.
Fig. 8. *Paradoxostoma flexuosum*, seen from left side. } ×84.
Fig. 9. The same, seen from above. } ×84.
Fig. 10. *Cytherura quadrata*, seen from left side. } ×84.
Fig. 11. The same, seen from above. } ×84.
Fig. 12. *Cytherideis subulata* (? variety), seen from left side. } ×50.
Fig. 13. The same, seen from above. } ×50.

Plate II.

Fig. 1. *Cytheropteron inornatum*, seen from left side. } ×84.
Fig. 2. The same, seen from above. } ×84.
Fig. 3. The same, seen from the front. } ×84.
Fig. 4. *Cytheropteron alatum*, seen from left side. } ×84.
Fig. 5. The same, seen from below. } ×84.
Fig. 6. The same, seen from front. } ×84.
Fig. 7. *Cytheropteron angulatum*, seen from left side. } ×84.
Fig. 8. The same, seen from above. } ×84.
Fig. 9. *Metacypris cordata*, superior antenna. } ×250.
Fig. 10. The same, inferior antenna. } ×250.
Fig. 11. *Cytherideis subulata* (typical form), superior antenna. } ×210.
Fig. 12. The same, „ „ mandible and palp. } ×210.
Fig. 13. The same, maxilla. ×300.

Table of Distribution of British Ostracoda.

The asterisks indicate the comparative abundance of the various species, * meaning rare, ** of moderate frequency, *** very common.

	1. Channel Islands.	2. S.W. England (Devon, Cornwall, South Wales, &c.).	3. West of Ireland.	4. Irish Sea (Clyde District, Isle of Man, N. Wales, Dublin Bay, &c.).	5. N.W. Scotland (Skye, Hebrides, &c.).	6. N. Scotland (Orkney, Sutherland, &c.).	7. Shetland.	8. E. Scotland (Aberdeenshire, Montrose, Frith of Forth, &c.).	9. N.E. England (Northumberland, Durham, Yorkshire, and Dogger Bank).	10. S.E. England (Norfolk, Fen-district, Thames, &c.).
Cypris										
fusca, *Strauss*	....	....	....	**	....	....	....	**	**	**
incongruens, *Ramdohr*	....	....	*	**	....	....	....	....	*	**
virens (*Jurine*)	....	....	....	***	....	....	....	....	**	**
obliqua, *Brady*	....	....	....	**	....	....	....	....	*	*
ornata, *Müller*	....	....	....	....	....	....	....	....	*	
ventricosa, *B. & R.*	....	....	....	....	....	....	....	....	....	*
tumefacta, *B. & R.*	....	....	....	....	....	....	....	....	*	
prasina, *Fischer*	....	*	....	*	....	....	....	....	*	*
elliptica, *Baird*	....	....	....	....	....	....	....	....	....	*
punctillata, *Norman*	....	....	....	....	....	....	....	*	*	
bispinosa, *Lucas*	*	....	*							
gibbosa, *Baird*	....	....	....	....	....	....	....	....	....	*
tessellata, *Fischer*	....	....	*	....	....	....	....	....	**	*
clavata, *Baird*	....	....	....	....	....	....	....	....	....	*
salina, *Brady*	....	....	....	**	....	....	....	*	**	
gibba, *Ramdohr*	....	**	....	**	....	....	....	**	***	**
trigonella, *Brady*	....	*								
reptans (*Baird*)	....	**	**	***	....	....	....	**	***	***
serrata (*Norman*)	....	*	....	....	....	....	....	....	*	
compressa, *Baird*	....	**	***	***	....	....	**	**	***	***
striolata, *Brady*	....	....	**	*	....	....	....	*	*	*
ovum (*Jurine*)	....	....	*	**	....	....	**	*	**	***
lævis, *Müller*	....	....	**	***	....	....	....	*	**	***
cinerea, *Brady*	....	....	....	....	....	....	....	....	*	
Joanna, *Baird*	....	....	....	....	....	....	....	*		
cambrica, *B. & R.*	....	*								
Cypridopsis										
vidua (*Müller*)	....	**	**	***	....	....	....	....	**	***
obesa, *B. & R.*	....	**	**	**	....	....	....	....	*	***
Newtoni, *B. & R.*	....	....	....	....	....	....	....	....	....	*
villosa (*Jurine*)	....	....	*	**	....	....	....	*	**	
aculeata (*Lilljeborg*)	....	*	....	**	....	....	....	*	**	**

Potamocypris										
fulva, (*Brady*)	....	*	*	*	....	*	....	*	*	*
Goniocypris										
mitra, *B. & R.*	....	....	....	....	....	....	....	*	....	*
Aglaia										
complanata, *B. & R.*	....	....	*							
Paracypris										
polita, *G. O. Sars* ...	**	....	....	....	**	....	**			
Notodromas										
monachus (*Müll.*) ...	....	....	*	**	....	....	....	....	**	*
Candona										
albicans, *Brady*	....	**	....	*	....	....	....	*	*	**
lactea, *Baird*	....	*	**	**	....	....	....	*	**	**
compressa (*Koch*) ...	....	....	....	*	....	....	....	*	....	**
candida (*Müller*) ...	....	**	**	***	....	....	....	**	***	***
detecta (*Müller*)	....	....	....	***	....	....	....	*	*	**
similis, *Baird*	....	....	....	*	....	....	....	....	*	*
Kingsleii. *B. & R.* ...	....	....	*	*	....	....	....	*	....	*
diaphana, *B. & R.* ...	....	....	*	....	....	....	....	....	....	*
hyalina, *B. & R.*	....	*	....	....	....	....	....	....	....	*
Argillœcia										
aurea, *B. & R.*	....	....	....	....	....	....	....	....	....	*
angusta (*Brady*)	....	*	*	....	....	....	....	*	....	*
cylindrica, *G. O. Sars*	....	....	....	*						
Pontocypris										
mytiloides (*Norman*)	**	**	***	**	**	**	**	*	**	*
acupunctata, *Brady* ...	....	....	*	....	*	....	*			
trigonella, *G. O. Sars*	**	*	**	**	....	**	*	....	*	*
Bairdia										
inflata (*Norman*)......	*	*	**	**	*	*	*			
acanthigera, *Brady* ...	*	**								
obtusata, *G. O. Sars*	....	....	....	....	*					
complanata, *Brady* ...	....	....	....	....	*	....	*			
Macrocypris										
minna (*Baird*)	....	....	....	....	....	....	*			
Loxoconcha										
multifora (*Norman*)	*	*	*	*	**	*	**	*	*	*
impressa (*Baird*)......	***	***	***	***	....	**	**	*	*	**
granulata, *G. O. Sars*	....	**	*	**	....	....	....	....	*	

TABLE (*continued*).

	1. Channel Islands.	2. S.W. England (Devon, Cornwall, South Wales, &c.).	3. West of Ireland.	4. Irish Sea (Clyde District, Isle of Man, N. Wales, Dublin Bay, &c.).	5. N.W. Scotland (Skye, Hebrides, &c.).	6. N. Scotland (Orkney, Sutherland, &c.).	7. Shetland.	8. E. Scotland (Aberdeenshire, Montrose, Frith of Forth, &c.).	9. N.E. England (Northumberland, Durham, Yorkshire, and Dogger Bank).	10. S.E. England (Norfolk, Fen-district, Thames, &c.).
Loxoconcha										
elliptica, *Brady*	**	....	*	*	....	....	....	*	**	***
tamarindus (*Jones*) ...	***	***	***	***	**	**	***	**	***	**
pusilla, *B. & R.*	....	....	....	*	....	....	....	**	**	*
fragilis, *G. O. Sars*...	....	....	....	*	....	....	....	*	*	*
guttata (*Norman*) ...	....	*	**	**	**	**	**	**	***	*
Xestoleberis										
aurantia (*Baird*)	**	**	***	*	....	....	**	**	**	*
depressa, *G. O. Sars*	**	**	***	**	**	**	***	**	***	
Cytherura										
nigrescens (*Baird*) ...	**	**	**	***	*	*	**	**	**	**
flavescens, *Brady*......	....	*	*	*	....	*	*	*	*	*
angulata, *Brady*	....	**	**	**	*	*	*	*	*	*
producta, *Brady*	....	....	*	*	*	....	*	....	*	*
striata, *G. O. Sars* ...	*	**	**	*	**	*	**	**	**	**
lineata, *Brady*	....	....	....	....	*	....	*			
cuneata, *Brady*.........	*	*	**	*	*	*	*	**	**	**
Sarsii, *Brady*	....	....	....	*						
simplex, *B. & R.*	....	....	....	....	....	....	....	....	....	*
similis, *G. O. Sars* ...	....	*	*	*	....	*	*	*	*	*
undata, *G. O. Sars* ...	....	....	**	**	**	**	**	*	*	
affinis, *G. O. Sars* ...	....	....	....	....	....	*	*	*	*	
Robertsoni, *Brady* ...	....	....	*	**	....	....	....	*	**	**
gibba (*Müller*).........	....	....	*	*	....	*	*	*	*	*
cornuta, *Brady*	....	....	*	*	....	*	*	....	*	
acuticostata, *G. O. Sars*	*	**	**	**	*	*	**	*	*	*
insolita, *Brady*	....	....	....	....	....	*				
pumila, *Brady*.........	....	....	....	....	....	....	*	*		
concentrica, *C., B. & R., MS.*	....	....	....	....	....	....	*			
propinqua, *B. & R.*....	....	....	....	....	....	....	....	....	....	*
quadrata, *Norman* ...	....	*	....	....	....	....	*			

navicula, *Norman* ...	....	....	....	....	....	....	*			
cellulosa (*Norman*)...	*	*	**	*	....	*	**	*	**	*
clathrata, *G. O. Sars*.	....	....	....	*	....	....	*	*	*	*
Sarsiella										
capsula, *Norman*......	....	....	....	....	....	....	*			
Cytheropteron										
subcircinatum, *G. O.*										
Sars	....	*	*							
latissimum (*Norman*).	....	*	....	**	....	**	**		**	**
pyramidale, *Brady* ...	....	*								
nodosum, *Brady*	....	*	**	*	*	....	**	*	*	*
punctatum, *Brady* ...	....	*	....	*	*	....	*			
inornatum, *B. & R.*...	....	....	....	*						
alatum, *G. O. Sars* ...	....	....	....	*	....	....	*			
angulatum, *B. & R.*...	....	....	....	*						
rectum, *Brady*.........	....	....	*	....	....	....	*	....	....	*
Bythocythere										
simplex (*Norman*) ...	....	....	....	**	*	....	*	**	*	
constricta, *G. O. Sars*	**	**	**	**	**	*	**	*	*	
turgida, *G. O. Sars*...	....	*	....	*	....	....	*	....	*	
Pseudocythere										
caudata, *G. O. Sars*...	*	*	*	**	*	*	*	*	*	
Cytherideis										
subulata, *Brady*	**	**	*	**	....	**	....	*	**	*
Sclerochilus										
contortus (*Norman*)...	**	**	**	***	**	**	***	**	**	**
Xiphichilus										
tenuissima (*Norman*).	....	....	....	*	....	....	*	*	*	
amygdaloides, *Brady*	....	....	....	....	....	....	*			
Paradoxostoma										
variabile (*Baird*)......	***	**	**	**	**	**	***	**	***	**
abbreviatum, *G. O. Sars*	....	*	**	**	**	*	*	*	**	*
Normani, *Brady*	*	*	....	....	*	....	**	*	*	
pulchellum, *G. O. Sars*	**	....	**	*	*	....	....	....	*	
Fischeri, *G. O. Sars* .	....	**	**	*	....	....	....	*	**	**
obliquum, *G. O. Sars*	*	*	**	*	*	....	*	*	*	
Hodgii, *Brady*.........	....	....	....	....	....	....	....	....	*	
orcadense, *B. & R.* ...	....	....	....	....	....	....	*			

TABLE (*continued*).

	1. Channel Islands.	2. S.W. England (Devon, Cornwall, South Wales, &c.).	3. West of Ireland.	4. Irish Sea (Clyde District, Isle of Man, N. Wales, Dublin Bay, &c.).	5. N.W. Scotland (Skye, Hebrides, &c.).	6. N. Scotland (Orkney, Sutherland, &c.).	7. Shetland.	8. E. Scotland (Aberdeenshire, Montrose, Frith of Forth, &c.).	9. N.E. England (Northumberland, Durham, Yorkshire, and Dogger Bank).	10. S.E. England (Norfolk, Fen-district, Thames, &c.).
Paradoxostoma										
hibernicum, *Brady* ...	....	*	*	*	*	....	....	....	*	
sarniense, *Brady*	**	**								
ensiforme, *Brady* ...	*	**	**	*	*	*	**	*	**	**
flexuosum, *Brady* ...	....	*	**	*	*	*	**	*	*	*
arcuatum, *Brady*......	....	....	*	....	....	....	*	*		
Darwinella										
Stevensoni, *B. & R.*...	....	*	*	*	....	....	....	....	....	**
Metacypris										
cordata, *B. & R.*	....	....	*	....	....	....	....	....	....	*
Cythere										
lutea, *Müller*	*	*	*	***	**	**	***	*	***	**
viridis, *Müller*	**	**	***	***	....	*	**	**	**	*
pellucida, *Baird*	**	***	**	***	**	**	**	**	**	***
castanea, *G. O. Sars* .	....	**	*	**	....	*	....	**	***	***
porcellanea, *Brady* ...	....	**	**	*	....	*	....	**	**	**
macallana, *B. & R.* ...	....	*	**	*	....	....	....	....	*	
tenera, *Brady*	....	**	**	**	....	*	*	....	*	**
crispata, *Brady*	....	*	**	**	....	*	....	*	....	*
badia, *Norman*.........	*	*	....	*						
gibbosa, *B. & R.*	....	....	*	*	....	....	....	*	*	
Robertsoni, *Brady* ...	....	*	*	**	....	....	....	**	*	*
oblonga, *Brady*	....	*								
rubida, *Brady*	....	....	....	*						
convexa, *Baird*	**	*	***	***	....	**	*	*	....	*
albomaculata, *Baird*. .	***	***	***	***	....	**	***	*	***	***
leioderma, *Norman* ...	....	....	....	....	....	....	*			
pulchella, *Brady*	....	*	*	*	*	*	*	*		
villosa (*G. O. Sars*) ...	**	**	**	***	**	**	**	*	*	**
fuscata, *Brady*.........	....	....	....	....	....	....	....	....	....	**
cuneiformis, *Brady* ...	*	*	*	*	....	*	....	*	*	*
limicola (*Norman*) ...	....	....	....	*	....	....	....	*	*	

globulifera, *Brady* ...	....	....	*	....	....	....	....	....	....	*
tuberculata (*G. O. Sars*)	**	**	**	**	**	**	*	**	***	**
concinna, *Jones*	....	....	*	**	*	*	*	*	*	
borealis, *Brady*	....	....	....	....	....	....	....	....	*	
angulata (*G. O. Sars*)	....	....	*	**	*	**	*	*	*	
emarginata(*G.O.Sars*)	....	....	....	*	....	....	*			
dubia, *Brady*	....	....	....	....	....	....	*	....	....	*
finmarchica, *Sars* ...	*	*	*	*	....	*	*	....	*	*
abyssicola (*Sars*)......	....	....	....	....	....	....	*	....	....	*
crenulata (*Sars*)	....	....	....	....	....	....	*			
costata, *Brady*.........	....	....	....	....	....	....	*			
Jeffreysii, *Brady*......	*	*	*							
laticarina, *Brady* ...	*	....	....	*						
marginata, *Norman*...	....	....	....	*						
quadridentata, *Baird*	....	....	*	*	....	*	**	....	*	
emaciata, *Brady*	....	**	**	*	....	*	*	*	*	*
mirabilis, *Brady*......	....	....	....	....	*					
mucronata (*G. O. Sars*)	....	....	....	....	....	....	*			
dunelmensis(*Norman*)	....	....	*	**	....	*	....	*	*	
Whiteii (*Baird*)	....	*	....	*	....	....	....	....	....	*
antiquata (*Baird*) ...	....	*	**	**	....	....	**	*	....	*
Jonesii (*Baird*)	....	*	*	*	*	*	*	*	*	
fidicula, *B. & R.*......	....	....	....	....	....	....	*	....	....	*
acerosa, *Brady*.........	....	*	....	....	....	*	*	....	....	*
semipunctata, *Brady*.	....	*	*	....	....	....	....	*	*	*
Limnicythere										
inopinata (*Baird*) ...	....	*	....	**	....	....	....	*	***	***
monstrifica (*Norman*)	....	....	....	....	....	....	....	*	....	*
Sancti-Patricii, *B.&R.*	....	....	*	....	....	....	....	....	....	**
Cytheridea										
elongata, *Brady*	**	***	**	**	....	**	....	**	....	***
cornea, *B. & R.*	....	....	*	*	....	....	....	*	*	**
papillosa, *Bosquet* ...	....	....	....	**	....	....	*	*	**	*
punctillata, *Brady* ...	....	....	....	**	....	....	*	*	*	*
torosa (*Jones*)	*	**	....	*	....	....	....	*	***	***
lacustris (*G. O. Sars*)	....	....	....	**	....	....	....	....	....	*
Sorbyana, *Jones*	....	....	....	*	....	....	*			

TABLE (*continued*).

	1. Channel Islands.	2. S.W. England (Devon, Cornwall, South Wales, &c.).	3. West of Ireland.	4. Irish Sea (Clyde District, Isle of Man, N. Wales, Dublin Bay, &c.).	5. N.W. Scotland (Skye, Hebrides, &c.).	6. N. Scotland (Orkney, Sutherland, &c.).	7. Shetland.	8. E. Scotland (Aberdeenshire, Montrose, Frith of Forth, &c.).	9. N.E. England (Northumberland, Durham, Yorkshire, and Dogger Bank).	10. S.E. England (Norfolk, Fen-district, Thames, &c.).
Cytheridea										
zetlandica, *Brady* ...	....	....	....	....	....	....	*			
subflavescens, *Brady*.	....	....	....	*	*	....	*			
inæqualis, *B. & R.* ...	....	....	....	....	....	....	....	....	....	*
Eucythere										
declivis (*Norman*) ...	*	**	**	*	*	*	**	*	**	*
Argus (*G. O. Sars*)...	....	*	*	*	....	*	*	*	**	*
anglica, *Brady*	....	....	....	*	....	....	....	*	*	
Ilyobates										
bartonensis (*Jones*) ...	....	....	....	*	*	*	*	....	*	
Cypridina										
norvegica, *Baird*......	....	....	....	....	....	....	*			
Philomedes										
interpuncta (*Baird*) .	*	*	*	**	*	....	*	....	*	
Bradycinetus										
brenda (*Baird*)	....	....	....	....	....	....	*	....	*	
Macandrei (*Baird*)...	....	....	....	*	*					
Lilljeborgii, *G. O. Sars*	....	....	*							
Asterope										
teres (*Norman*)	*	*	....	*						
Mariæ (*Baird*).........	*	*	*	**	*	....	**			
Conchœcia										
obtusata, *G. O. Sars*.	....	....	....	....	....	....	*			
Polycope										
orbicularis, *G. O. Sars*	....	....	*	**	*	....	*			
compressa, *B. & R.*...	....	*	*	....	....	....	....	....	....	*
dentata, *Brady*.........	....	....	....	....	....	....	*			
Cytherella										
scotica, *Brady*	....	....	....	....	*	....	*			
lævis, *Brady*............	....	....	....	....	*					

VI.—*The American* Spongilla *a Craspedote Flagellate Infusorian.* By H. James-Clark, A.B., B.S., Prof. Nat. Hist. Kentucky University, Lexington, Ky.*

[Plate XI.]

The argument of Häckel and others, that the Sponges are essentially compound Polypi, is virtually based upon the assumption that the minor (afferent) and major (efferent) ostioles of the former correspond to the mouths of the latter, and that the profusely branching afferent and efferent canals of the Sponges are strictly comparable with similar canals in the polypidom of Halcyonarians—and, by implication, that the cilia-bearing cells of the interior lining wall of the zoophyte find their homologues in the ciliated cell-like bodies of the interior chambers of the Porifera. If, now, it should turn out that these last are not altogether mere cell-components of a tissue, but are each, severally, an independent body, although closely connected with others in a common bond, then the attempted parallelism between the two groups must utterly fail of confirmation. The tendency of Carter's later investigations, and our own too, is to show that this is no vain supposition.

For ourselves, we hold that each *ciliated body* of the sponge is a *cephalic* member (a *cephalid* in this case) of a polycephalic individual †. We believe, as far as we can understand his undecided, rather hesitating position, Carter's latest decision is that the sponge is a community of amœbous individuals ‡, and not a polycephalic unit. Yet, whichever view prevails, the tendency is the same, and the polyp theory is negatived most unquestionably. The incompatibility of the interior organisms of the two groups above mentioned is so great that it would seem as idle to elaborate a proof of it as to attempt the demonstration of an axiom. The question is really circumscribed, according to the method of Häckel, to arguing that, since a system of branching canals in the sponge reminds one very strongly of the intricate network of passage-ways in the basal parts of certain polyps, therefore the two are homologous and bear an identical relation to the rest of the organism. Carter has answered this far-fetched homology with considerable detail in a recent paper ("On new Sponges," &c., Ann. & Mag.

* From Silliman's American Journal, December 1871.

† See our article on "Polarity and Polycephalism," Sill. Am. Journ., January 1870.

‡ See Carter, "On Fecundation in the two *Volvoces*; on *Eudorina*, *Spongilla*," &c., Ann. & Mag. Nat. Hist., January 1859, also for July 1871, "On new Sponges," &c.

Nat. Hist., July 1871); and we do not, therefore, feel called upon to add more to it.

The principal aim of this article is to furnish new material in proof of the polycephalism of the Spongiæ, and particularly in regard to their relation with the *Protozoa flagellata.* We are highly pleased to find that Carter has lately (*ut sup.*, July 1871) confirmed our earliest observations* as to the organization of the collar-bearing monads of *Leucosolenia*, by an investigation of *Grantia compressa.* He has also accepted our interpretation of the horn-like processes of the sponge-cell of *Spongilla alba*, that they are the outlines of a membranous collar in profile.

We have now to bring forward a fourth example of a *craspedote* flagellate monad cephalid in a sponge. It seems to be a *Spongilla*; but specifically, at least in its monads, it differs from the English forms. For convenience' sake we will call it *Spongilla arachnoidea*, from its resemblance to an irregular spider-web. It lives in freshwater streams and ponds, usually about the bottom of the stems of water plants, or wherever there is considerable shade, apparently avoiding the light, as we seldom, if ever, found it in open water. In size it varies from a few inches to a half a line in diameter, of no definite shape, and has a uniform fuscous or yellowish-brown colour, and is wrapped about by a filmy, transparent, colourless envelope ("*investing membrane*," Carter). The brown colour is inherent to the interior mass, in which the groups of monads are imbedded; in fact the latter are themselves as strongly coloured by brown granular contents. The "investing membrane" is also slightly tinged with amber colour by the large and small spicules which are imbedded in it. Excepting in very small specimens, foreign matter is often so thickly spread over the surface as to obscure the view and seriously interfere with a correct interpretation of the relation of parts. We have been most fortunate in our endeavours with the minuter individuals, which occasionally, we found, would allow a view through and through their entire bulk, and of course left full opportunity for a satisfactory study of the details of special parts without our resorting to the dissecting-needles. Any one who knows by experience the intense contractility of the living sponge can appreciate the advantage of not being obliged to destroy and sever parts of an organism from their natural relations. Premising that thus every thing has been studied "in place," even to the details of the monads, we shall endeavour to de-

* Memoirs Boston Soc. Nat. Hist. vol. i. 1867, "On the Spongiæ ciliatæ as Infusoria flagellata;" Ann. & Mag. Nat. Hist., Feb., March, and April 1868.

scribe this sponge as if it were to be the type for future comparison.

General plan.—The whole individual sponge is endowed with a double envelope (Pl. XI. fig. 1, *a a*¹, *c d*) the outer and inner parts of which are directly continuous with each other at many points. The outer division (*a*, *a*¹) lies at a considerable distance from the monadigerous mass (*g*), and is, as it were, suspended on the points of the larger far-projecting spicules (*e*), just as a tent canvas is supported on the ends of poles. The inner division (*c*) closely embraces the monadigerous mass like an epidermis, and even plunges between the hollow groups of monads, forming to them a basis of support. The outer and inner divisions are continuous with each other at many points, as stated just now, but only where the larger spicules project. There the envelope (*d*) runs along the spicules, completely embracing them, as if in a sheath, from their tips to their bases, where they rest on the brown mass of monads. In brief, we might say that the sponge is covered with a miniature colonnade, whose ceiling is the outer division of the envelope, the pillars are the bundles of spicules, and the floor is tapestried by the inner division, which about the pillars hangs from the ceiling in lofty folds. The continuity of the outer division of the envelope is broken by numerous round or oval openings of various and frequently changing sizes, sometimes very large, which allow a free ingress of the water to the space just beneath. These are the *afferent ostioles* (*os*), through and into which a constant current of floating particles may be seen moving with considerable vivacity. Here and there, scattered at wide distances, finger-like hollow processes from the outer division arise singly and at various angles. Each is terminated by a large aperture, the *efferent ostiole*, from which a current of water and floating matter emerges with more or less spasmodic irregularity. The smaller individuals, from half a line to half an inch in diameter, possess only one such ostiole; and those an inch in diameter seldom have more than two or three like conduits; but they are very large, sometimes a quarter of an inch in length when fully extended, and of the proportions and taper of the human fore finger.

Plunging the focus of the objective to the floor of the colonnade, the inner division (*c*) there is found to be pierced by much more numerous openings (*i*), but far smaller in diameter and quite methodically arranged, each one corresponding to and overlying a hollow group of monads (*h*). The outer division is further embellished with irregularly scattered minute spicules (e^1), which lie imbedded in the cytoblastema, parallel with the surface of the envelope, and occasionally crossing each other at various angles. To complete this general sketch, we will state more definitely the relation of the constituents of the monadigerous mass. There are essentially but two elements here,—namely, the inner division (*c*) of the investing membrane, and the groups of monads (*h*) which are imbedded in it below its surface. In a fully expanded individual these groups seldom lie so closely as to touch each other. They vary considerably in size and are usually globular or spheroidal and form a single *stratum*, with rather narrow interspaces (c^1) between them.

It seems proper here, at least for the sake of precision, that the *cytoblastematous basis*, in which the monad groups are imbedded, should be considered apart from the epithelium-like inner (*c*) investing membrane which overlies it, although the two are essentially one, the epithelioid membrane, by prolonging itself between (at c^1) and beneath the groups, forming for them a continuous foundation. In this light, then, we shall speak of the monadigerous mass as consisting of three elements, —namely, the inner investing membrane proper, the group of monads, and the *cytoblastematous basis*. This *basis* seems to constitute a large part of the bulk of the body, since it occupies all of the interior space beneath the monad groups. In specimens which grow over flat surfaces in depressed patches, or around stems of plants, it forms a relatively thin layer; but where the body stands out as an irregularly rounded mass, sometimes an inch in diameter, the cytoblastematous basis fills up the interior, in enormous proportion to the bulk of the monad layer.

Organography.

The Investing Membrane.—The *investing membrane* (fig. 1, $a\ a^1 c d$) consists essentially of two histiological elements—namely, a very diffuse *cytoblastema* (a^1), and irregularly disposed cells (b, b^1, b^2) scattered through it. The intercellular *cytoblastema* forms a very thin layer (a^1) between the cells (*b*); but where the latter are imbedded in it, its outer and inner faces are as wide apart as the considerable depth of the cells demands; and thus it happens that the membrane (both the outer and the inner divisions) presents in profile (a^1, *c*, *d*) such an irregular thickness. The *cytoblastema* (a^1) is colourless, hyaline, and apparently homogeneous under a low power; but when magnified to about four hundred diameters, it displays a very finely granular aspect. It occupies wide intervals between the cells, certainly more than one half, and fully three fifths of the whole area of the membrane. Its apparent extent, in a general view, is even more than that, owing to the extreme transparency of the cells and their consequent inconspicuousness. That the cytoblastema, notwithstanding its low, undeveloped state, is the true contractile element in this membrane there can scarcely be a doubt, when we consider both its wide-spread preponderance and its relative continuity, as contrasted with the scattered, disconnected condition of the cells (b^2) which are imbedded in it. Sometimes it is barely possible to discover even the trace of a cell on the border of an afferent ostiole (*os*); and in that case we must infer, inevitably, that it is cytoblastema which opens and closes the aperture. We find it, too, embracing the extreme tips of the larger spicula, where the cells utterly fail to appear.

The *cell-element* (*b*) of this membrane is also in a lowly condition, only partially developed. There is no *cell-wall*. What may appear to be a wall is really the thin stratum of cytoblastema (a^1) overlying the distal and proximal faces of the cell. This is our conclusion after the most critical scrutiny with a carefully corrected objective. Were it not, indeed, for the usually constant presence of a distinct nucleus (*n*) in each cell, we should be strongly inclined to look upon it as merely a dense collection of coarser granules than are generally diffused through the cytoblastemic layer. The irregular and jagged outline and the caudate projections of the cells (b^2) also tend to tempt one to the latter view. The cell-element in this case, then, corresponds only to what is usually considered the cell-contents and a nucleus. The contents are composed of coarse and fine grey granules, which at times are quite conspicuous, but most frequently are so transparent and slightly refractive as to appear, collectively, unless specially focused upon, as a faint blotch in the investing membrane. This renders it all the more difficult to trace the outline of the cell, and particularly where it throws out irregular caudate prolongations to blend with those of other cells. We have been able to detect but one layer of cells in this membrane* when it is well stretched out. The depth of the cells, as may be seen in a sectional profile view (*b*), is about equal to their breadth; and their length is from one half to more than twice their breadth; but frequently they are as broad as long. They stand in no particular relation to the ostioles, and, as stated above, sometimes scarcely touch their border. The *nucleus* (*n*) may be readily detected by its peculiar strong refraction and its considerable superiority in size over the granules. Its bright refractiveness in this connexion reminded us of a contractile vesicle; but, although suspecting it of such a function, we could detect no change other than might be

* Carter figures two or three cells overlying each other in *Spongilla alba* (Ann. & Mag. Nat. Hist., July 1857, pl. 1. fig. 7).

produced by the varying length and breadth of the cell, and the shifting of the relative position of the coarse granules. In the *inner division* (*c*) of the investing membrane the cells are usually smaller than those in the outer division, but differ in no respect otherwise, either in form or arrangement. They lie flat on their sides in the cytoblastematous layer; but, except in profile, they are most difficult to discover, on account of the underlying brown mass of monad groups and granular interstitial substance.

We have been unable to discover any distinct cell-elements in the cytoblastematous mass immediately around and beneath the monad groups, nor have we found it possible to distinguish it from the cytoblastema lying on the surface; and since the continuity between the two is unbroken, we must, perforce, consider them as one. The underlying portion of the cytoblastematous mass, however, is characterized by irregularly scattered, moderately coarse, brown granules (c^1). These serve very well as a dark frame or setting to the monad-chambers (*h*), and by contrast bring them out more strongly.

The Monad Cephalids.—We now proceed to describe the most essential feature of this animal, the *monads*. They are the characterizing, the dominating element, in reference to which the whole organism is contrived and constructed. They are not cells; they are the *heads* of a polycephalic individual, and consequently correspond functionally to the tentaculated heads of Polypi, and not to their interior epithelial cells. We must first describe what we call the monad-chamber.

The *monad-chambers* (fig. 1, *h*, fig. 2, fig. 4) are deep spherical hollows which form the receptacles of the groups of monads (*j*). They are mere cavities, and have no lining wall*. They may be easily recognized in young specimens as clear, more or less circular, areas scattered in pretty close proximity to each other over the "cytoblastemic mass." Each chamber has a single, small, circular aperture (*i*) which perforates the inner (*c*) investing membrane, and allows egress into the circulatory apartment (*f*). The aperture (*i*) varies in size at times, and may even be completely closed. We have never seen it open wider than one third the diameter of the chamber, and very rarely more than one fifth as wide. That it is a true per-

* The hollow groups of monads were originally described by Carter (Ann. & Mag. Nat. Hist., July 1857) as lining a hypothetic vesicle, which he named the "ampullaceous sac." He has since (Ann. & Mag. Nat. Hist., January 1859) revoked that view and adopted another. We believe him to be, excepting the inferred "ampullaceous sac," in the main, right in his first interpretation; but as our species are different we cannot speak definitely.

foration, and not a clear spot, may be demonstrated by bringing a chamber into profile, so that its aperture (fig. 4, *i*) lies on the extreme border; for then an actual break in the continuity of the investing membrane becomes evident.

Entering this aperture, we do not meet with any obstacle for a little distance around it; there is a clear open space (fig. 4); but pressing onward beyond that, either to the right or the left or directly forward, the cavity appears filled by a collection of vibrating bodies. They seem to be arranged radiatingly from and about the centre. Close inspection, however, modifies this view, and it turns out that they are based upon the periphery of the chamber, and converge towards its centre, where is a small unoccupied space. We presently recognize these converging bodies to be *craspedote flagellate* monads (*j*), so closely packed together, side by side, as to form a continuous *stratum* (figs. 2 and 4) over the whole concave face of the chamber, excepting immediately about the aperture. Every feature of the monad is strongly marked; even the cylindrical collar is so heavy and conspicuous that its outlines may be seen with as low a power as two hundred diameters. We have studied these bodies with a $\frac{1}{8}$-inch objective, and found it not at all difficult to focus down upon the details of their organization without pressing upon or even touching the specimen.

These monads are in every general essential identical with those which we originally found in *Leucosolenia*, and like those also recently described by Carter (Ann. & Mag. Nat. Hist., July 1871) in *Grantia compressa*. They are attached to the concave face of the chamber by their posterior end (fig. 4, *j*); and the anterior extremity, with its flagellum (fig. 3, *l*) and collar (*k*), projects freely into the open space, and toward the centre of the apartment. When fully expanded, the length of the body and collar together is about one third, or a little more, of the diameter of the chamber, so that nearly one third of the latter is unoccupied at the centre, except by the tips of the flagella converging from every direction. As the monads lie touching each other on every side (fig. 2), they mutually flatten their bodies, sometimes so much so as to give them a strong polygonal outline; or, when the whole mass is expanded, they scarcely impress each other, and therefore retain a rounded contour. By plunging the focus so as to look into the aperture of a chamber, down upon the monads at the bottom (fig. 2) of it, an end view of each cephalid is obtained. From this point the foreshortened cylindrical collar looks like a strong dark circle (fig. 3^a, *k*), which retains its conspicuousness as we plunge down further, even to the base, where it is attached to the body (*j*). The outline of the latter is considerably without the "dark circle," the two being concentric to each other. At the same time we see in the centre of the dark circle a black spot (*l*) which may also be focused up and down upon, and hence it is inferred to be a continuous line foreshortened. Other views (fig. 3, *l*) confirm this, and show that it is a single *flagellum*. The monads are so transparent, and the organization so distinct, that the collar and flagellum may be seen clearly from an opposite point of view, looking directly through the body of the cephalid. This, too, is the best position from which to study the *contractile vesicles*.

A sectional profile view of a group (fig. 4), to be obtained by plunging the focus halfway through a chamber, serves best to disclose the manner in which the posterior ends (*j*) of the monads are affixed to the concave face of their receptacle; and we also here obtain a strictly profile aspect of a monad. Figure 3 is such a view, representing a single cephalid under a much higher power than in figures 2 or 4. An excellent and least-obstructed side view, but not strictly a profile, is to be had by focusing upon the monads immediately about the aperture of the chamber. Here we look directly into the doorway, or through the bordering transparent epithelioid membrane which it penetrates.

The body proper (fig. 3, *j*) of a cephalid is a little shorter than it is broad, on the whole spheroidal in shape. Its posterior end is broadly rounded; and so is its anterior extremity. In front arises a cylindrical membranous "collar" (*k*), which tapers slightly and projects forward to a distance equal to considerably more than twice the length of the body. Its diameter is not more than two thirds, or even less than that, of the body. Although colourless and homogeneous, it is remarkably conspicuous, on account of the thickness of the membrane of which it is composed. Near its open extremity it is more transparent and less obvious than towards its basal attachment.

The *flagellum* (*l*) arises from the centre of the anterior end of the body, in the midst of the area which is surrounded by the membranous cylinder (*k*), and, without tapering, extends a little further than the open end of the latter. It vibrates usually throughout its length, but is most active near its tip. We have never seen it assume a rigid, arcuate position, as in some other species of monads. It is particularly remarkable for its want of transparency, and looks like a black thread more than any vibrating cilium that we have ever met with. Its action, at times, is rather that of a strong wriggle than a vibration.

The *contractile vesicles* (*v*).—The body of the monad is distinctly marked by a coarse, scattered, brown granulation, with two or three rather large clear spots at a considerable distance from each other, but always close to the periphery. These clear areas are the *contractile vesicles* (*v*). They do not occupy any particular place in the body, although usually they are not in front. The systole and diastole are extremely slow, but very distinct, if sufficient patience is summoned to watch them fixedly and without interruption. The last third of the systole is abrupt; and then only does the vesicle appear to contract suddenly; whereas by watching it through a complete circuit of diastole and systole, one learns that its function is, on the whole, performed very slowly. This very abrupt movement, quite happily, may serve to rebut any such objection as that the otherwise tardy action is merely the result of protoplasmic contraction of the body as in certain palmellate zoospores. Their immovable position, as regards the body-contents, is another item of rebutting evidence.

The *spicula* (fig. 1, *e* e^1) are very slender, slightly curved, needle-shaped bodies, gradually tapering to a sharp point at each end. They have a bright amber colour, and a rather dark, strongly refractive outline. From tip to tip they are slightly roughened by irregularly scattered, low, but acute prominences or knobs. There are two kinds of spicules, large and small; but they differ in no other respect. The larger (*e*) are from four to six times as long and thick as the smaller ones; they occur in bundles of two, three, or four, and act as props to hold up the outer investing membrane, as described in the early part of this article. They seldom arise perpendicularly from the monadigerous mass, but more or less obliquely, and, in forming bundles, stand across each other like stacked arms. We seldom found spicules penetrating the monadigerous mass far beyond the epithelioid inner investing membrane. They evidently belong, universally, to the investing membrane, and assist it in forming a framework in which the inner mass is suspended. The *smaller spicules* (e^1) are strictly confined to the outer division (*a*) of the investing membrane, and lie there on their sides, completely immersed in its thickness. They are scattered irregularly and sparsely about, and frequently cross each other at varying angles. We observe no nearer approach to a methodical arrangement among either the large or the small spicules; yet their very irregularity, being after a kind, and constant in that kind, may be recognized in some sense as methodical.

General Considerations.—Seeing the secluded position of the monad cephalids, deeply ensconced in little chambers below the general surface of the circulatory apartment, it is not directly evident that their *flagella* have any agency in keeping up the inflow and outflow of currents through the afferent and efferent ostioles. Nowhere else are vibrating or non-vibrating cilia or cilia-like bodies to be met with than in the monad-chambers; and since the efferent ostioles are irregularly interspersed among the much more numerous afferent ostioles, we cannot conceive how the flagella in any way could influence currents to move in a particular direction from the smaller apertures toward the larger ones. They no doubt keep up a direct flow of matter into the sunken chambers; but the current comes from the inner depths of the circulatory apartment, and far away from the ostioles. In this way, only a turbulence of floating matter is sustained; but the general great current is due to a far different cause. We conceive that the contraction and expansion of the body-mass in general, modified by the alternate opening and closing of the afferent and efferent ostioles, is the true motive power in this phenomenon. We have observed, often, that the outer division of the investing membrane is not kept at a uniform distance from the central monadigerous mass: at one place it will be found to be close to its inner division, so that the circulatory apartment is very shallow there; while at another point the two divisions of the membrane are widely separated, and the circulatory apartment is very deep, and between the shallow and the deep apartments a curtain is drawn, more or less completely, extending from one pillar-like bundle of spicules to another. Each of these temporarily enclosed portions of the general apartment, it is plain now (although our actual observation on this point is very defective), may contract or expand without disturbing the contents of any other. Such an apartment, with its afferent ostioles closed, may be contracting and forcing a current out at its efferent ostiole, while a neighbouring apartment may have its efferent ostiole closed, and, expanding, draw in currents through its open afferent ostioles.

We regret that we have not the means, in this locality, for completing these researches. Our specimens were gathered and studied on the spot where they lived, in the western part of Massachusetts, several hundred miles away from our present residence. Unfortunately we put off the attempt to feed the sponge with coloured matter until we had completed other methods of investigation, and then we were prevented by circumstances from carrying out our designs.

In regard to the afferent and efferent canals seen by Carter (Ann. & Mag. Nat. Hist. 1857, *ut sup.*) in the monadigerous mass ("*parenchyma*," Carter), we have not met with any trace of them in the species described in this article. It is possible they may exist in the oldest and largest individuals; but as we worked only on very small and transparent specimens, our direct observations, in this respect, strictly apply to the latter. It is more likely that ours is a different genus from the *Spongilla* of Carter, in favour of which we cite the curious fact that each aperture in the inner division (not mentioned by Carter) of the investing membrane exactly overlies and is inseparable from the entrance to a monad-chamber ("*ampullaceous sac*," *partim*, Carter); so that whatever enters these chambers must go out by the same way that it came in, not out into a system of branching canals burrowed in the monadigerous mass, but into the great circulatory apartment.

EXPLANATION OF PLATE XI.

Spongilla arachnoidea, Jas.-Cl.

The following letters apply to identical parts in all of the figures:—*a*, investing membrane, outer division; a^1, sectional profile of the cytoblastema of *a*; *b*, cells in the thickness of *a*; b^1, cells (like those at *b*) about the spicules (*e*); b^2, cells of the investing membrane with their nucleus, a surface view; b^3, temporary junction (by contact only) of the outer (*a*) and inner (*c*) divisions of the investing membrane; *c*, investing membrane, epithelioid inner division, in sectional profile; c^1, interspaces between monad-chambers; *d*, junction of the divisions of the investing membrane along the spicules; *e*, larger spicules; e^1, smaller spicules; *f*, circulatory apartment; *g*, monadigerous mass; *h*, monad-chambers and monad groups; *i*, aperture of *h*; *j*, monads, or the body proper in figs. 3 and 3 *a*; *k*, cylindrical collar of *j*; *l*, *flagellum*; *n*, nucleus; *os*, minor ostioles; *v*, contractile vesicles.

Fig. 1. Magnified 320 diameters. Part of a very young *Spongilla*, of an oblate spheroidal form, and about $\frac{1}{25}$ of an inch in diameter. On the right is presented a face view of the investing membrane and the underlying monadigerous mass. On the left the focus is so adapted as to be fixed on a face view of the monad mass, and at the same time on a sectional profile of the investing membrane at a^1, b^3, *c*, and *d*.

Fig. 2. Magnified 780 diameters. Interior of a monad-chamber seen through the aperture; the monads appear in end view and crowded together side by side like a pavement-work.

Fig. 3. Magnified 1600 diameters. A single monad, as seen in profile in the monad-chamber. Only two contractile vesicles were present in this specimen. The cylindrical collar (*k*) is extended to its utmost.

Fig. 3 *a*. Magnified 1600 diameters. Foreshortened front view of a monad; the body (*j*) in the distance; the hollow cylinder (*k*) projecting toward the observer like a dark hoop, and the *flagellum* (*l*) in the centre appearing as a black spot.

Fig. 4. Magnified 780 diameters. Sectional view of a monad-chamber, bringing the aperture (*i*) into profile, as well as the monads which lie at the same level, thus showing their convergence about the central open space.

VII.—*Additional Information on the Structure of* Tethya dactyloidea, *Cart.* By H. J. Carter, F.R.S. &c.

[Plate X. figs. 1–5.]

This sponge (erroneously termed "sand-sponge," because it grew in the sand, whereas the term should rather be restricted to sponges which build up their respective structures *partly* with sand &c.) I described and figured in the 'Annals' for Jan. 1869, vol. iii. p. 15; and at p. 16 is the following line:—"More detail I cannot offer, as I have given away the specimen." The fact is that I had left only the drawing and what I remembered of the circumstances connected with the sponge itself to assist me in retrieving for science all that I could glean of this interesting form, which I found in the "land-wash" on the south-east coast of Arabia, in the autumn of 1845, and subsequently gave to one who could or will make no use of it.

What the woodcut in the 'Annals' shows of it, with the exception of the spicule, is almost a facsimile of the sponge of its natural size; for I had taken care to secure this long before I parted with the specimen; and, with the exception of having stated that this sponge was "hollow internally," the text is equally correct.

Searching, however, a few days since for an illustration of the antheridium of *Chara* in my journal, I came upon the whole microscopic description, with illustrations and measurements, of *T. dactyloidea*, and thus am able to offer the additional information which will complete the description of this interesting sponge.

Omitting that which has already been published, the rest of the matter in my journal runs as follows:—

"July 1854.

"The free extremity [of the sponge] is provided with a large aperture, which may be seen to divide into several canals a short way in.

"When the shreddy twisted fibres of the base or root are examined, they are found to be composed of bundles of long spicules overlapping each other in spiral arrangement, respectively surrounded by granular sarcode, and finally ending in anchor-shaped extremities, which were originally imbedded in the sandy bottom of the sea where the sponge grew (Pl. X. figs. 1 & 2).

"When, again, the surface of the body is examined, the projecting spicules there, which are in little tufts, are also found to be long and flexible; but their free extremities, instead of being anchor-shaped, are all trifid extended, consisting of one long and two short arms (fig. 3).

"On making a vertical section of the sponge, the terminal aperture is observed to divide into a number of branches, which, subdividing, permeate the mass generally down to its base.

"Immediately where the aperture begins to be divided is a portion of the fleshy substance which is more dense than the rest, owing to the presence of a greater number of spicules and their smaller size, from which also arises a framework chiefly composed of acerate, slightly curved spicules of different lengths (fig. 4), that more or less, in bundles, extends in a radiating manner backwards to the periphery of the body generally. No spicules take the opposite direction, as in the globular species (*T. arabica*, see 'Annals,' vol. iv. p. 1, July 1869), where this denser part, which represents the 'nucleus,' is at the base or middle, and not at the summit of the species.

"Throughout the fleshy mass, which is very tough and elastic, are a number of little white specks, of different sizes, which can be seen with a magnifying-glass of low power, being about 4-4300ths of an inch in diameter. They are spherical, filled with granules, and chiefly visible about the middle of the body. With them, also, is occasionally seen a much larger spherical one (viz. 11-4300ths of an inch in diameter), which seems to have a hilous opening, and is covered with points more or less quincuncially arranged. The former are probably sponge-cells, and the latter the gemmules.

"Where these bodies were most numerous there was also an abundance of minute C- and S-shaped siliceous bodies [bihamates], which in some places were not single, but in groups, as if developed in cells. These average 1-1800th of an inch long in the curve" (fig. 5).

Thus on the south-east coast of Arabia we have a sponge very like Schmidt's *Tetilla polyura* (Atlantisch. Spong. Faun. p. 66, tab. vi. f. 8), which came from Iceland, with only these differences, viz. that in the latter the surface was not uniform, but interrupted by nodular projections, and among the inæquifurcate spicules there were also anchor-headed ones. Of the colour Schmidt states nothing; and there are no anchor-headed spicules represented on the surface of the body in his *figure*, all being confined to the long bundles at the base, where there is an equal absence of forked spicules (just as in *Tethya dactyloidea*), as if they had been intended to act as little grapnels in the sand. But how fares this inference, when, in *Tethya casula* ('Annals,' Aug. 1871, vol. viii. pl. 4), there are no anchor-headed spicules in any part of the sponge, and the long spicules which were imbedded in the sand, similar to those of the foregoing species, are *all* forked? Is it not that, whether recurved or extended, the presence of these arms serves this purpose?

Hence we have on the shores of Iceland, the south-east coast of Arabia, and the Cape of Good Hope, a similar kind of *Tethya*, all probably, certainly the two latter, fixed in the sandy bottom of the sea by similarly extended bundles of spicules, and all agreeing in possessing the minute bihamate spicules in great abundance.

EXPLANATION OF PLATE X. figs. 1–5.

Fig. 1. *Tethya dactyloidea*, Cart. Diagram of twisted bundle of anchor-headed spicules of the root: *a a*, anchor-heads.

Fig. 2. The same, anchor-head much magnified, to show its characteristic shape.

Fig. 3. The same, trifid or inæquifurcate head of spicule abundant in the tufts which project from the surface of the body.

Fig. 4. The same, form of acerate spicule.

Fig. 5. The same, bihamate spicules.

N.B. Figs. 2, 3, & 5 are relatively magnified on the scale of 1-24th to 1-4300th of an inch.

VIII.—*Fossil Coral allied to* Merulina (*Ehrenberg*), *from the Upper Greensand of Haldon Hill, near Exeter.* By W. Vicary, F.G.S.

[Plate X. fig. 6.]

Merulina ?, n. sp.

Corallum composite, foliaceous, with the ridges rounded, reticulately coalescent. Septa serrulate and alternately larger. Ridges 1-20th of an inch wide; distance between them 1-35th of an inch; height of ridges 1-20th of an inch. Specimen fragmentary; natural size about one inch square. (Plate X. fig. 6, magnified a little more than two diameters.)

Loc. Upper Greensand, Haldon Hill, near Exeter, Devonshire.

Mineral composition siliceous.

Obs. The Haldon Hills are situated about five miles to the south-west of Exeter. Their base is composed of the New Red Sandstone; and they are capped by the Upper Greensand. The latter has been found to be prolific in species of corals, compared with the Greensand of other localities, since it contains ten species out of the sixteen which is the entire number stated by Dr. Duncan, in his "Monograph" published by the Palæontological Society, to have been found in this formation.

At Black Down, on the eastern borders of Devon, where the beds are evidently of the same age as those of Haldon, only three species have been found. The Gasteropoda and Conchifera are nearly the same at both places, but only one species of coral, viz. *Favia stricta.*

In addition to the above-named number, *i. e.* "ten species," I have lately found the coral herewith figured, which I believe to be nearly allied to *Merulina*, if, indeed, it does not belong to that genus. Should this be the case, we shall then not only possess a new species from Haldon Hill, but a form that will assist the "Dredging-expedition" (although in a reverse direction) to supply a link between the past and the present forms.

IX.—*Descriptions of some Ceylonese Reptiles and Batrachians.* By Dr. Albert Günther, F.R.S.

Mr. G. H. K. Thwaites, Director of the Royal Botanic Gardens at Peradeniya, has presented to the British Museum a very fine series of Reptiles, and especially Batrachians, which appear to have been collected chiefly in the neighbourhood of the locality named. It is only recently that we have received specimens from that central district, which is inhabited by many peculiar forms unknown in the littoral and best-explored parts of the island. The majority of the new Batrachians added by me on a former occasion (Proc. Zool. Soc. 1868, p. 478) to the fauna of Ceylon are again represented in this collection sent by Mr. Thwaites—for instance *Nannophrys*, which grows to a length of $1\frac{3}{8}$ inches, *Ixalus femoralis*, *I. temporalis*, and *I. macropus*, *Polypedates reticulatus*, *P. nasutus*, and *P. cavirostris*. The three species of *Ceratophora* appear to be common, especially *C. aspera*, which varies considerably in the arrangement and development of the folds and tubercles; *Geckoëlla punctata* also inhabits this district. *Rhinophis punctatus*, *Rana* (*Hoplobatrachus*) *ceylanica* (Peters), and *Ixalus Schmardanus* (Kelaart) *, which I had never received before, are evidently scarce, as only two examples of the first and one of the two latter were in the collection. But our knowledge of the reptilian fauna of this island is evidently still far from being complete, nearly every collection containing some new forms; and particular attention should be paid to the small burrowing snakes or snake-like lizards, and to frogs.

Mr. Thwaites's collection contained the following new species:—

* Three other, very fine, examples have been recently obtained by Mr. Holdsworth.

Nessia Thwaitesii.

Toes four in front and four behind. Nostril close to the hind margin of the rostral shield, and without longitudinal slit behind.

This species might be taken for a Sepoid, in consequence of the situation of the nostril, which is in contact with the hinder edge of the rostral shield. However no other shield enters into the circumference of the nostril, which is entirely within the rostral. Otherwise the pholidosis of the head is very similar to that of the other two species known. Two loreals, one behind the other. Trunk surrounded by twenty-six longitudinal, and seventy-two transverse series of scales. Præanals and subcaudals like the other scales. Limbs rather more developed than in *N. Burtonii*; the hind leg nearly as long as the head. All the toes distinct and clawed; the anterior very short; the first of the posterior shorter than the second, the second shorter than the third and fourth, which are nearly equal in length. Ear-openings minute, hidden. Upper parts brown, the lower of a lighter colour.

One specimen 4 inches long; tail $1\frac{1}{3}$ inch.

Calotes liocephalus.

No spines whatever on the side of the head. Dorsal crest composed of slender spines of moderate length on the neck, a low, merely serrated crest in the middle of the trunk, but reappearing in the sacral region as a short series of three or four spines. *A very distinct fold in front of the shoulder*, covered by granular scales. Gular sac very slightly developed. About forty-five series of scales round the middle of the trunk. Scales round the part of the tail in which the penis is hidden much the largest. Green, with irregular dark cross bands on the back. Upperside of the head marbled with dark green. A narrow green band from the eye to above the tympanum. Tail olive, with broad brown rings. Limbs with alternate lighter and darker green rings.

One adult male is 15 inches long, the tail being 11 inches.

Hemidactylus Coctæi.

Ceylonese specimens are not specifically distinct from those of the continent, as has been ascertained also by Cantor (see Kelaart, Prodr. Faun. Zeyl. i. p. 160). Examples occur in which the ornamental colours are unusually dark, in the form of clouded transverse bands.

Gymnodactylus frenatus.

The coloration of the young is extremely similar to that of *Eublepharis Hardwickii.*

Bufo kandianus.

Crown flat, without bony enlargement. Snout rather obtuse, with angular canthus rostralis. Limbs and fingers of moderate length; the fourth finger longer than the second. Toes rather short, *completely webbed.* Metatarsus with two small flat callosities; *a cutaneous fold along the edge of tarsus.* Skin with small tubercles in small number. *Parotoid long and very narrow. Tympanum entirely hidden by the skin.* Inner nares narrow; Eustachian tubes very narrow. Upper parts uniform brownish grey, except the snout, which is yellowish, the yellowish part being sharply defined by an interorbital line. Lower parts yellowish.

One specimen, apparently immature, is 30 millims. long; hind limb 40 millims.

Ixalus fimbriatus.

Snout flattened, not obtuse in front, with the loreal region concave and sloping outwards; canthus rostralis distinct. Eye large, prominent; tympanum distinct, about one third of the size of the eye. Skin of the upper parts covered with rough tubercles and larger warts; an oblique fold on the upper eyelid, but no prominent spines; hinder margin of the forearm and foot fringed; a transverse series of white tubercles below the vent. Throat finely granulated like the abdomen. Metatarsus with a single tubercle; fingers not webbed. The interdigital web of the hind foot extends to the outer phalanx of the third and fifth toes. Disks of the fingers and toes moderately developed. The length of the body is conspicuously more than the distance between vent and heel. Upper parts dark brown, marbled with black; limbs with dark cross bars; hinder side of the thigh immaculate; cutaneous fringes white. Lower parts yellowish; throat with small brown spots.

One example is 32 millims. long, the hind limb being 47 millims.

Ixalus adspersus.

Snout short, not obtuse in front, with the loreal region flat, subvertical, and with the canthus rostralis angular. Eye large, prominent; tympanum distinct, about one fourth of the size of the eye. Skin of the upper parts with scattered flat tubercles; throat granular, the granules being finer than those on the abdomen. Metatarsus without fringe or fold, with a single tubercle. Fingers not webbed; the interdigital web of the hind foot does not reach the last phalanx of the third and fifth toes. Disks well developed. The length of the body equals the distance between the vent and distal end of metatarsus. Upper parts dark violet (in spirits), with numerous round, smaller and larger, bright yellow spots. Hinder side of the thighs marbled with brown. Lower parts dirty yellow, throat marbled with brown.

One specimen is 34 millims. long, the hind limb being 48 millims.

Ixalus oxyrhynchus.

Snout rather elongate, sharply pointed, projecting beyond the mouth; loreal region flat, vertical; canthus rostralis angular. Eye of moderate size; tympanum distinct, one-third the size of the eye. Upper parts smooth, with a pair of folds commencing from the eyelid, and converging towards the middle of the back. Throat smooth, not granular. Metatarsus without fold, with a single tubercle. Fingers not webbed; the interdigital web of the hind foot does not reach the last phalanx of the third and fifth toes. Disks small. The length of the body is rather less than the distance between the vent and heel. Upper parts reddish olive, with a large, hourglass-shaped brown blotch on the back; its anterior base is between the orbits, and laterally it is bordered by the convergent folds of the skin. Limbs with a few blackish bars; an almost black spot occupies the hand and its root. Loreal region and a tympanic spot, the vent and hind parts of the thighs, and the lower part of the foot black. Lower parts white, throat dotted with brown.

Two specimens, the larger of which is 24 millims. long, the hind limb being 42 millims.

Ixalus pulchellus.

Snout depressed, obtuse, but rather longer than the eye, without canthus rostralis. Tympanum covered by the skin. Skin smooth; abdominal surface coarsely granular, the granules extending over a part of the throat. The length of the body is a little more than the distance between vent and heel. No fold along the tarsus; metatarsus with a small tubercle. Interdigital web rather broad, extending nearly to the ultimate phalanx of the third and fifth toes. The two outer fingers united by a membrane for a considerable part of their length. Disks well developed. Upper parts yellow (in spirits), mottled with violet, and with scattered minute black dots; upper arm, anterior and posterior sides of the femur colourless; lower parts uniform white.

One specimen is 23 millims. long, the hind limb being 38 millims.

X.—*Notes on* Arctocephalus Hookeri, *Gray*. By Dr. BURMEISTER*.

UNDER this title my esteemed friend Dr. J. E. Gray described, in the year 1845 (The Zoology of the Voyage of H.M.SS. 'Erebus' and 'Terror,' p. 4, pls. xiv. & xv.), a seal found in the Falkland Isles and on the shores of Cape Horn, which has been recognized by him as a well-founded species.

This animal has not since been found and examined by any competent scientific person. The authors that speak of it, as Peters in his Catalogue of Seals with external ears (Monatsber. d. kön. Acad. d. Wiss. z. Berlin, 1866, viii. 269. no. 5), give no other information than extracts from Dr. Gray's description. Sclater alone believed that he recognized the same species in a young seal that was brought alive to London from Buenos Ayres, and purchased for the Menagerie of the Zoological Society (Proc. Zool. Soc. 1866, p. 80). This individual was one of the two that had been seen alive here in St. Martin's Street, No. 75, and which also is figured in the popular newspaper 'The Field,' vol. xxvii. no. 689, March 10, 1866, p. 191, as also in these 'Anales,' tom. i. p. 303.

The two figures, in the 'Field' and by Sclater (*ll. cc.*), are very good, and represent the animal very naturally, as it was drawn alive, as I can testify from my own repeated observations of the two specimens seen in Buenos Ayres.

Murie shares this opinion, in his note on the death of this specimen, caused by the poor animal having swallowed a little bit of canvas (Proc. Zool. Soc. 1867, p. 243). And again, more recently (*ibid.* 1869, p. 108), that author thought that he could identify *Otaria Hookeri* of Gray with *Otaria Philippii* of Peters; but in fact it is altogether different.

Two years ago Sclater retracted his first opinion of this animal, submitting to the judgment of Gray and Peters that the living seal in London was none other than a young specimen of *Otaria jubata* s. *leonina* of older authors (Proc. Zool. Soc. 1868, p. 190).

Considering this difference of opinion between men so distinguished in science, it has appeared to me a matter of much importance to have received the skin and skull of a male seal, lately killed at the mouth of the Rio Paraná, about 60 miles above Buenos Ayres, by some fishermen, in the month of May 1869; but at the first glance, on examining the skin and skull as they were, I also took it for *Arctocephalus Hookeri* of Gray;

* Translated from the 'Anales del Museo Publico de Buenos Aires,' 1870, by J. P. G. Smith, Esq.

and under this title I have introduced it in the list of Mammals of the country published in the 'Anales,' tom. i. p. 464. no. 168; but since then, the skull having been more perfectly cleaned, and the body of the animal set up in its proper shape, I have observed that it is not very different from the other specimens of *Otaria jubata* s. *leonina* preserved in our museum. On studying the animal with greater attention, I saw that it was nothing else than a young male of this species, and that the *Arctocephalus Hookeri* of Gray represents a distinct species, and is in no manner the young state of *Otaria jubata*, although by its external appearance the young *Otaria jubata* resembles a good deal *Arctocephalus Hookeri*.

Externally, the length of the ears is a marked character, being much larger (0·030 mètre in place of 0·015) in *A. Hookeri*. Then the two species may be distinguished by the fore flippers, which have no nails in any of the specimens of *Otaria jubata* that we have in our collection, although Gray figures them distinctly in his *Arctocephalus Hookeri* (pl. xiv.).

The posterior flippers, also, are different. Gray figures five claws on them, describing the second and third nails as the larger, the fourth and fifth as less, and the first as the smallest. Our specimens of *Otaria jubata* have three nails very large ($1\frac{1}{4}$–$1\frac{1}{2}$ inch), the middle one of them the largest, and the others (the first and fifth) generally wanting; or if they are present, they are very small, scarcely visible, one line broad; the fifth is almost always wanting.

Lastly, the young males, which in shape and colour very much resemble *Arctocephalus Hookeri*, have a large dusky-yellow blotch about the eyes, which is wanting in *Arctocephalus*, and which appears very characteristic of the young *Otaria jubata*.

The skull shows other differences: it is more depressed in *Arct. Hookeri* in comparison with its length; and the anterior part, which corresponds with the mandibles, is relatively larger. The *Arctocephalus* has much smaller teeth than individuals of the same size of *Otaria jubata*; but the lateral tubercles of the crown of the molars are much larger.

Lastly, the shape of the "palate" is very different: its hinder portion is much narrower and shorter in *Arctocephalus Hookeri*, the posterior margin of the "palate" of *Otaria jubata* being shown almost to the anterior margin of the glenoid cavity for the inferior mandible; whilst in *Arctocephalus Hookeri* this margin does not pass beyond the posterior angle springing from above the zygomatic arch. This character is constant in every age of the animals, being present even in the skull of a recently born *Otaria jubata* in our museum, the skull of which is not more than five inches wide.

From all these characteristics there can be no doubt of the distinctness of *Arctocephalus Hookeri* as a different species, which must not be confused with the young state of *Otaria jubata.*

I had already confirmed this opinion by repeated observations on different individuals of *Otaria jubata* in our museum, when I received, about a month ago, by favour of its author, the work of J. A. Allen on Seals with ears, recently published in the 'Bulletin of the Museum of Comparative Zoology at Harvard College,' vol. ii. no. 1 (Cambridge, U.S.A.), in which the author, alluding to former publications, confesses himself disposed to unite anew *Arctocephalus Hookeri* with *Otaria jubata*, presuming that the noted differences were irregular ("to be in an unusual state," p. 40). I cannot share this opinion: characters which manifest themselves in three different specimens that Gray enumerates in his 'Catalogue of Seals,' p. 54, are, according to my view, regular, and not exceptional, especially if different authors acknowledge them (*cf.* Peters, Monatsb. 1866, p. 668); and for this reason I accept them as diagnostics. Also I ought to correct the note (p. 13) in which the author affirms that the marine seals of our museum were collected by Dr. Maack. The truth is that this gentleman accompanied, by my invitation and at the expense of the Public Museum, the hunter for the museum, Santiago Pozzi, in his excursion to Patagonia, without, however, giving him any other assistance than that of companionship. Moreover the work of killing the animals and preparing the skins was done by Pozzi, and not by Dr. Maack.

Very well founded, on the other hand, is the observation of Dr. Murie that *Otaria Philippii*, Peters, is not identical with *Arctocephalus Hookeri*, Gray (p. 15). This species is very near to *Otaria falklandica* (described by me, Ann. & Mag. Nat. Hist. ser. 4, vol. i. p. 99); but I do not believe the two animals to be identical, which I endeavour to prove in the Zeitschr. für d. ges. Naturw. vol. xxxi. p. 300. *Otaria Philippii* is identical with *Phoca porcina* of Molina (Comp. d. l. Hist. Nat. de Chile, i. p. 314), *Otaria porcina*, Gay (Hist. Nat. de Chile, Zoolog. i. p. 75); and if it were also identical with *Arctocephalus falklandicus* of our Patagonian coasts, this species ought to differ in its individuals in the same manner as *Otaria jubata* s. *leonina.*

XI.—*On the Distribution of Marine Animals on the Southern Coast of New England.* By A. E. Verrill *.

In connexion with the investigations concerning the fisheries under the direction of Professor S. F. Baird, U. S. Commissioner, thorough explorations of the adjacent waters were undertaken in order to ascertain the character of the bottom and the distribution of the lower animals, especially of those that furnish food for certain fishes. The Fish Commission had its headquarters at Wood's Hole, Mass., situated on the point of land between Vineyard Sound and Buzzard's Bay. In addition to the shore collections, extensive and systematic dredging-operations were undertaken by means of a steam-launch in the waters of Vineyard Sound and Buzzard's Bay; and by the aid of a U. S. revenue-cutter, the steamer 'Moccasin,' the dredgings were carried outward to the deeper parts of Muskeget Channel, situated off Martha's Vineyard, and from thence to a point off the mouth of Buzzard's Bay †. These explorations were made by means of dredges (of several different sizes) of the usual forms, a rake-dredge of novel construction especially adapted to soft muddy bottoms, an iron frame to which unravelled ropes (or "tangles") were attached for use on rocky bottoms, a large trawl-net, surface towing-nets for swimming creatures, &c.‡ The points where dredgings were made were carefully located on coast-survey charts, and were sufficiently numerous to give a satisfactory knowledge of the nature of the bottom and its inhabitants throughout the region explored. The total number of hauls of the dredges during the three months was about four hundred. The surface-dredging also yielded many things of great interest.

At this time I wish to call the attention of zoologists to one of the most important of the results of these investigations, leaving a full account of the large and valuable collections for another occasion. The discovery referred to is, that while the shores and shallow waters of the bays and sounds, as far as Cape Cod, are occupied chiefly by southern forms, or the Virginian fauna, the deeper channels and the central parts of Long-Island Sound, as far as Stonington, Conn., are in-

* From Silliman's American Journal, November 1871.

† The dredgings in the first part of the season were made under the direction of Mr. S. I. Smith, and later by Professor J. E. Todd, Professor A. Hyatt, Dr. A. S. Packard, and the writer, all more or less aided at various times by other naturalists, and especially by Dr. W. G. Farlow, who collected the Algæ.

‡ Some of these instruments will be described in a future number of the American Journal.

habited almost exclusively by northern forms, or an extension of the Acadian fauna.

There is also a corresponding difference in the temperature of the water, the change in some cases amounting 5° F., both at the surface and bottom, within a distance of two miles, and without much change in the depth; and consequently there must be an offshoot of the arctic current setting into the middle of the sound, although the shores feel the influence of the Gulf-stream, as shown by the occurrence of southern forms of pelagic animals in their waters.

The shores of Buzzard's Bay and Vineyard Sound present nearly all varieties of stations, and are therefore favourable for collecting; they are occupied, except on some of the outer islands, by an assemblage of animals characteristic of the coasts further south, and known as the *Virginian fauna*. A few northern forms occur, however, on the rocky shores, which do not extend as far as New Haven. Among these *Purpura lapillus* is most conspicuous. This shell is associated there with *Eurosalpinx cinerea*, in about equal numbers; but at New Haven the latter occurs alone, while on the northern coasts of New England the *Purpura* is found unaccompanied by the other, which is rarely found north of Cape Cod. But in nearly all other respects the littoral fauna is very similar to that of the vicinity of New Haven, or the coasts further south, as far as Cape Hatteras, making allowance only for differences in the stations, and especially for the absence of rocks south of New York.

In Vineyard Sound and Buzzard's Bay the water is everywhere shallow, usually from 3 to 8 fathoms deep, and rarely exceeding 12 or 14 fathoms, even in mid-channel. In Vineyard Sound the bottom is generally sandy, and extensive reefs of shifting sands are numerous and often nearly destitute of life; but extensive regions of gravelly and shelly bottoms occur, and these are often almost completely covered by several species of compound ascidians growing in large masses. One of these, which forms large hemispherical or irregular masses, made up of an aggregation of long slender colonies, united together at their bases and usually thickly covered throughout with sand, is very abundant, often entirely filling the dredge with masses up to six inches in diameter: this is the *Amouroucium pellucidum*, Verrill. Another one, nearly as abundant, forms smooth cartilaginous masses in the form of flat lobes, crests, and plates, sometimes two feet long and about an inch thick, the surface covered with stellate colonies, while the colour of the masses is of a delicate bluish or sea-green tint by reflected light, although yellow by transmitted light: this is *Amouroucium stellatum*, V., described with the last in a former number of this Journal. A third species* of the same genus is also common, although still undescribed: this forms smooth gelatinous masses, varying from light orange to yellowish in colour, with beautifully stellated colonies over its upper surface. With these were several simple ascidians, chiefly *Cynthia partita*†, Stimp., and *Molgula manhattensis*, V., while creeping over them was a beautiful green species of *Perophora*‡, which is the first representative of the social ascidians discovered on our coast. This species also occurred in abundance on the piles of the government wharf at Wood's Hole, associated with the three last named. In the interstices of *A. pellucidum* were numerous annelids of several species; and growing upon or with the ascidians were many species of hydroids, bryozoa, and sponges. Among the sponges a massive sulphur-yellow species (*Spongia sulphurea*, Desor) is very conspicuous. While young this species perforates and destroys dead bivalve shells, but later in life grows up into hemispherical or irregular masses. Upon the same bottoms were found the common southern greenish starfish (*Asterias arenicola*), *Amphipholis elegans*, *Gouldia mactracea*, *Eulima oleracea* on *Thyone Briareus*, *Anachis avara*, *Columbella lunata*, *Cancer irroratus*, *Libinia canaliculata*, *L. dubia*, *Eupagurus pollicaris*, *E. longicarpus*, and many other less common species. On rocky and stony bottoms, and especially in the tide-way of

* *Amouroucium constellatum*, sp. nov. Masses thick, turbinate, often incrusting; surface usually convex, smooth; substance firm, gelatinous, translucent, but softer than in *A. stellatum*. Systems stellate, circular, oval or elliptical, often elongated, or irregular and complex. Zooids much elongated, slender, the branchial tube short, with six rounded lobes. Branchial sac elongated. Colour of the masses usually light orange-red, varying to yellowish and pale flesh-colour; the branchial orifices with six radiating white lines. Zooids generally orange-yellow; the orifices and tubes with upper part of mantle bright orange or lemon-yellow; branchial sac usually flesh-colour or pale yellow, sometimes bright orange; stomach with bright orange-red glandular ribs; mantle with minute opaque white specks.

† *Cynthia stellifera*, V., proves to be a depressed variety of this species.

‡ *Perophora viridis*, sp. nov. Individuals small, about ·10 to ·12 of an inch high, connected by slender stolons, and thickly covering the surfaces over which they creep. Test compressed, seen from the side scarcely higher than broad, oval, elliptical, or subcircular, often one-sided or distorted, with a short pedicle or subsessile at base. Branchial orifice large, terminal; anal lateral or subterminal, both a little prominent, with about 16 angular lobes, alternately larger and smaller. Test transparent; mantle beautifully reticulated with bright yellowish green; intestine yellow.

the channel at Wood's Hole, the southern purple sea-urchin (*Echinocidaris punctulata*), the orange starfish (*Cribrella sanguinolenta*), the green starfish, the coral (*Astrangia Danæ*), and many other interesting species occurred. All the species referred to, excepting the widely diffused species of *Cribrella* and *Amphipholis*, are either characteristic southern forms or else species that are not yet known except from the region explored. Several species were also obtained in Vineyard Sound which had not previously been found so far northward. Among these the flat sea-urchin with five perforations (*Mellita pentapora*) is especially worthy of mention, as it has hitherto been regarded as peculiar to the Carolinian fauna*. The free-swimming forms taken at the surface in this region were also numerous, and are likewise chiefly southern species; or if new, they belong to southern types. Among the most interesting were:—*Salpa Cabotii*, which occurred in vast quantities about the 1st of September, and was found in abundance off Gay Head, as well as in the sound; a splendid species of *Saphirina*, reflecting brilliant blue and red colours like a fire opal, which occurred mingled with the *Salpæ*; a new free-swimming crab; *Idotæa robusta*, Kr.; innumerable young lobsters, crabs, and shrimps, in the zoea and megalops stages of growth; numerous jelly-fishes, among which *Mnemiopsis Leidyi* was perhaps the most abundant; but a species of *Cyanea* and *Dactylometra quinquecirra* were common, and both frequently gave shelter to several young "butter-fishes" (*Poronotus triacanthus*) of all sizes, from those just hatched up to two inches or more in length. In some cases twenty or more were found together under one jelly-fish; they also occurred, in the evening, under *Zygodactyla grœnlandica* earlier in the season. The "Portuguese man-of-war" (*Physalia Arethusa*) was met with several times. Two Pteropods not before recorded from the United-States coast were obtained,—one of them (*Stiliola*, sp.) living, associated with *Salpa*; but of the other (*Cavolina tridentata*) the shells only were dredged, but in a very fresh condition.

In the deeper outer channels, as between Gay Head and No Man's Land, and at nearly all points outside of the latter where the water is more than ten fathoms in depth, the fauna is very different from that of the sounds and bays, and closely resembles that of Massachusetts Bay and the coast of Maine. The difference in the temperature of the water is also well marked. The surface temperature, during the latter part of

* This and *Lytechinus variegatus* were found by the writer, Mr. S. I. Smith, and Prof. J. E. Todd at Great Egg Harbour, N. J., last spring, but they are very rare at that locality.

August, was 69° to 71° in Vineyard Sound. On Sept. 9th, in the mouth of Vineyard Sound, west from Gay Head, the surface temperature was 67° F., and the bottom, in 15½ fathoms, was 63°; but proceeding about two miles further out, off No Man's Land, the surface temperature was 62°, and the bottom, in 18 fathoms, was 58½°, showing a decrease of 5° within this short distance, both at the surface and bottom. A few miles further out, at the same depth, the bottom temperature was 57°, which was the lowest temperature obtained. A short distance west of No Man's Land, on a gravelly bottom in 11 fathoms, where codfish are caught in winter, the temperature was 63° at the surface and 59° at the bottom. Off the mouth of Narragansett Bay, about sixteen miles south from Newport, the depth over a limited area is 29 fathoms, which was the deepest water found. At this locality the surface temperature was 62° and the bottom 59°. The bottom in these deeper waters was generally composed of soft mud, filled with innumerable tubes of worms and Amphipod crustacea, among which a species of *Ampelisca*, which makes a soft flabby tube, two or three inches long and covered with mud, is extremely abundant. At the last named locality numerous specimens of the rare and beautiful *Epizoanthus americanus*, V., were found coating the shells inhabited by hermit crabs (*Eupagurus bernhardus*) and finally absorbing the shells entirely. This remarkable Actinian has been found previously only on two occasions,—first on a deep bank off the coast of New Jersey, by Capt. Gedney, and since in deep water off Massachusetts Bay. With this was also found a rare Holothurian (*Molpadia oolitica*), previously known only from specimens taken from fish-stomachs.

The various muddy bottoms in the deeper and colder areas yielded nearly the same assemblages of animals, most of which are either strictly northern types, many of them not before observed so far south, or else species of wide range extending much further north as well as south. Among those of special interest are the following. Of RADIATA:—*Edwardsia farinacea* V., previously known only from the Bay of Fundy; *Thyonidium*, sp. Of MOLLUSCA:—*Molgula pilularis*, V., and *Glandula mollis*, Stimp., both known before only from the Bay of Fundy; *Cyprina islandica*, *Cardita borealis*, *C. novangliæ*, *Yoldia sapotilla*, *Y. limatula*, *Nucula proxima*, *N. delphinodonta*, *Cardium pinnulatum*, *Astarte quadrans*, *A. castanea*, *A. lutea* (?), Perkins, *Lyonsia hyalina*, *Anatina papyracea*, *Lucina filosa*, *Callista convexa*, *Crenella glandula*, *Modiolaria nigra*, *M. corrugata*, *Pecten tenuicostatus* (young = *P. fuscus* Lins.), *Buccinum undulatum*, *Chrysodomus pygmæus* (large and abundant), *Crucibulum striatum*, *Margarita obscura*, *Cylichna alba*. Of ANNELIDS:—*Clymene torquata*, Leidy; *Ophelia simplex*, Leidy?; *Trophonia*, sp.; *Sternaspis fossor*, *Aphrodite aculeata* (large and common), *Nephthys* (large species), *Sipunculus bernhardus*, and species of *Nereis*, *Lumbriconereis*, *Aricia*, &c. Of CRUSTACEA:—species of *Ampelisca* (abundant), *Unciola irrorata*, and several other Amphipods, *Crangon vulgaris*, *Pandalus annulicornis*. On sandy bottoms *Echinarachnius parma* was very abundant, as it was, also, everywhere in the sounds; for it is a widely diffused species, occurring as far south as Great Egg Harbour; *Molgula arenata*, St., also occurred, with a few other species of interest. A large species of sandy Foraminifera, often a quarter of an inch in diameter, was abundant. In the channel between Gay Head and No Man's Land the bottom is gravelly and stony; and here some very interesting species were found: among the RADIATA were:—*Alcyonium carneum*, Ag., *Edwardsia* (new species), *Grammaria gracilis*, St., and many other hydroids; *Cribrella sanguinolenta*; *Asterias vulgaris*, V.; *Ophiopholis aculeata*, Gray; *Euryechinus drobachiensis*, V. Of ASCIDIANS:—*Amouroucium pallidum*, V.; *Molgula papillosa*, V.; *Cynthia carnea*, V.; *C. hirsuta*, Binney; *C. partita*, St.,—all northern species except the last. Of shells, many of the northern forms already named and some additional species; of CRUSTACEA—*Eupagurus bernhardus*, *Cancer borealis* (thrown on shore and fragments dredged), *C. irroratus*, with numerous Amphipods.

The brief lists of species given above are quite sufficient to show the marked northern character of the fauna in the deeper waters of this region. Several of the northern shells enumerated above have also been dredged by Mr. Sanderson Smith in Gardiner's Bay, L. I., and some of them have long been known from Montauk Point. Mr. Linsley, in his catalogue of the shells of Connecticut*, also records many of the same northern species, with a few additional ones, from Stonington. I have been informed by Mr. H. C. Trumbull, who collected the shells attributed to Stonington, that all these northern species were obtained by him from the stomachs of haddock &c. which were taken within a few miles of Stonington. This would indicate that the northern cold current has a decided influence as far westward as that locality, beyond which its influence has not yet been traced.

* Silliman's American Journal, ser. 1, vol. xlviii. 1845.

MISCELLANEOUS.

On the Systematic Position of the King Crabs and Trilobites. By M. E. van Beneden.

Whilst recognizing in theory that a classification founded upon a single character cannot be a natural classification, and that it is not by a single character that truly natural groups are distinguished, a great many naturalists, and even eminent men, have departed in practice from this principle, which is unanimously accepted in theory. Thus in the system of classification of Latreille and Milne-Edwards, almost unanimously accepted by entomologists, the Arthropoda are divided into two great groups, in accordance with the characters of their respiratory apparatus, and the Crustacea are distinguished from all the other Condylopoda by their branchiæ. Every Arthropod with branchiæ is a Crustacean; every Arthropod with tracheary respiration is either an Insect, a Myriopod, or an Arachnidan.

By thus basing a classification upon the existence of a single character, it becomes exceedingly easy and simple to decide the place that such or such an animal should occupy in the classification. The place of the *Limuli*, for example, cannot be doubtful for a moment; the Xiphosura form, with Milne-Edwards and the great majority of naturalists, a division of the class Crustacea, sometimes placed in the group of the Branchiopoda by the side of the Phyllopoda and Trilobites, sometimes approximated to the Isopoda; whilst sometimes the Pœcilopoda have formed a separate division in the class Crustacea.

But now that it is generally admitted that classification should represent the true affinities of creatures (that is to say, their genealogical connexions), it is necessary to take into account as much as possible characters derived from the totality of their organization, from the history of their palæontological development, and especially from the history of their ontogenic or embryonic development, which represents an abridgment of the history of their genealogical development.

I am indebted to the kindness of my learned friend, Dr. Packard, of Salem, Massachusetts, for having been able to study here in Belgium the whole embryonic development of *Limulus Polyphemus*. Dr. Packard had the extreme complaisance to send me several portions of ova and embryos of *Limulus*, deposited and fecundated upon the American coasts; and I have been able to follow all the phases of the development of these singular creatures, whose affinities have been completely misunderstood hitherto. Strauss-Dürckheim alone, founding his opinion upon important anatomical characters, opposed the current of received ideas with regard to the position of the *Limuli*, and he put forward the opinion that the Gnathopoda should form a separate order of the class Arachnida.

The study of the embryonic development of these animals, and of their anatomical characters, has led me to the following conclusions, which I may now formulate:—

I. The *Limuli* are not Crustacea; they have nothing in common with the Phyllopoda; and their embryonic development presents the greatest analogy with that of the *Scorpions* and other Arachnida, from which they cannot be separated. In the course of their embryonic development we cannot distinguish any of the characteristic phases of the development of the Crustacea; and it is impossible to distinguish in the course of this embryonic development either a *Nauplian* or a *Cyclopean* phase.

II. The analogy between the *Limuli* and the Trilobites, and the affinity which connects together these two groups, cannot be doubted for a moment by any one who has studied the embryonic development of these animals. The laws of development are the same in the Trilobites and the Xiphosura; and the analogy between the young Trilobites and the young *Limuli* is the greater in proportion as we examine them at a less advanced period of their development. On examining these young *Limuli* MM. Packard and Woodward were struck with these analogies.

III. The *Trilobites*, as well as the *Eurypterida* and the *Pœcilopoda*, must be separated from the class Crustacea, and form, with the *Scorpionida* and the other *Arachnida*, a distinct branch, the origin of which has still to be ascertained.

Note.—We do not yet positively know the characters of the legs of Trilobites; nevertheless, according to an important discovery made last year in the United States, and published in the 'Quarterly Journal of the Geological Society of London,' Mr. Billings thinks he has demonstrated that the Trilobites had articulated legs like those of the *Limuli*. The question of the form and characters of these appendages, however, is a secondary question from the morphological point of view. The form varies with the functions of the organs in the same natural group. The *Nebaliæ*, with their foliaceous feet, are true Decapods; and the *Cladocera* are not Phyllopods, but Entomostraca which, from the morphological point of view, must be placed beside the Copepoda. Even if the Trilobites were completely destitute of appendages, we could not conclude from this that they do not belong to the same group as the Pœcilopoda.—*Comptes Rendus de la Soc. Entom. Belg.* October 14, 1871 (No. 67), p. 10.

Cells in Crystalline Form. By Hermann Karsten.

That the vegetable cell may appear in an actual crystalline form was discovered by Karsten in 1847 in the milky juice of a Euphorbiaceous plant (*Jatropha curcas*), and made known by him at one of the meetings of the Society of Friends of Natural History in Berlin. It was only in the year 1859 that the discoverer referred to the subject in more detail in Poggendorff's 'Annalen;' and all those who conceive the first origin of plants in primæval time as a process of crystallization, having for its basis an organic primitive material, must have had particular satisfaction in the knowledge of this fact. It is, in fact, sufficiently striking. For generations past chemistry has accustomed us to the phenomenon of products of organic activity, so-called organic compounds, especially the highly oxygenated acids and the alkaloids, being capable of separation from their solutions in the crystalline form; but that the elementary organs, the cells themselves, could pass over directly (and, indeed, their firmer part, or membrane) into the crystalline form, and in this way establish direct intermediate terms between organic and inorganic forms, might justly surprise us, because, in the first place, we did not suspect it, and because there is another side of philosophical contemplation which regards the origin of the plant not as a process of crystallization, but, on the contrary, as a process of cell-formation. The cell-crystalloids occurring in organic nature seem to repeat the forms of the inorganic crystallized bodies in the same way as the leaf-forms of one group of plants repeat themselves in another, whilst the two are perfectly different as regards the structure of the fruit, spores, &c. In both cases, both in organic and in inorganic nature, these crystalline forms are certainly dependent on their chemical composition. But that they are so renders the simple fact one of great promise, because, to express it in a single word, it follows therefrom that matter and form are two inseparable quantities.

The organic crystalloids (*i. e.* hollow bodies, in contradistinction to the solid inorganic crystals) are in most cases the membranes of young cells still consisting of highly nitrogenous proteiniform compounds; and these not unfrequently repeat the sharp-edged angular forms so closely that one seems to have real crystals before one. As I learn directly from Karsten, they appear very beautifully as rhombohedra in the well-known Pará nut, and as octahedra in the seeds of *Ricinus* and in the juice of *Jatropha curcas.* It may be that the forms of these crystalloids are in part dependent on the nature of the inorganic basic matters which form chemical compounds with a definite albuminous matter. But cells which have already given off the whole of the nitrogen from their membrane, and, like cellulose, have passed off into more highly carbonized compounds, also occur in the crystalline form.

When Karsten had once called attention to them, similar crystalloids were also found abundantly by other observers; for the combinations mentioned in the last paragraph but one, especially by Hartig, and these, were measured and discussed by Radlkofer and Nägeli. Of the combinations of the preceding paragraph, examples were detected only by Karsten—namely, non-azotized, highly carbonized cell-membranes. He found them, for example, in the cells of the seed-lobes of our common yellow lupine (*Lupinus luteus*); the crystalloids which make their appearance in this in the form of tables were formerly regarded as proteine-crystals, which, according to Karsten, they are not, as they do not acquire the well-known changes of colour, either with iodine or with Millon's mercurial salt. According to Karsten, these trapezoidal tables are the nuclear cells of the tissue-cells of the seed-lobes. They enlarge up to the time of germination, and begin to dissolve after the cotyledons push forth from their envelope into the air. All the cellules occurring with these crystalloids are coloured by the above-mentioned reagents; their membranes behave like proteine compounds. These highly albuminous cellules form a continuous layer on the inner surface of the tissue-cell-membranes, whilst a crystalloid floats in the cell-fluid within this layer. New cells originate in both kinds of content-cellules; in the crystalloids only one or two, which sometimes grow forth above the surface of their lamelliform mother cell (like twin or triple crystals), while in each of the numerous proteine-cellules numerous new cellules make their appearance, some of which grow into chlorophyl-vesicles.

The free, highly albuminous cells which form yeast may be seen, under certain conditions of nutrition, to acquire the tabular form, as was pointed out by Karsten in his recent work, 'Chemismus der Pflanzenzelle' (Vienna, 1869). These tables then resemble that well-known cell-form which has been regarded as a plant, under the name of *Sarcina,* since Goodsir's time, but which, according to Karsten and my own observations, belongs to the yeast series.

Many alkaloids (for example, theobromine in the fruits of the cacao-tree) likewise appear to be crystallized metamorphoses proceeding from proteine-vesicles. Karsten is also inclined to ascribe the same origin to the carotine in the root of the carrot (*Daucus carota*), and to arrange it with the crystalloids of the lupine. He also thinks that all the alkaloids and the nitrogenous glycosides (such as amygdaline, myronic acid, &c.) are in like manner chemically metamorphosed membranes of young cells (sap-vesicles) previously consisting of proteine materials. The alkaloids he regards as similar bodies, which, generally combining with organic acids produced at the same time from the membranes of the tissue-cells, may be called acid salts, which consequently dissolve in the cell-sap.—*Die Natur*, 1871, p. 323.

Anatomico-zoological Remarks upon Oncidium celticum, *Cuvier.* By M. L. Vaillant.

The presence on the French coasts of the curious Gasteropod mollusk designated, since the time of Cuvier, by the name of *Oncidium celticum* is a well-known fact: nevertheless it appears to have been but rarely met with; for, since it was mentioned by M. Milne-Edwards in 1828, it has not, I believe, been indicated in any catalogue. It is only in England that it has been described in a complete manner. We may, however, be surprised that so interesting an animal has not given rise to any thoroughgoing investigation, and that the only attempts to make known to us its anatomical organization, first by Cuvier (in 1804), and quite recently by Keferstein (in 1868), were made upon individuals preserved in spirit. The size of these species presented some facilities which do not exist with that of our shores, the extreme dimensions of which are scarcely more than 3 centimetres; but all anatomists know that a great number of important details can only be properly studied in the fresh animal. In order to try to fill up this gap I have undertaken a series of investigations, of which I here desire to give the principal results.

It was in the month of October 1870 that, for the first time, I chanced to meet with *Oncidium celticum* on the walls of the Briantais, towards the embouchure of the Rance; I could not afterwards find it during the winter months; and it was only in March 1871 that I saw a few individuals reappear. It is therefore probable that, like many other pulmonate Gasteropods, this animal does not come out during the cold season. After this period I at first found some difficulty in procuring it, in consequence of my not having studied with sufficient care the circumstances under which it is to be met with. In fact this mollusk only inhabits a very restricted zone, corresponding pretty exactly to the upper part of the second zone of MM. Audouin and Milne-Edwards, characterized by the presence of *Fucodium nodosum*; nor does it exist at all parts of this; and it appears especially to seek the spots covered with that greyish mud which is known by the name of *tangue*, and, I believe, where infiltrations of fresh water may be met with; this last fact, which is always difficult to ascertain, requires confirmation. Lastly, these animals do not at all times issue from the fissures which they inhabit; it is when the level just mentioned has been uncovered for about an hour that they begin to appear in numbers: for about two hours we may see them crawling to and fro upon the mud; afterwards they become scarce and disappear. In mild and bright weather they are more numerous; nevertheless I have likewise found them in the rain; they have therefore much less dread of fresh water than a great number of other marine animals.

The nervous and digestive apparatus, although presenting interesting peculiarities, have been described with so much care, at least in fundamental points, that I do not think I need speak of them here.

The arterial system is remarkable in most individuals by its peculiar aspect; the vessels of which it consists, and their ramifications, are of a silvery whiteness, resembling, in a certain degree, the tracheæ of insects; but here this effect is due to the accumulation in the walls of refractive, fatty granulations. This colour is more or less marked, and depends, perhaps, upon the season or the state of the individual; this question I was unable to decide. The principal trunks are three in number:—one anterior, neuromuscular; a second, middle one, gastro-hepatic; the last genital. The blood returns to the heart, at least in great part, by venous vessels, situated in the dorso-lateral walls, vessels which open into two great lateral sinuses (*veins* of Cuvier); and these sinuses themselves enter the pulmonary vessels.

Respiration, as is shown by anatomy and by observation, is performed in two ways—namely, by the so-called *pulmonary cavity* and by the skin. In the first place the dorso-lateral veins, which I have just mentioned, evidently collect hæmatosed blood from the cutaneous surface; their arrangement sufficiently indicates this. On another hand, if we place one of these animals in sea-water and keep it there, contrary to what has been stated by some authors, it lives there perfectly well, although it can respire only by the skin. Moreover, by examining the way in which the animal behaves in different situations, we see that, under water, its cutaneous projections become more prominent and the pulmonary orifice closes; in the air, on the contrary, especially in freedom, and in dry weather and high wind, the projections seem to disappear, the skin is almost smooth, with small distant spines, whilst the pulmonary orifice is widely opened beneath the raised margin of the mantle. In aquaria the *Oncidium* seems to live indifferently in the air or in water; very frequently one sees the anterior part immersed, whilst the caudal extremity is out of the water and the pulmonary orifice open.

The foot presents a cavity which communicates with the exterior by an orifice situated as usual, below and behind the mouth, near two great muscular masses which the animal seems to employ in the fashion of two supplementary tentacles, and which are perhaps the analogues of the small tentacles of the quadritentaculate pulmonate Gasteropods. By this cavity it is easy to inject the venous lacunæ; and, with very penetrating injections of carmine or oxalic Prussian blue, we may even fill the heart and a great part of the arterial system.

The genital apparatus, which is simpler, at least as regards the male portion, than in the species studied by Cuvier and Keferstein, is constructed upon the ordinary type of that of the monœcious Gasteropods. The female apparatus includes a large hermaphrodite gland with its coiled excretory canal, a vitellogene (albumen-gland of authors), a matrix, which can be distinguished from the preceding organ only in the fresh state, and which is continued into a canal to which it will be best to reserve the name of the *oviduct*; at the points where this must be designated the *vagina* there are inserted on the one side the canal of the copulatory pouch, and on the other a vaginal prostate formed of a long tube swelled into a clavate form. The female orifice is situated just in front of the anus. In the male apparatus the deferent canal, properly so called, runs directly to the side of the female orifice, and, as has been very well observed, is continued into a channel situated on the right side of the foot, and which extends to its anterior part, close to the corresponding subbuccal muscular mass. Here this channel opens at an orifice leading into a long tube folded upon itself, which must be regarded as a seminal reservoir; this tube finally terminates in a hollow muscular inflation, which is nothing but the invaginated penis (sheath of the penis of authors); the orifice by which this organ issues is situated in front of and close to the termination of the deferent channel. Thus we see that the spermatic fluid, after having traversed the deferent canal properly so called, must follow the deferent channel in order to enter afresh into the interior of the body, in the seminal receptacle. The copulation is reciprocal; the two individuals are placed side by side in opposite directions, adhering by the foot and the left portion of the mantle, the right portion being raised to expose the genital orifices. I have observed these animals coupled at two very different seasons, namely March and October.

To sum up, *Oncidium celticum* undoubtedly approaches the pulmonate Gasteropoda, among which it is very properly placed; nevertheless by its respiration, which is in great part cutaneous, and the arrangement of its reproductive apparatus, it presents certain relations with the Opisthobranchs, to which it evidently forms a passage. —*Comptes Rendus*, November 13, 1871, tome lxxiii. pp. 1172–1174.

Drosera (*Sun-dew*) *as a Fly-catcher.*

A valued correspondent and accurate observer, Mrs. Treat of Vineland, New Jersey, writes :—

"For several summers in succession I have taken *Drosera rotundifolia*, *D. longifolia*, and *D. filifolia* from their moist beds, and placed them in sand and water in such a way that they made most charming window-plants. What I take for *D. longifolia* has spatulate-oblong reddish leaves, and long, erect, reddish petioles covered with glands like those of the leaf. This species I find a much more effective fly-trap than *D. rotundifolia*. On some of the plants in my window this summer almost every leaf held a common house-fly prisoner until it died; and it did not take the leaf very long to fold completely round its victim. My husband was terribly shocked, and thought it the most cruel thing he ever saw in nature; but with my prepossessions and habits, both as an entomologist and a housekeeper, I was contentedly interested to see the work go on."

If we rightly remember, in *D. rotundifolia* it is only the gland-tipped bristles that bend inward and hold the insect fast, while they probably suck the juice out of him. This folding of the blade of the leaf itself around the fly is a new fact to us, and is so especially interesting (being a step towards *Dionæa*) that we would call particular attention to it, in the hope of further observations and independent confirmation. We are told that the blade incurves from apex to base in the manner of its vernation. What was long ago known of the action of *Drosera rotundifolia* in fly-catching had almost completely died out of the books and out of the memory of the present generation until very lately; and the most remarkable things relating to it and to *Dionæa* are not yet in print.—Prof. Asa Gray in *Silliman's American Journal*, Dec. 1871.

Note on a Fragment of a Teleosaurian Snout from Kimmeridge Bay, Dorset. By J. W. Hulke, Esq., F.R.S., F.G.S.

In this paper the author described a fragment of the snout of a Teleosaurian obtained by J. C. Mansel-Pleydell, Esq., F.G.S., from Kimmeridge Bay, and which is believed to furnish the first indication of the occurrence of Teleosaurians at Kimmeridge. The specimen consists of about 17 inches of a long and slender snout, tapering slightly towards the apex, where the præmaxillæ expand suddenly and widely. The nostril is terminal and directed obliquely forwards; the præmaxillæ ascend 2·5 inches above the nostril, and terminate in an acute point; and each præmaxilla contains five alveoli. The lateral margins of the snout are slightly crenated by the alveoli of the teeth, of which the three front ones are smaller than the rest: most of the teeth have fallen out; but a few are broken off, leaving the base in the sockets.—*Proc. Geol. Soc.* June 7, 1871.

THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[FOURTH SERIES.]

No. 50. FEBRUARY 1872.

XII.—*Investigations upon the Structure and Natural History of the* Vorticellæ. By Dr. Richard Greef*.

[Plates XII.-XVI.]

The *Vorticellæ* are among those Infusoria which were earliest and have been most frequently examined. From Leeuwenhoek, who first observed them and with them the first Infusorial forms, down to the most recent times, most naturalists seem to have turned with particular preference to this elegant group of animals. Leaving out of consideration that many were probably induced, by the exceedingly attractive phenomena of form and existence presented by the bell-animalcules, to a closer examination of them, there is perhaps no Infusorial family which can be observed with more ease and certainty. In all waters, whether stagnant or flowing, fresh or salt, *Vorticellæ* occur, often appearing in great quantities by the extension of their colonies. Almost all are attached to stems, and therefore are on the whole better adapted for examination (although with occasional interruptions, as in the contractile-stalked forms) than most other Infusoria, which pass restlessly to and fro in the field of vision, and can often only be brought to the desired state of quietness by a pressure which more or less alters the normal conditions of form and life.

It is no wonder, then, that, with regard to these animalcules, many interesting facts of extreme importance to the knowledge of the lower animal world were early ascertained (such, for example, as the process of division and the formation of bud-like structures), and that, with the advancing diffusion and improvement of the microscope, and the lively interest that was directed towards the Infusorial world, the field of observed phenomena has become a very extensive one.

* Translated by W. S. Dallas, F.L.S., from the 'Archiv für Naturgeschichte,' Jahrg. xxvi. p. 353.

But notwithstanding all the labour that has been bestowed both upon the bell-animalcules and upon the Infusoria in general, notwithstanding numerous interesting individual observations, and especially notwithstanding the great abundance of systematic materials, it appears that we are still far from having even a moderately satisfactory insight into the organization and vital history of the Infusoria—nay, that in many respects we have perhaps made only the first still uncertain steps in the knowledge of this remarkably multifarious class of animals, in whose varied company we have to seek many forms more or less allied to or constituting the parent forms of other groups of animals, especially the Vermes and perhaps the Cœlenterata, and which, by their universal distribution and their constantly recurring forms (in other words, by their truly cosmopolitan character), possess a special interest precisely in the above-indicated direction of their relationships to other animals.

The material for the present observations was furnished, as regards the freshwater forms, by the rich Infusorial fauna of the Schlossweiher of Poppelsdorf and some other stagnant waters in the environs of Bonn. Although I have submitted many of the genera and species occurring here to careful investigation, in these communications some forms to which I am indebted for the most abundant and important results are brought prominently forward, especially a species of *Epistylis*, which nearly approaches Ehrenberg's *Epistylis flavicans.* I say "nearly approaches," as I greatly doubt whether all the forms here noticed by me under this name belong to a single species, or, rather, whether we have not before us several different species or, at least, varieties, as, indeed, a glance at the appended figures (Pls. XV. & XVI.) may show. Not only do differences of size, colouring, and even, although in a less degree, of habitus occur, but also in the possession of apparently essential parts (that is to say, of organs), *e. g.* the peculiar shining capsules, hereafter to be described, which are furnished with a filament capable of being shot forth, and which display a close agreement with the nettling-capsules of the Cœlenterata (Pl. XV. fig. 5, *k*). In the course of our communications we shall again revert to the distinctness or identity of these forms.

The marine species which I have had the opportunity of examining are all from the North Sea at Ostend, where the occurrence of abundant material was always certain, especially in the oyster-parks there. These marine forms are represented on Plates XII. & XIII. (with the exception of fig. 8 on Pl. XIII.), in which the act of division and the gemmiform conjugation are shown in detail, and the remarkable tuft of *Zoothamnium* in Pl. XIV. figs. 6 & 7.

Systematic Limitation of the Family Vorticellina.

Ehrenberg first founded the family Vorticellina nearly in accordance with our present conception of it, and with 8 genera and 38 species*. The systematic characters are so happily seized, that the family has recently been accepted by Stein essentially with the limitation given to it by Ehrenberg. Ehrenberg characterized the Vorticellina "as (polygastric) animalcules which possess an alimentary canal uniting the stomachs, have the mouth and efferent orifice separate but placed together in the same pit, and therefore are without a hinder part, which bear no carapace, and either move freely individually, or are attached, and often, by imperfect self-division, acquire a minute frutescent or arborescent form." The eight genera united in this family were:—*Stentor*, *Trichodina*, *Urocentrum*, *Vorticella*, *Carchesium*, *Epistylis*, *Opercularia*, and *Zoothamnium*. Stein †, and after him Claparède and Lachmann ‡, first of all, on account of the different organization in many respects, rightly separated from these the genus of the Stentors §, now generally placed with the Bursarieæ, as they are ciliated over the whole body, whilst the true body of the *Vorticellæ* is naked and only bears a so-called adoral circlet of cilia; moreover the anus of the Stentors, as Lachmann demonstrated, is different in position from that of the *Vorticellæ* &c. Then Claparède and Lachmann further separated the genus *Urocentrum* || (without sufficient foundation or investigation, indeed) from the Ehrenbergian system, forming with it a peculiar family, and united Ehrenberg's

* A very full and admirable summary of the older literature, with indications of the earlier conceptions as to the structure and systematic position of the Vorticellina, is given by Ehrenberg in his great work, 'Die Infusionsthierchen als vollkommene Organismen,' pp. 260, 269, 275, 279, 286, &c. At p. 275 especially there is a very valuable critical revision of the older system of *Vorticellæ* and of the synonyms of the individual species. We learn from it that the genus *Vorticella* alone displayed no fewer than 120 specific names, which were reduced by Ehrenberg to 9 for actual, distinct and well-characterized species.

† Die Infusionsthiere auf ihre Entwicklungsgeschichte untersucht, p. 94.

‡ Etudes sur les Infusoires &c. i. p. 77.

§ Recently, as is well known, the Stentorinæ, as, indeed, was previously proposed by Lachmann (Müller's Archiv, 1856, p. 361 & p. 364, note 1), have been raised by Stein (Der Organismus der Infusionsthiere, ii. p. 170) to the rank of a distinct family, with the genera *Stentor* and *Freia*, and placed in the order of the *Infusoria Heterotricha*.

|| Etudes &c. i. pp. 78 & 134.

genus *Opercularia* with *Epistylis*, so that of the eight original genera of Ehrenberg's Vorticellan family three were eliminated, namely *Stentor*, *Urocentrum*, and *Opercularia*.

On the other hand, however, Claparède and Lachmann, following Stein's example, included the *Ophrydina* (which Ehrenberg had placed, as *carapaced bell-animals*, in a separate family) in the Vorticellan family, side by side with the true naked Vorticellina, taking into consideration, certainly with justice, the in other respects similar habit and organization of the carapaced and naked forms, and regarded the gelatinous envelope of the *Ophrydina* as morphologically equivalent to the gelatinous stem of the *Vorticellæ*, which is secreted by similar processes, and especially to the rigid stem of *Epistylis*. From Ehrenberg's *Ophrydina*, which included the genera *Ophrydium*, *Tintinnus*, *Vaginicola*, and *Cothurnia*, before incorporating them with the Vorticellina, they separated *Tintinnus*, on account of the essential differences in its ciliation and organization; so that, by this addition of three genera, the original number of the members of the family was reestablished. But, besides this, three new genera were added, namely *Lagenophrys* in the place of *Tintinnus*, as a carapaced *Vorticella*, and the two naked forms, *Scyphidia* and *Gerda*—the first established by Stein *, the second by Dujardin but first accurately characterized by Lachmann †, and the third discovered by Lachmann and Claparède ‡.

With all these additions and deductions, therefore, the Ehrenbergian family of the Vorticellina had grown to eleven genera, with a very considerable number of species. As the characters of this family, those previously established by Ehrenberg, (with the exception of the polygastric nutritive apparatus, which Ehrenberg had assumed for all Infusoria, and therefore, of course, for the bell-animalcules), were essentially retained by Claparède and Lachmann, especially as regards the position of the mouth and anus, whilst at the same time they added the adoral ciliation, which was not indicated by Ehrenberg as a special character, and which they represented, from Lachmann's observations, as running round the ciliary disk in a spiral line and sinking into the buccal orifice.

In order to trace the fate of the Vorticellan family to its present constitution, it only remains for us to mention briefly the alterations which Stein, in his most recent work on Infusoria, has finally made in the system gradually elaborated by

* Die Infusionsthiere auf ihre Entwicklungsg. untersucht, p. 85.
† Müller's Archiv, 1856, p. 348, note 1.
‡ Etudes &c. i. p. 117.

himself and by Claparède and Lachmann. The limits which he and his successors had at first widened have been again contracted by Stein himself nearly within the original bounds, as he has again separated the *Ophrydina* from the *Vorticellæ**, and accepted their right, first recognized by Ehrenberg, to form a carapaced family side by side with the naked bell-animalcules. He has also dissolved the union of the genus *Opercularia* with *Epistylis* made by Claparède and Lachmann, and raised the former, as was done by Ehrenberg, to the rank of an independent genus. On the other hand, he has separated *Urocentrum*, like Claparède and Lachmann, but on the grounds of a more accurate investigation than they had made—and also *Trichodina*, which had hitherto remained combined with the *Vorticellæ*, but differs from them in many essential points, especially by the possession of a peculiar adherent apparatus at the hinder end of the body, by the constant absence of a posterior circlet of cilia and of a protrusible and retractile rotatory organ, &c., so that at first Stein even ascribes to the *Trichodinæ* the rank of a distinct family on account of these peculiarities†, although subsequently he arranges them as a genus of the newly formed family of the Urceolarina. As new members, the genera *Scyphidia* and *Gerda*, already introduced by Claparède and Lachmann, are accepted, and to these the genus *Astylozoon*, discovered by Engelmann‡, is added: it is characterized by the possession of two springing-bristles, situated at the posterior end, in place of a stem.

Thus it comes to pass that, after all these changes, the present systematic constitution of our family (with the above-mentioned natural exception of the Stentors) is once more nearly the same as when it was founded by Ehrenberg. The genera, also, have again been brought back to their original number, namely eight; and these, after the alterations above indicated, are:—*Vorticella*, *Carchesium*, *Epistylis*, *Zoothamnium*, *Opercularia*, *Scyphidia*, *Gerda*, and *Astylozoon*.

The characters of the family thus united, as they have been developed or, rather, have gradually acquired a sharper prominence in the way above described, may now be summed up in the following points:—In the first rank we must place the *position of the mouth and anus in a common cavity* in the bottom of the first section of the nutritive tube, the so-called *vestibule*, which was correctly recognized and indicated as a primary character by Ehrenberg. Next to this comes the

* Der Organismus der Infusionsthiere, ii. p. 168.

† Der Organismus der Inf. ii. p. 146.

‡ Zeitschr. für wiss. Zool. xi. p. 389, pl. 31. figs. 15, 16.

peculiar nature of *the anterior rotatory organ, or the so-called adoral ciliary zone*, which, in the true *Vorticellæ*, according to Claparède and Lachmann, always forms a *left-handed spiral*, running round the ciliary disk and then sinking into the vestibule, which commences between the peristome and the ciliary disk. The *ciliary disk*, i. e. *the whole rotatory organ*, can moreover be *retracted* into the interior of the body, and in this case is closed up *by the membranous peristome as by a sphincter or a screen*. When the *ciliary disk* is opened outwards, it is surrounded, as if by a collar, by *the peristome*, which is separated from it by a more or less deep furrow, and *rolled outwards*. The faculty of suddenly *springing back* of the whole body, which contracts at the same time, and of the stems, where contractile stems are present, is connected as an essential character with the retractile rotatory organ.

For the closer limitation of the Vorticellina, with regard to the allied families, especially the Ophrydina, the gelatinous envelope, which occurs in the latter and is wanting in the *Vorticellæ*, has been again adopted by Stein as the distinctive character between the two families, it having been already, as we have seen, employed by Ehrenberg for this purpose, but suppressed by Claparède and Lachmann. For my own part I can only regret this repeated separation, as, if we leave out of consideration the stem of the Vorticellina and the envelope of the Ophrydina, the two families agree so closely in their whole habit, structure, and vital phenomena, even to the most minute points, that, in the presence of this agreement, a severance of the Ophrydina from the immediate alliance of the *Vorticellæ* must be regarded as forced, and opposed to the natural relationship of these two groups. Probably even the most experienced and careful observer would scarcely be able to recognize, as such, a fissional scion of an Ophrydine (*e. g. Cothurnia*, see Pl. XII.) furnished with its posterior circlet of cilia, and just escaped from the envelope of its parent—that is to say, to distinguish it from the fissional scion of a true *Vorticella*. It is therefore merely the exterior finger-like envelope that is destined to separate the two families. But this alone, as we shall endeavour to show, can not suffice for the satisfactory establishment of this separation. If we could put opposite to each other the forms furnished with an envelope and adherent by short peduncles, and at the same time perfectly freely movable and non-pedunculate forms, such as may be represented by the fissional scions or by *Gerda*, the separation under consideration would perhaps appear more justified. But most *Vorticellæ* are likewise attached to peduncles, which on their part, again, are attached—with the exception of two forms, namely:—the *Astylozoon* described by Engelmann, which rejoices in constant spontaneous mobility, but at the same time possesses two springing-setæ (*Schnellborsten*) at the hinder end of the body, perhaps as the homologue of the peduncle; and, further, the genera *Scyphidia* and *Gerda*, which are, indeed, completely non-pedunculate, but are more or less sessile. But if we examine the peduncle of the *Vorticellæ*, especially in comparison with the peduncle and envelope of the Ophrydina, we cannot reject out of hand the intimate correlation of these structures. The peduncle of the *Vorticellæ* consists of a hyaline homogeneous exterior envelope or sheath and a darker, more or less granular axis. The latter is either muscular substance*, and in this case, with the whole peduncle, retractile (*Vorticella*, *Carchesium*, &c.), or the axis contains no muscular elements, and then the peduncle is rigid (*Epistylis*). But in both cases the exterior hyaline envelope of the peduncle embraces the hinder basis of the body of the animal, whilst the axis alone penetrates into this base, becoming amalgamated with it, and here either serves merely for the attachment of the animal and of the retractor muscular elements in it (*Epistylis*), or, when the axis itself is of a muscular nature, radiates out continuously in the body (*Vorticella*, *Carchesium*). Now in the Ophrydina in general both the envelope and the body of the animal are likewise attached by a peduncle, although this is usually very short; and yet this may be regarded as morphologically equivalent to the peduncle of the *Vorticellæ*, and, indeed, especially to that of *Epistylis*. The sheath which in the *Vorticellæ* envelopes the axis of the peduncle, and terminates at the hindmost base of the body of the animal, is continued forward beyond this base in the Ophrydina, rising into a wide beaker-shaped case, within which the whole animal can retract itself. But even the axis of the Vorticellan peduncle is not wanting in the Ophrydina, but it is what, just as in the *Vorticellæ*, enters the base of the body and effects the attachment. Thus the more accurate investigation of the constitution and secretion or development of these structures may only render their identity still more clear. From all this it seems to me more natural to accept the individual genera of the Ophrydina as members of the Vorticellan family than to separate them from the latter.

Stein has further placed the family of the Vorticellina

* We retain here the denomination "axis" for the sake of uniformity, even for the contractile peduncles, although, as is well known, in *Vorticella* and *Carchesium* the muscular cord has a spiral course round the axis within the sheath, and only occupies a position in accordance with the true axis in *Zoothamnium*.

under his order of Peritrichous Infusoria *, in which it forms the true ordinal type, the "nucleus and central point" to which the other groups approximate upwards and downwards.

We have treated the systematic history of the Vorticellan family in more detail perhaps than the following observations may render necessary; but the history of the classification of a group of animals is always the true expression of the development of the knowledge of it; and in the present case it is of the greater interest, because it shows in how rare a fashion the Vorticellina have shown themselves to be a coherent and closed group, as, in spite of all efforts at further development, the systematic combination has remained essentially the same, although the characters in the meanwhile, as we have seen, have attained a much greater sharpness. But, besides this, we shall be able often to make use of the stand-point arrived at in the above explanations in our further statements, in order to attach our own observations, without being constantly obliged to make long digressions.

[To be continued.]

XIII.—*On the* Microxylobius Westwoodii, *Chevr.*, *from St. Helena.* By T. Vernon Wollaston, M.A., F.L.S.

Having lately had an opportunity, through the kindness of W. W. Saunders, Esq., of examining the type of the little Curculionideous *Microxylobius Westwoodii*, from St. Helena, which was described in the first volume of the Entomological Society's Transactions, and which, after the lapse of thirty-six years, still remains unique in his collection, I have thought that it would be worth while to draw out an accurate diagnosis of it, in order to call attention to the exact characters in which it recedes from the other members of the genus (twelve in number) which have hitherto been brought to light. And this seems to be the more desirable, since the few words of M. Chevrolat which take the place of a description are quite insufficient for even its approximate identification. Judging solely from the excellent figure of it which was supplied by Prof. Westwood, I had imagined that it might perhaps prove to be identical with the species which I enunciated, in 1869, under the name of *vestitus*; but I now perceive that it is not only totally distinct from that insect, but equally so (as may be gathered from the subjoined remarks) from every other *Microxylobius* which has come under my notice.

* Der Organismus der Infusionsthiere, ii. p. 168.

Microxylobius Westwoodii.

M. angusto-elongatus, ovato-cylindricus, obscure subnigro-æneus (et etiam obsoletissime subvirescens), alutaceus, subopacus, calvus; capite rostroque minute et leviter sed argute punctulatis, hoc breviusculo sed lineari et supra subgibboso; prothorace angusto, cylindrico-subovato, punctulis minutissimis parce et leviter irrorato; elytris subcylindricis sed pone medium paulo latioribus, confuse transversim rugatis (fere quasi subrimosis) sed haud sculpturatis (i. e. vix striatis et vix punctatis), sutura antice subcarinatis; antennis pedibusque piceo-nigris, illis basi rufo-ferrugineis.
Long. corp. lin. $1\frac{1}{4}$.

Microxylobius Westwoodii, Chevr., *loc. cit.* 98 (1836).
—— ——, Woll., *ibid.* v. (n. s.) 381 (1861).
—— ——, Id., Ann. Nat. Hist. ser. 4. vol. iv. p. 403 (1869).

Obs. Species inter reliquas distinctissima; differt corpore angustiore et multo magis cylindrico, ubique alutaceo, subopaco, calvo, prothorace minutissime tantum parceque punctulato, elytris transversim substriguloso-rugatis sed longitudinaliter vix sculpturatis, sutura antice acutiusculo, subcariniformi.

Judging from the type before me, this little *Microxylobius* is as small as even the *M. vestitus*, being only a line and a quarter in length. It is, however, relatively narrower and much more cylindrical than that species (indeed more so than any of the *Microxylobii* which have hitherto been detected); and it is likewise darker in hue, and perfectly free from even a trace of pubescence. Its rostrum is a little wider than that of the *M. vestitus*, and its tibiæ are rather more curved, and the punctation of its head and prothorax (the latter of which is comparatively unexpanded behind the middle) is even more delicate still; and it is further remarkable for its elytra (which have their suture slightly raised, or somewhat keel-shaped, in front) being transversely marked with remote, obscure *scratches*, or irregular strigæ, but almost devoid of longitudinal sculpture; and its entire surface is coarsely alutaceous, and therefore but very faintly shining.

Before closing this short paper, I may just state that Mr. G. R. Crotch informs me that he possesses two examples of the *Cydonia vicina*, Muls. (a Coccinellid which is widely spread over the African continent, and which we captured abundantly in the Cape-Verde archipelago), from St. Helena, received by him in company with the *C. lunata*, which is so universal in the island. This, therefore, will add one more species to the St.-Helena catalogue, augmenting the entire number to 96; and I would desire, consequently, to record it as follows:—

Cydonia vicina.

Cheilomenes vicina, Dej., Cat. 459 (1837).
—— *circumflexa* (Klug), Id., *ibid.* (1837).
Cydonia vicina, Muls., Sécurip. 440 (1851).
—— ——, Woll., Col. Hesp. 155 (1867).

Hab. Sanctam Helenam, teste cl. G. R. Crotch.

I have likewise a note from Mr. Crotch to the effect that the *Sphæridium dytiscoides* of Fabricius is still preserved in the Banksian collection, and that a friend of his who has recently examined it reports it to be totally distinct from the *Dactylosternum abdominale*, being, in point of fact (as, indeed, I had ventured to think probable), a true *Cyclonotum*, and one which occurs also at the Cape of Good Hope.

XIV.—*On the Anatomy of the Nervous System of* Diphyes, *affording presumptive evidence of the existence of a similar System in the other forms of Oceanic Hydrozoa.* By John Denis Macdonald, M.D., F.R.S., Staff-Surgeon of H.M.S. 'Lord Warden.' *

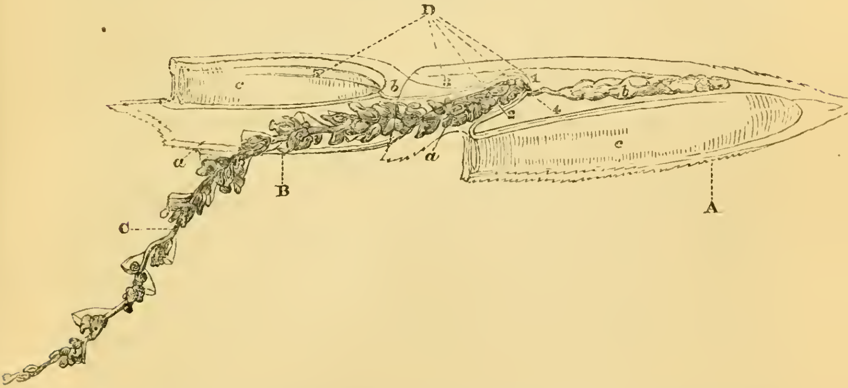
While cruising off the coast of Portugal, a few hauls of the towing-net brought up many specimens of a species of *Diphyes* which I have not determined, as the suitable books were not at hand; this, however, may be readily done by referring to the figure accompanying this paper. I very carefully examined several of these animals (or, I am rather tempted to say, animal forms) in relation to the received views of the structure and organization of the group to which they belong. In some instances the two nectocalyces were nearly intact, while in others they were separated, which is more usually the case. This latter remark is also quite true of the parts of numerous other oceanic Hydrozoa, which were quite problematical to most students of zoology until Professor Huxley elucidated their structure by independent research, which enabled him also to render the results obtained by others more intelligible.

In the present species the proximal nectocalyx is about twice as large as the distal one, sharp-pointed, three-sided, and much laterally compressed at the free extremity, but distinctly quadrilateral at the base, where two angular pro-

* Communicated by the Director-General of the Medical Department of the Navy.

cesses, with curtain-like flaps between them, bound the polype-cell, including the apex of the distal nectocalyx. This latter is also four-sided and laterally compressed, bearing the propulsive chamber or nectosac above, and a deep longitudinal groove for the chaplet of polypes beneath, while the free extremity terminates in a double-pointed projection. All the angles and edges of both nectocalyces are faintly serrated, with the points directed towards the base in each, so as to offer little or no resistance to the water during natation. The figure will give a sufficient idea of the general characters of this species, without further description, except what is to be said of the nervous system, the exposition of which is the principal object of this paper.

At the base of the polype-cell, just within the attachment of the cœnosarc, and above the duct of the somatocyst, there appeared to me to be a little ganglionic mass; but of this I cannot be quite certain until I investigate the matter a little more closely. I am satisfied, however, that I have been able to trace a nerve-trunk from that point along the inferior wall of the polype-cell to the angle between it and the open end of the nectosac, the upper wall of which is supplied with two long and tapering nerves, bifurcating from the primary trunk. A second principal nerve was distinctly traceable into the



A, the proximal nectocalyx: *a*, polype-cell, lodging the cœnosarc and polypes; *b*, somatocyst, communicating with the cœnosarc cavity; *c*, nectosac or propulsive chamber.

B, the distal nectocalyx: *a*, protective groove for the polypes; *b*, pedicel of the nectosac including the nerve; *c*, the nectosac.

C, chaplet of cœnosarc and polypes.

D, the nervous system: 1, nervous centre? ; 2, proximal nerve-trunk; 3, distal nerve-trunk; 4, branches to proximal nectosac; 5, branches to distal nectosac.

apex of the distal nectocalyx; and having run along the polype-groove as far as the fundus of the nectosac, where it was surrounded by a tubular process of endoderm, it also terminated in a bifurcation, the resulting branches being distributed to the upper wall of the sac, as in the former case.

Though the movements of *Diphyes* are very variable, the normal position is that in which the chaplet of polypes trails from the groove of the distal nectocalyx, the nectosac being superior or on the neural side.

The nectosacs give propulsion to the whole organism, with the pointed extremity of the proximal nectocalyx foremost; nevertheless I am disposed to think that the movement is truly retrograde, as in the case of the cuttlefishes; and if this be true, all the terms of relation used in the description of animals having a bilateral symmetry will be applicable to *Diphyes*.

H.M.S. 'Lord Warden.'
Gibraltar, Oct. 10, 1871.

XV.—*Note on* Prof. Heller's *Catalogue of the Hydroida of the Adriatic**. By the Rev. Thomas Hincks, B.A.

We are indebted to Prof. Heller for very valuable contributions to our knowledge of the Invertebrate fauna of the Adriatic. In 1867 he published at Vienna an admirable Catalogue of the Polyzoa which occur in that sea, containing descriptions and figures of a large number of new species. In 1868 he continued his work, and dealt with the Zoophytes and Echinodermata of the same region, in the paper which is the subject of the present communication. The zoology of the Adriatic has been illustrated by a long line of able investigators, extending from the times of Donati and Olivi (1750–1792) to the present day; but Prof. Heller has shown us that its riches were far from being exhausted. It is unnecessary to say a word as to the value of such local catalogues and the relation which they bear to the interesting problems connected with geographical distribution. It is obvious, however, that, inasmuch as they form the storehouses from which the theorist draws his facts, it is of the first importance that they should be characterized by rigorous accuracy in the discrimination and identification of species. In that portion of his work which relates to the Hydroida, Prof. Heller has needlessly increased the chances of error, has rendered, indeed, a certain amount of

* "Die Zoophyten und Echinodermen des Adriatischen Meeres, von Prof. Cam. Heller in Innsbruck," 1868.

error inevitable, by his strange neglect of the later literature of his subject. He supplies us with a list of the authors, ranging from Donati in 1750 to Grube in 1864, who have concerned themselves specially with the fauna of the Adriatic; but of English writers on the Hydrozoa none are cited of later date than Johnston (1847); while there are but scanty references to the Continental and other works published since his time.

It is impossible that any treatment of the Hydroida can be satisfactory which practically ignores the researches of Alder, Allman, Busk, Strethill Wright, and others in this country, who have cast so much new light on this department of zoology. In the hope of adding to the value of Prof. Heller's work, by supplying a few points that have escaped him, I venture to submit his Catalogue of Hydroida to some critical revision.

The list is a small one for a district so fertile in other forms of animal life, embracing only thirty-seven species, of which twenty-three are included under the five genera into which Prof. Heller divides the *Sertularia* and *Plumularia* of Johnston. The most remarkable deficiency occurs in the Athecate or Tubularian section, under which only four species are recorded. About eighty species have been described from the British seas. It is highly improbable that this important group is not largely represented in the Adriatic; and I hope that Prof. Heller may have the opportunity of continuing his investigations, and giving us a more complete account of this interesting portion of his subject.

Of the four Athecate Hydroids included in the Catalogue, one is recorded as the *Coryne pusilla* of Gaertner: this is an obscure species, which it is hardly possible to identify with certainty; and there is nothing to indicate to what particular form Prof. Heller applies the name. A considerable number of species of *Coryne* and the allied genus *Syncoryne* are now known, and to one of them Gaertner's name has been assigned; but, in the absence of all reference in the synonymy to later authors, it is impossible to decide which of these the Adriatic form may be. The brief account of it given by our author does not help us; for the characters which he ascribes to it are almost exclusively generic. At present, therefore, we can only affirm, generally, that one species of Corynoid at least is a native of the Adriatic.

The species included by Johnston in the old genus *Sertularia* Prof. Heller ranges in two divisions, for one of which he retains the latter name, and assigns to the other Lamouroux's name *Dynamena*. This arrangement, which is based on the mode in which the calycles are disposed, whether alternately or in pairs, seems to me to be merely artificial, and not in any measure to represent the natural relationships of the forms in question. A well-marked group, of which *S. polyzonias* may be taken as the type, has been defined by Gray under the name of *Sertularella*; another, equally natural, characterized by the peculiar structure of the reproductive capsule (which is well exemplified in *S. rosacea*), has been constituted by Agassiz as *Diphasia*; a third, to which the Linnean name may be appropriated, will include the remaining forms, whether they have opposite or alternate calycles, a point in which the most closely allied species differ. Those which have the calycles in pairs may, for convenience' sake, be ranked as a subsection.

Sertularia Ellisii is amongst the species recorded in the Catalogue. It should be noted that this is the well-known and widely distributed *S. polyzonias* of authors, one of the most cosmopolitan of the Hydroida. Heller adopts the opinion of Milne-Edwards, that Ellis has figured two distinct species under the name of *polyzonias*; and also follows him in assigning the name *Ellisii* to the commoner of the two forms. It is unfortunate that the new name should have been given to the well-known species, while the old and classical designation has been reserved for a form which rarely occurs and has attracted little attention. In my 'History of the British Hydroid Zoophytes' (vol. i. p. 235) I have cited *S. Ellisii* as a synonym of *Sertularella polyzonias*; but, after a more careful examination of Ellis's figures and description, I am disposed to believe that Johnston was wrong in uniting them, and that the erect variety, with ovate calycles and a plain aperture to the gonotheca, is a well-marked species. At the same time I have never found it myself, nor have I met with specimens of it: but one of Ellis's figures is unimpeachable evidence; and variable as *S. polyzonias* is within certain limits, it never, so far as I am aware, makes an approach to the characters which he has so clearly represented in his figure B. Couch records both the forms as occurring on the Cornish coast, and regards them as specifically distinct (Cornish Fauna, p. 17). But, while accepting Milne-Edwards's species, I am strongly of opinion that the names should be reapportioned—that the more common form, which was probably the one known to Linnæus, should bear the older name (*polyzonias*), and that the one which Ellis was the first to figure should stand as *S. Ellisii*.

Dynamena (*Diphasia*) *pinaster*.—The specimens thus named, it is evident (from the description of the capsule and the reference to Johnston's fig. 12, *c*, *d*, p. 72), should be assigned to *Diphasia attenuata*, mihi, a species which has occurred at Port Adelaide as well as on the British coasts. Heller seems to have met with the female gonotheca only, which he rightly describes as much attenuated below, and above covered with numerous spines.

Thuiaria lichenastrum.—This species is recorded by Olivi as a native of the Adriatic; but Heller considers it probable, from the description given of it, that the form intended should be referred to the *T. articulata*, Pallas. The *Sertularia lichenastrum* of Linnæus is closely allied to the latter; but Pallas, who had seen specimens from Ceylon exactly answering to Linnæus's description, considered the two forms distinct. It seems probable that the Adriatic species is identical with our British *articulata*.

The genus *Plumularia* Prof. Heller subdivides into three: he retains Lamarck's name for the *P. pluma* section, in which the nematophores ("*Nebenzellen*" of Heller) are developed only in connexion with the calycles, and the latter are approximate, and adopts Donati's *Anisocalyx* for the group in which the nematophores are generally distributed, the calycles comparatively distant, and long and short internodes alternate on the branches. For the section in which the shorter intermediate internodes are wanting he proposes a new genus, under the name of *Heteropyxis*. But the character relied upon as a generic distinction in this latter case is quite insignificant. Of the most intimately allied species (e. g. *Plumularia echinulata*, Lamk., and *P. similis*, Hincks), some possess the intermediate joint, and some want it. Of the two British species of *Antennularia*, *antennina* has it, but it is not present in *ramosa*. The difference is of the most trivial kind, and should have no place in a generic diagnosis, much less should it stand as the chief criterion of a genus. Nor can I agree with Prof. Heller when he adopts Donati's *Anisocalyx* for the group in which the nematophores are distributed over the stem and branches. The nomenclature of the Italian naturalist (who regarded the zoophytes as plants) has not obtained any currency in the literature of the Hydroida; and the particular name in question seems to have had no reference originally to this section of the *Plumulariidæ*, but to have been applied to certain forms belonging to the other group, of which the *Sertularia pluma* (Linnæus) is the type. Under these circumstances it seems to me better to retain the two well-known and widely used names of Lamouroux and Lamarck, *Aglaophenia* and *Plumularia*. Meneghini assigns the name *Anisocalyx* to a genus which he has founded for the *Sertularia secundaria*

(Cavolini), a form which cannot be separated from *Plumularia* (mihi); while Costa ('Fauna di Napoli') seems to have applied it to the whole group. As it seems to me, it must either be retained for the *pluma*-section or abandoned altogether; and in the interests of scientific *order* I should adopt the latter course.

Under the genus *Anisocalyx* Heller records five species as found in the Adriatic; to these may be added the two which he has relegated to his new genus *Heteropyxis*, and also *Plumularia frutescens*, which he has wrongly associated with the *P. pluma* section. Of these eight species, four are regarded as new; they are distinguished from one another and from previously known forms chiefly by minute differences in the character of the internodes and the disposition of the nematophores. *A. bifrons*, Heller, comes very near *P. setacea*, Ellis, the chief difference being that in the former two pinnæ spring from each division of the stem, in the latter only one. A single nematophore also is mentioned as occurring in *A. bifrons* above the calycle, whereas in the allied form there are two. The gonotheca is said to be oval or pyriform. The *Anisocalyx* (*Plumularia*) *setaceus* of the Catalogue does not appear to be identical with the British species of this name: it has only a single nematophore, which is described as "a rudimentary cell in the form of a small projecting denticle" placed in the middle behind the calycle, whereas the true *P. setacea* has two bithalamic nematophores above the calycle, one below it, and one on the intermediate joint. The gonotheca, too, is said to be "elliptical and smooth," which would certainly not be a satisfactory description of the elegant, flask-shaped capsule of *P. setacea*. If I am right in conjecturing that the Adriatic is distinct from the British form, I would propose for the former the name of *P. Helleri*.

Another of Heller's new species is the *A. pinnatifrons*, which, judging from the diagnosis, comes very near the last. The *A. diaphanus* is more strongly marked, and is characterized by an ample development of nematophores, both on stem and branches. Of the two species of *Heteropyxis* recorded, one has the pinnæ opposite, the other alternate; in all other points they seem to agree. As I have said before, these forms have no claim to be separated from *Plumularia* (mihi).

One other species of *Anisocalyx* (*Plumularia*) is included in the Catalogue, *A. secundarius*, which is identified with the *Sertularia secundaria* of Cavolini. As I have stated in my 'History of the British Hydroida,' there can be little doubt that this curious form is only a stemless variety of *Plum. Catharina* (Johnston) or some kindred species.

It appears, then, that in the Adriatic there is a considerable group of *Plumulariæ* distinguished from one another by comparatively slight differences, most of which have not hitherto been noticed elsewhere.

Laomedea dichotoma.—The description given of this species is not sufficient for identification; and in the absence of any reference to the later writers, who have most carefully investigated the Campanulariidæ, it is impossible to decide what form is intended.

Laomedea gelatinosa.—The brief diagnosis and the reference in the synonymy to Johnston's plate xxv. figs. 3, 4, would seem to show that the Adriatic species to which this name is applied is the *Campanularia flexuosa*, Hincks. It is certainly not the *Laomedea* (*Obelia*) *gelatinosa* of Pallas.

Campanularia volubilis. — The *Campanularia* (*Clytia*) *Johnstoni* of Alder is, no doubt, the species intended. The description shows that it is not the *C. volubilis* of Linnæus.

To sum up, of the 37 species of Hydroida recorded by Prof. Heller as occurring in the Adriatic, two (*Coryne pusilla* and *Laomedea dichotoma*) cannot be identified with any certainty; of the remaining 35, 18 are also found in the British seas. The list of species that are common to Great Britain and the Adriatic, as now revised, is as follows:—

Eudendrium ramosum.
Tubularia indivisa.
—— larynx.
Halecium halecinum.
Sertularella polyzonias.
Sertularia abietina.
—— operculata.
Diphasia tamarisca.
—— attenuata.
Thuiaria articulata.
Antennularia antennina (?). [It is not improbable that *A. Janini* was the species recorded by Olivi under this name.]
Aglaophenia pluma (*cristata*, Heller).
—— myriophyllum. I have this species also from the Red Sea.
Plumularia frutescens.
Obelia geniculata.
Campanularia flexuosa.
Clytia Johnstoni.
Lafoëa dumosa.

Of the foregoing, *Sertularella polyzonias* and *Sertularia operculata* are cosmopolitan species.

Of the remaining 17 species contained in Prof. Heller's list six are new, and so far have only been found in the Adriatic; and five of the six are referable to the genus *Plumularia*. The rest are known Mediterranean and Adriatic forms.

I hope that Prof. Heller may continue his researches, and give us a much fuller account of the Hydroid fauna of this interesting district.

XVI.—*Notulæ Lichenologicæ.* No. XXXV. By the Rev. W. A. Leighton, B.A., F.L.S., F.B.S. Ed.

Recognitio Monographica Ramalinarum. Scripsit William Nylander, Caen, 1870.

Dr. W. Nylander has published, in the 'Bulletin de la Société Linnéenne de Normandie,' ser. 2. t. iv., and also separately, a very valuable monograph of one of the most difficult genera of Lichens, *Ramalina.* In respect of difficulty and uncertainty the genus *Ramalina* is amongst lichens analogous to the genera *Rubus* and *Hieracium* amongst flowering plants. The critical acumen and painstaking discrimination of Dr. Nylander have now, however, placed in our power the clue to this puzzling labyrinth. In effecting this, Dr. Nylander has discovered that the differences of the external surface of the receptacles of the apothecia, and also the form and size of the spores and spermatia, which have been hitherto altogether neglected or overlooked, do in reality afford useful essential characters. To these must be added the chemical reactions resulting from the application of hydrate of potash to the medulla, which in one species is tinged with yellow, or yellow which soon changes into red, whilst in other species no reaction is produced. "Medullam eo adminiculo tum crocee vel lateritio-rubricose vel sanguinee tingi (præcedente flavescentia), apud alias vero species nullam talem coloris mutationem observavi." He cautions students that this reaction is instantaneous or nearly so, and that the discoloration resulting from slow drying or a secondary and slow reaction is to be altogether disregarded. "Reactionem ejusmodi dico eam, quæ applicato adminiculo chemico mox vel fere mox prodit, nec respicio colorationem obscuram interdum desiccatione lente accedente ortam vel secundariam et tardam."

With regard to chemical reactions generally, I may take this opportunity of mentioning that different observers have, according to their statements, not unfrequently obtained different reactions from those indicated by writers on this subject. This may probably be accounted for in several ways. Either the experimenter has relied entirely on the supposed accuracy of the labels attached to specimens in published Exsiccati, without also ascertaining, by examination into essential characters, whether the lichen be really that indicated by the label or not; or the chemicals used were old or feeble, or had become wanting in energy by exposure to the atmosphere. Both of these would be sources of error, and hence also different results. My own experience induces me to regard as of essential importance that the chemicals be of the very best quality, and that the solutions be freshly prepared and of the requisite strength. Hydrate of potash is best compounded of equal weights of caustic potash and water*. It is also of importance that the solution used on one day should not be left exposed to the air in a vessel until another day, but thrown away, and the vessel cleanly wiped. Nor should fresh quantities of the solution be added to any reserved from a previous experiment; for the proper results will fail. The late severe cold weather has convinced me that temperature has something to do with successful reaction; for with all properly compounded appliances, I have failed (in various lichens previously experimented upon with satisfactory reactions) in obtaining the second red reaction after the yellow one, with hydrate of potash, until I warmed the moistened portion of the lichen at the fire, when the red reaction ensued. Excessive cold would seem therefore to render the second reaction very tardy and insufficient.

I may also add to the reactions obtained by Dr. Nylander in the genus *Ramalina* another which I have obtained on the cortical layer of the thallus—which, on being moistened with hydrate of potash, exhibits no reaction, but on the subsequent application of hypochlorite of lime, shows a feeble yellow reaction, intensified into a deeper yellow, or even orange, by a second application of hydrate of potash (K—, C faint yellow, K deeper yellow). But this reaction, being observable in all the *Ramalinæ*, does not aid us with any distinguishing character.

Sixty-five species of *Ramalina* are described, 33 of which occur in Africa, 27 in North America, 27 in South America, 19 in Asia, 18 in Europe, 11 in Australia, 5 in Polynesia; 5 are found in the arctic zone, 33 in the north temperate zone, 32 in the equinoctial zone, and 14 in the south temperate zone.

The cortical layer is variously composed: in some species it is horny and subamorphous, or with indistinct cellules; in others and the generality its external portion is amorphous, and its internal portion is formed of longitudinal tubulose conglutinated filaments. The structure of the cortical layer may be best observed by placing a thin section in hydrate of potash, under the microscope. In the spermogonia the sterigmata are

* The experimenter must also be certain that he obtains from the chemist *hydrate* of potash; for it has happened to myself that *iodide* of potassium was once given me by a respectable chemist, with the remark that "hydrate" was the old name, but "iodide" the modern name for the same chemical. But with it I could not obtain the requisite reactions.

subsimple or pauciarticulate, and are accompanied by elongated and anastomosing filaments, as represented in Tulasne's Mém. Lich. t. 2. f. 13–15. The form of the spermatia is peculiar, being straight cylindrical or oblongo-cylindrical, apparently more solid at the obtuse apices than in the middle.

The species are thus arranged:—

A. Spermogonia in conceptacles entirely black.

a. Cortical layer very thin, fragile, here and there cribrose; thallus cylindrical, soft, internally empty.

1. *R. inanis*, Mont. (Medulla K –.)

b. Thallus rigescent, internally filled with a woolly medulla; cortical layer without longitudinal filaments.

2. *R. ceruchis* (Ach.). 3. *R. combeoides*, Nyl. 4. *R. homalea*, Ach. 5. *R. testudinaria*, Nyl. 6. *R. flaccescens*, Nyl. (Medulla in all K –.)

c. Thallus rigescent, fruticulose; cortical layer formed of longitudinal filaments.

7. *R. melanothrix*, Laur. (Medulla K –.)

B. Spermogonia half-black.

8. *R. carpathica*, Krbr. (Medulla K –.)

C. Spermogonia in pale or colourless conceptacles.

1. Stirps *R. gracilis*. Thallus attenuate, fruticulose, subterete or subanguloso-terete, or attenuato-compressed; cortical layer filamentose.

† Medulla K yellow, then red.

9. *R. rigida* (Pers.). 10. *R. anceps*, Nyl. 11. *R. arabum* (Ach.). 12. *R. dasypoga*, Tuck.

†† Medulla K –.

a. Spores straight, or nearly so.

13. *R. gracilis* (Pers.). 14. *R. angulosa*, Laur. 15. *R. implectens*, Nyl. 16. *R. thrausta* (Ach.). 17. *R. gracilenta*, Ach. 18. *R. Montagnei*, D. N. 19. *R. taitensis*, Nyl.

b. Spores curved.

20. *R. camptospora*, Nyl.

2. Stirps *R. usneoidis*. Thallus lineari-attenuate, elongate, compressed, generally pendulous, striate or substriatulate. Medulla K –.

a. Spores straight.

21. *R. australiensis*, Nyl. 22. *R. rectangularis*, Nyl. 23. *R. usneoides* (Ach.) and its vars. *usneoidella*, Nyl., and *capensis*, Nyl.

b. Spores curved.

24. *R. reticulata* (Noehd.). 25. *R. bogotensis*, Nyl. 26. *R. chilensis*, Bert.

3. Stirps *R. fraxineæ*. Thallus compressed, more or less longitudinally striato-nervose or subcostato-unequal.

a. Cortical layer filamentose.

† Medulla K yellow, then red.

27. *R. subpollinaria*, Nyl. 28. *R. denticulata* (Eschw.) and its var. *canalicularis*, Nyl.

†† Medulla K –.

29. *R. complanata* (Sw.); **R. hypodectodes*, Nyl. 30. *R. peruviana*, Ach. 31. *R. canaliculata*, Tayl.; **R. linearis* (Sw.). 32. *R. alludens*, Nyl. 33. *R. calicaris* (Hffm.) and its vars. *subampliata*, Nyl., and *subfastigiata*, Nyl.; **R. Roesleri*, Hochst. 34. *R. farinacea* (L.); **R. protensa*, Nyl.; **R. subcomplanata*, Nyl. 35. *R. fraxinea* (L.) and its vars. *platyna*, Nyl., and *calicariformis*, Nyl.; **R. fastigiata* (Pers.); **R. confirmata*, Nyl.; **R. subcalicaris*, Nyl. 36. *R. subfraxinea*, Nyl., and its var. *subcanaliculata*, Nyl.; **R. polycarpa*, Mnt. MS.; **R. Menziesii*, Tuck.; **R. interponens*, Nyl.; **R. leiodea*, Nyl. 37. *R. cumanensis*, Fée. 38. *R. bistorta*, Nyl. 39. *R. sorediantha*, Nyl. 40. *R. yemenensis* (Ach.); **R. ovalis*, Tayl. & Hook. 41. *R. lanceolata*, Nyl. 42. *R. sulcatula*, Nyl. 43. *R. sepiacea* (Pers.). 44. *R. polymorpha*, Ach., and its var. *capitata*, Ach. 45. *R. pollinaria*, Ach.

b. Thallus generally transversely or subreticulately unequal. Cortical layer amorphous or nearly so.

† Medulla K yellow, then ferruginous red.

46. *R. vulcania* (Mnt).

†† Medulla K –.

47. *R. Bourgæana*, Mnt. 48. *R. evernioides*, Nyl. 49. *R. maciformis*, Delile. 50. *R. crispatula*, Despr. 51. *R. Webbii*, Mnt.

4. Stirps *R. scopulorum*. Thallus firm, solidly corticate, subtereti-compressed, unequal on the surface; external portion of the cortex amorphous, internal portion filamentose.

† Medulla K yellow, then ferruginous red.

52. *R. scopulorum* (Dicks.) and its vars. *incrassata*, Nyl., and *nematodes*, Nyl.; **R. decipiens*, Mnt.; **R. subwebbiana*, Nyl.

†† Medulla K – .

53. *R. cuspidata* (Ach.) and its vars. *crassa* (Del.) and *subvittata*, Nyl. 54. *R. vittata*, Nyl. 55. *R. tingitana*, Salzm. 56. *R. inæqualis*, Nyl.

5. Stirps *R. pusillæ*. Thallus smooth or nearly so, fistulose, here and there perforated. Medulla K – (except in *R. subpusilla*, which has a yellow reaction).

A. Cortical layer amorphous.

57. *R. pusilla*, Le Prév.

B. Cortical layer filamentose.

a. Spores straight.

58. *R. tasmanica*, Nyl. 59. *R. inflata*, Hook. fil. & Tayl. 60. *R. geniculata*, Hook. & Tayl.; **R. subpusilla*, Nyl. 61. *R. minuscula* (Nyl.) and its vars. *pollinariella*, Nyl., and *dendroidella*, Nyl.; **R. intermedia*, Del. 62. *R. pumila*, Mnt.; **R. javanica*, Nyl. 63. *R. subgeniculata*, Nyl. 64. *R. Panizzei*, D. N.

b. Spores curved.

65. *R. abyssinica*, Nyl.

[Those marked * are subspecies.]

From the above we find that our British species must be rearranged thus:—

1. *R. thrausta* (Ach.). Pale straw-colour, *filiformi-terete or subterete*, here and there compressed, somewhat shining, very slenderly divided and *excessively branched*, *capillari-attenuate and interwoven at the apices*; cortical layer filamentose; medulla K –; apothecia unknown.

On subalpine rocks, rare.

Syn. *Alectoria thrausta*, Ach. L. U. 596, Syn. 294. *R. thrausta*, Nyl. Mon. Ramal. 18; Leight. Lich. Fl. G. B. 94.

Exs. Fries, L. S. 267.

Geog. distrib. Europe.

England. Longmynd!, Shropshire.

Scotland. Coast of Kincardineshire; Morrone; Braemar; Craig Tulloch, *Rev. J. M. Crombie.*

Channel Islands. The Warrens, Noirmont, Jersey!, *Mr. Larbalestier.*

2. *R. calicaris* (Hffm.). Pale glaucous-grey, albescent, or albido-flavescent, rigescent, erect, dichotomously branched; *laciniæ linear, compressed, elongated, attenuated at the apices, longitudinally lacunoso-canaliculate*; cortical layer filamentose; medulla K – ; *apothecia terminal, subtended by the deflexed*

and elongated extremities of the laciniæ; receptacle rugose beneath; spores 8, colourless, ellipsoid, *straight*, 1-septate; spermogonia in pale or colourless receptacles.

On trees.

Syn. *Lobaria calicaris*, Hffm. Fl. Germ. 139. *R. fastigiata*, var. *calicaris*, Ach. L. U. 604, Syn. 297. *R. calicaris*, var. *canaliculata*, Fr. L. E. 30. *R. calicaris*, Nyl. Mon. Ramal. 33; Leight. Lich. Fl. G. B. 92.

Fig. Dill. t. 23. f. 62, A, B; Moris. 3. § 15, t. 7. f. 5; Ach. Act. Holm. 1797, t. 9. f. 1, I.

Exs. M. & N. 452; Mudd, 44; Welw. Lusit. 42.

Geog. distrib. Europe, Asia, Africa, North and South America.

England. Airyholme woods!, Ayton, Yorkshire, *Mr. Mudd*; Oswestry!, Shropshire, *Rev. T. Salwey*; Shropshire generally!

Scotland. Ayrshire!, *Mrs. Dobie*; Johnstone Hill, Forfar!, *Dr. Gilchrist.*

Wales. Llandrindod!, Radnorshire, *Rev. T. Salwey.*

Var. *subampliata*, Nyl. *Laciniæ* of thallus *broader and more dilated*, similarly to *R. fraxinea*, longitudinally nervoso-rugose, lacunose and canaliculate; *apothecia marginal and terminal*; *receptacle rugose*; *spores straight.*

On trees.

Syn. Nyl. Mon. Ramal. 34 (1870).

Fig. Ach. Act. Holm. 1797, t. 9. f. 1, G, K.

Exs. Anzi, Lich. Ital. Sup. 63; Anzi, Langob. 419.

Geog. distrib. France, Portugal, Algeria, East Indies.

England. Yorkshire!, *Mr. G. Dixon.*

Var. *subfastigiata*, Nyl. Similar in general appearance to *R. fastigiata*; *apothecia terminal*; *receptacle rugose*; *spores straight.*

On rocks and trees.

Syn. Nyl. Mon. Ramal. 34 (1870).

Fig. Ach. Act. Holm. 1797, t. 9. f. 1, H.

Exs. Welw. Lusit. 44; Mandon, Mad. 24.

Geog. distrib. France, Portugal, Madeira, North America.

Ireland. Rocks near Coachford, 11 miles west of Cork!, *Mr. Carroll*; near Fermoy!, *Mr. Chandler.*

Wales. Llandrindod!, *Rev. T. Salwey.*

3. *R. farinacea* (L.). Whitish, pale straw-coloured or glaucescent, erect, subrigescent, dichotomously branched; *laciniæ linear, elongated, undulato-attenuated at the apices, compressed, plane and polished*, sometimes sublacunose, canaliculate, *with white, oblong, more or less confluent soredia on the edges*; cor-

tical layer filamentose; medulla K –; "apothecia testaceo-pallida vel glaucescentia, receptaculo infra lævi; sporæ ellipsoideo-oblongæ vel fusiformi-ellipsoideæ, rectæ" (Nyl. Mon. 35); spermogonia in pale or colourless receptacles.

On trees and palings.

I have never seen any specimens in fructification.

Syn. *Lichen farinaceus*, Linn. Fl. Suec. ed. 2, 1089. *R. farinacea*, Ach. L. U. 606, Syn. 297; Nyl. Mon. Ramal. 34; Leight. Lich. Fl. G. B. 93.

Fig. E. Bot. t. 889; Ach. Act. Holm. 1797, t. 11. f. 1.

Exs. M. & N. 356; Anzi, Etr. 6; Anzi, Ital. Sup. 67; Schær. 494; Mudd, 45.

Geog. distrib. Europe, Asia, Africa, North and South America, Polynesia, Australia.

England. Norfolk, *Rev. H. Bryant*; Clapham Park Wood, Bedfordshire, *Rev. C. Abbot*; near Newton! and Kildale!, Cleveland, Yorkshire!, *Mr. Mudd*; Oswestry!, Shropshire, *Rev. T. Salwey*; Thirsk!, Yorkshire, *Mr. Baker*; Shomere woods!, Haughmond Hill!, Shropshire; Dinmore Wood!, Herefordshire.

Scotland. Balthayock woods!, Perth, *Dr. Lindsay*; Ayrshire!, *Mrs. Dobie.*

Ireland. Fermoy!, *Mr. Chandler.*

Wales. Glynn, near Capel Curig!

Very variable; many forms, minute in size, frequently occur, but scarcely worth distinguishing.

4. *R. fraxinea* (L.). Pale straw or yellowish, or glaucescent, *pendulous, straggling*, subrigescent; laciniæ compressed, *more or less broadly applanato-dilated*, lacunose, longitudinally rugose or nervose, *elongated and attenuated at the apices*; cortical layer filamentose; medulla K –; *apothecia* large, *marginal and superficial*, brownish-yellow or glaucescent; *receptacle rugose or plicato-rugose*; *spores* 8, colourless, oblong, *curved*, 1-septate; spermogonia in pale colourless receptacles.

On trees, very common.

Syn. *Lichen fraxineus*, Linn. Fl. Suec. ed. 2, 1091. *R. fraxinea*, Ach. L. U. 602, Syn. 296; Nyl. Mon. Ramal. 36; Leight. Lich. Fl. G. B. 94.

Forma typica *tæniæformis*, Ach. *Laciniæ moderately dilated*, very much *elongated, attenuate at the base and apex, longitudinally rugose* or nervoso-plicate.

Syn. *R. fraxinea*, var. *tæniæformis*, Ach. L. U. 603; Nyl. Mon. Ramal. 37.

Fig. E. Bot. t. 1781; Westr. Faergh. t. 12, c.

Exs. Anzi, Ital. Sup. 60, and 59, A, B, D; Mass. Ital. 117;

Anzi, 116; M. & N. 158 (two lower specimens); Schær. 492 (left-hand specimen).

Geog. distrib. Europe, Asia, Africa, North and South America, Polynesia, Australia.

Wales. Llandrindod!, *Rev. T. Salwey*; Edderton Wood!, Montgomeryshire.

Forma *ampliata*, Ach. *Laciniæ excessively and very broadly applanato-dilated*, lacunose, *longitudinally coarsely rugose or nervose, and transversely subreticulato-rugose, apices obtuse and deformed.*

Syn. *R. fraxinea*, var. *ampliata*, Ach. L. U. 603; Nyl. Mon. Ramal. 37.

Fig. Hoffm. Pl. Lich. t. 18; Dill. t. 22. fig. 59, C.

Exs. Anzi, Ital. Sup. 62, 59, C; Schær. 492 (right-hand specimen); M. & N. (upper specim.); Leight. 38; Mass. 119, 118, A; Mudd, 42; Bohl. 21.

Geog. distrib. Europe.

England. Charnwood Forest!, Leicestershire, *Rev. A. Bloxam*; Thirsk!, Yorkshire, *Mr. Baker*; Oswestry!, Shropshire, *Rev. T. Salwey*; near Ayton!, Cleveland, *Mr. Mudd*; near Shrewsbury!, Pulley!, Shropshire; Dinmore Wood!, Herefordshire.

Scotland. Invercauld!, Braemar, *Dr. Lindsay.*

5. *R. fastigiata* (Pers.). Pale-yellowish straw-colour, small, *densely cæspitose*; *laciniæ* subcompressed, *dilated and inflated upwards*, smooth and somewhat lacunose and nervoso-rugose; cortical layer filamentose; medulla K—; apothecia terminal, peltato-sessile, *subfastigiate, subtended by the very short, deformed, divaricate extremities of the laciniæ*; *receptacle plicato-rugose*; *spores* 8, colourless, ellipsoideo-oblong, *straight, curved and gibbous*, 1-septate; spermogonia in pale colourless receptacles.

On trees, common.

Syn. *Lichen fastigiatus*, Pers. in Uster. N. Ann. Bot. i. p. 256. *R. fastigiata*, Ach. L. U. 603, Syn. 296; Nyl. Mon. Ramal. 39; Leight. Lich. Fl. G. B. 94.

Fig. E. Bot. t. 890 (lower left-hand fig.); Dill. t. 23. f. 62, C; Ach. in Act. Holm. 1797, t. 9. f. 1, B, E; Westr. Faergh. t. 12. f. E.

Exs. Bohl. 22; Leight. 39; Larbal. 60; Mudd, 43; Welw. Lusit. 41; M. & N. 452; Anzi, Etr. 5; Anzi, Ital. Sup. 64.

Geog. distrib. Europe, Asia, Africa, North America.

England. Charnwood Forest!, Leicestershire, *Rev. A. Bloxam*; Oswestry!, Shropshire, *Rev. T. Salwey*; Ayton!, Cleveland, *Mr. Mudd*; Pulley!, Haughmond Hill!, near Shrewsbury!; Dinmore!, Herefordshire.

Scotland. Kinnoul Hill!, Perth; Yester House!, Haddington, *Dr. Lindsay.*

Ireland. Great Island!, Cork, *Mr. Carroll.*

Wales. Edderton Wood!, Montgomeryshire.

Channel Islands. Jersey!, Serk!, &c., *Mr. Larbalestier.*

Of this lichen Dr. Nylander remarks (*l. c.*):—"Vix est nisi varietas *R. fraxineæ*, thallo magis contracto et subfastigiato-diviso vel laciniis subfastigiatis. Sporæ magis typice curvulæ quam in *R. calicari*, quæ certe arctissime affinis, et forsan hæ ambæ aliæque cohabitantes sæpe hybridas proferant formas intercedentes, quarum determinatio aliquando nonnihil incerta maneat; typus tamen sæpius notis datis sat facile est agnoscendus."

6. *R. polymorpha*, Ach. Pale straw-colour or glaucescent, rigid, small, *robust*, *densely cæspitose*, sublineari-laciniate; *laciniæ dilatato-compressed*, *coarsely longitudinally striato-rugose and sublacunose*, *globuloso-granuloso-sorediate*; cortical layer filamentose; medulla K –; apothecia marginal or subterminal; *receptacle rugoso-unequal or nearly smooth*; *spores* 8, colourless, oblongo-ellipsoid or oblong, *nearly straight or straight*, 1-septate; spermogonia in pale colourless receptacles.

On maritime rocks.

Syn. *R. polymorpha*, Ach. L. U. 600, Syn. 295; Nyl. Mon. Ramal. 50.

Fig. Ach. Act. Holm. 1797, t. 11. f. 3.

Exs. Fries, L. S. 144.

Geog. distrib. Europe, Africa.

Forma *ligulata*, Ach. *Laciniæ thick*, rigid, cartilaginous, *either plane* and nearly simple or *broader and deformed*, *and covered with sorediate pustules.*

On maritime rocks.

Syn. *R. polymorpha*, var. *ligulata*, Ach. Syn. 295; Nyl. Mon. Ramal. 51; Leight. Lich. Fl. G. B. 92.

Fig. Ach. Act. Holm. 1797, t. 11. f. 3, A, B, E, F, K.

Exs. Mudd, 47; Leighton, 73.

England. Roseberry Topping!, Howden Gill!, Cleveland, *Mr. Mudd*; Whitsuncliffe!, near Thirsk, Yorkshire, *Mr. Baker*; Shanklin church!, Isle of Wight, *Rev. T. Salwey.*

I have never seen any fructification.

7. *R. pollinaria*, Ach. Pale straw-colour or whitish, or albido-glaucescent, *densely cæspitose*, *membranaceo-laciniose*; *laciniæ short*, *dilated and compressed*, somewhat shining, sublacunose or lacunoso-corrugate, *flaccid*, *covered with broad*, *white*, *farinoso-sorediate*, *confluent patches*; cortical layer filamentose;

medulla K – ; apothecia marginal and terminal; *receptacle unequal*; *spores* 8, colourless, oblong, *straight or gibbous*, 1-septate ; spermogonia in pale colourless receptacles.

On trees, palings, rocks, &c.

Syn. *R. pollinaria*, Ach. Syn. 298; Nyl. Mon. Ramal. 52; Leight. Lich. Fl. G. B. 95.

Geog. distrib. Europe, Africa.

Forma *elatior*, Ach. *Laciniæ suberect*, *elongate*, plane, *sublinear*, attenuate and albo-pulverulento-*sorediate at the apices.*

Fig. Ach. Act. Holm. 1797, t. 11. f. 2, A, B, C, F.

Exs. Schær. 393; Hepp, 564, 565; M. & N. 546.

England. Caer Caradoc!, Haughmond Hill!, Shropshire.

Forma *humilis*, Ach. *Membranaceo-dilated*, *laciniose*, with *broad*, *confluent*, powdery white *soredia.*

Fig. Ach. Act. Holm. 1797, t. 11. f. 2, D, E.

Exs. Leight. 41; Mudd, 46.

England. Gopsall!, Leicestershire, *Rev. A. Bloxam*; Ingleby!, Cleveland, *Mr. Mudd*; Haughmond Hill!, Shropshire.

8. *R. scopulorum* (Dicks.). Pale straw-colour, rigid, cartilaginous, shining; *laciniæ elongate*, *linear*, *subtereti-compressed*, simple, or branched at the apex, attenuate; cortical layer solid, external portion amorphous, internal portion filamentose; *medulla* K *yellow*, *then ferruginous red*; apothecia marginal and subterminal; *receptacle nearly smooth*; *spores* 8, colourless, oblong, straight, 1-septate; spermogonia in pale colourless receptacles, sometimes nigricant.

On maritime rocks, rare.

Syn. *Lichen scopulorum*, Dicks. Crypt. Brit. 3. 18. *R. scopulorum*, Ach. L. U. 604, Syn. 297; Nyl. Mon. Ramal. 58; Leight. Lich. Fl. G. B. 91 (in part).

Fig. E. Bot. 688; Nyl. Syn. t. 8. f. 29.

Exs. Larbal. 13; Bohl. 112.

Geog. distrib. Europe, Africa.

England. Lamorna Cove, Cornwall, *Mr. Knapp*; Land's End, *Messrs. Turner & Sowerby.*

Scotland. Mr. Dickson (l. c.).

Channel Islands. Grosnez Common, Jersey!, *Mr. Larbalestier.*

9. *R. cuspidata* (Ach.). Pale straw-colour, rigid, cartilaginous, *shining*; *laciniæ elongate*, *linear*, *compressed*, *more or less longitudinally striato-nervose*, *lacunose*, *and sorediato-tuberculate*, *simple or dichotomously branched*; cortical layer solid, external portion amorphous, internal portion filamentose; *medulla* K – ; apothecia marginal and subterminal; *receptacle*

smooth; *spores* 8, colourless, oblong, *straight*, 1-septate; spermogonia in pale colourless receptacles.

On maritime rocks, frequent.

Dr. Nylander (*l. c.*) remarks:—"Forsan non vere specie differat a *R. scopulorum*, tamen præsertim ob reactionem kalicam deficientem, seorsim hic est exponenda."

Syn. *R. scopulorum*, var. *cuspidata*, Ach. L. U. 605, Syn. 297. *R. scopulorum*, Leight. Lich. Fl. G. B. 91 (in part). *R. cuspidata*, Nyl. Mon. Ramal. 60.

Fig. Ach. Act. Holm. 1797, t. 9. f. 2, B; Dill. t. 17. f. 39, A.

Exs. Th. M. Fries, 1; Anzi, Ital. Sup. 69; Schær. 554; Hepp, 837; Leight. 2; Rabh. 864.

Geog. distrib. Europe, Asia, Africa, North America.

England. Yorkshire!, *Mr. Dixon.*

Wales. South Stacks!, Holyhead.

XVII.—*Additions to the Australian* Curculionidæ. Part II. By Francis P. Pascoe, F.L.S. &c.

OTIORHYNCHINÆ.

Titinia marmorata.

LEPTOPODINÆ.

Polyphrades longipennis.
Cherrus aureolus.
Stenocorynus vittatus.
—— aridus.

DIABATHRARIINÆ.

Atelicus miniatus.

ATERPINÆ.

Aterpus griseatus.
Rhinaria foveipennis.
—— caliginosa.
—— myrrhata.

HYLOBIINÆ.

Demyrsus, n. g.
—— meleoides.

ERIRHININÆ.

Cydmæa, n. g.
—— bimaculata.
Cydmæa luctuosa.
—— pusilla.
—— viridula.

BELINÆ.

Rhinotia elytrura.
—— venusta.

BALANINÆ.

Balaninus Mastersii.

DERELOMINÆ.

Ochrophœbe, *n. g.*
—— uniformis.

LÆMOSACCINÆ.

Læmosaccus dapsilis.
—— longimanus.
—— narinus.
—— cryptonyx.

CRYPTORHYNCHINÆ.

Melanterius vinosus.
—— cinnamomeus.
—— servulus.

Titinia marmorata.

T. anguste ovata, nigra, albido-squamulosa et nigro-setosa, supra fusco varia; capitis fronte rostroque in medio linea longitudinaliter impressa; antennis subtestaceis, squamulis filiformibus adspersis; clava vix pedunculata; prothorace subcylindrico, utrinque leviter rotundato, fusco trivittato; scutello rotundato; elytris lineatim striatis, interstitiis latis, postice magis convexis, singulis in medio longitudinaliter fusco marmoratis vel maculatis; pedibus testaceo-ferrugineis, sat dense albido-squamosis. Long. $1\frac{1}{2}$ lin. (rostr. incl.).

Hab. New South Wales.

The coloration, as well as the smaller size, will differentiate this species from *T. ignara*, Pasc. (Ent. Month. Mag. vi. p. 101). *Titinia* is best separated from *Idaspora* by its rostrum having no raised lines or costæ bordering the scrobes on each side and continued back nearly to the eyes, as in the latter. This character, therefore, should be taken from the specific and added to the generic formula.

Polyphrades longipennis.

P. elongato-obovatus, subnitide niger; rostro nonnihil breviusculo, quinquecarinato; antennis fuscis, sparse squamulosis, scapo breviusculo, apice valde incrassato; prothorace modice transverso, utrinque ampliato, crebre subtiliter mamillato-granulato; elytris elongato-trigonatis, prothorace angustioribus, apice paulo divaricatis, subtilissime parce squamulosis, lateribus modice rotundatis, sulcato-punctatis, interstitiis parum convexis; corpore infra albo squamuloso; pedibus sublævigatis. Long. 5 lin.

Hab. South Australia.

This species has the habit of *Cherrus Mastersii*; but the short scape, which is also remarkably thick at the apex, shows that it belongs to *Polyphrades*. The females in this genus are more regularly ovate than the males, and the prothorax much narrower; but even in males of the same species this last character is subject to variation. The scales appear to be unusually deciduous.

Cherrus aureolus.

C. oblongus, fuscus, squamulis minutis albidis sejunctim vestitus; capite rostroque antice dense aureo-grisescenti, lateribus albo squamulosis; antennis setigeris; funiculo articulo secundo quam tertio vix longiore; prothorace manifeste transverso, supra modice convexo, transversim corrugato; elytris ovatis, prothorace vix latioribus, dorso sulcato-punctatis, punctis oblongis, approximatis, interstitiis sat latis, modice convexis, lateribus dense fuscescenti-squamulosis; corpore infra pedibusque dense aureo-grisescenti squamulosis, his squamis majusculis interjectis; femoribus fusco-variegatis. Long. $4\frac{1}{2}$ lin.

Hab. King George's Sound.

At once differentiated from its allies by the corrugated prothorax. The scales at the sides and underneath have, under a strong lens, a pale golden lustre, very bright in certain lights.

Stenocorynus vittatus.

S. oblongo-ovatus, niger, omnino squamis griseis vel viridescentibus dense tectus; rostro modice elongato, in medio carinato, lateribus oblique sulcato; antennis tenuioribus, funiculo articulo primo haud incrassato secundo breviore, clava elongata, attenuata, basi excepta, nigra, articulis quatuor ultimis funiculi longitudine æquali; prothorace transverso, postice parallelo, ♀ magis transverso; elytris ovalibus, striato-punctatis, interstitio suturali, quarto decimoque elevatis, nigrescentibus, septimo etiam elevato, sed concolori; abdomine, segmento ultimo excepto, sparse granulato. Long. 6 lin.

Hab. Night Island (N.E. coast).

Closely allied to *S. crenulatus*, Fab., but differs in outline, antennæ, and dark stripes on the elytra. The following is also an allied species, having, *inter alia*, a shorter and proportionally broader form.

Stenocorynus aridus.

S. ovatus, omnino niger, sat dense griseo-squamosus; rostro crassiusculo, breviore, in medio carinato, sulcis lateralibus obsoletis; funiculo articulo primo brevi, haud crasso, secundo paulo longiore, clava ovali, haud elongata, basi excepta, nigra; prothorace valde transverso, in medio linea longitudinali nigra impresso; elytris breviter ovatis, striato-punctatis, interstitiis quarto, septimo decimoque parum elevatis, apicibus paulo divaricatis; pedibus breviusculis. Long. 4 lin.

Hab. Lizard Island.

Atelicus miniatus.

A. elongatus, ovali-cylindricus, omnino ruber, squamulis minutis albidis sat sparse, lateribus corpore infra pedibusque magis dense vestitus, supra punctis singulis squama majuscula instructis, regulariter adspersus; prothorace transverso, conico; scutello parvo; elytris seriatim punctatis, postice sensim declivibus; apicibus parum emarginatis. Long. $1\frac{2}{3}$ lin.

Hab. Moreton Bay.

Differs in its more oval outline and uniform red-lead colour, partially toned down by the minute whitish scales, from the other members of the genus.

Aterpus griseatus.

A. breviter subovatus, niger, omnino dense grisescenti, supra subfusco variegatus, squamosus; rostro breviusculo, basi interrupte transversim sulcato, supra bilobo; funiculo articulo secundo primo breviore; prothorace parum oblongo, antice gibboso, utrinque valde rotundato, subremote granulato, setulis albis adpressis parce obsito, disco fusco; scutello elevato, rotundato; elytris basi prothorace fere duplo latioribus, latitudine sesquilongioribus, lateribus leviter inflexis, seriatim punctatis, punctis modice approximatis, singulis unisquamigeris, interstitiis elevatis, subremote tenuiter granulatis, apice rotundatis, in medio sæpissime late albido fasciatis, apicem versus pallidioribus; corpore infra pedibusque dense pallide squamosis, squamis elongatis intermixtis. Long. 4–4½ lin.

Hab. Queensland.

Aterpus cultratus, Fab., and *A. horrens*, Bois., may be taken as representatives of two types of form in the genus; this rather common species will furnish another.

Rhinaria foveipennis.

R. oblonga, nigra, pallide fusco-squamosa, squamulis elongatis albis parcius intermixta; fronte inter oculos tri- vel subquinqueverrucosa (verruca infera sulcis duabus longitudinalibus impressa); rostro nigro nitido, a basi arcuato; funiculo clavaque elongatis, hac obovata, acuminata; prothorace latitudine parum longiore, rugoso, remote punctato, granulis nitidis irregulariter adsperso; scutello elevato, albo-squamoso; elytris basi prothorace fere duplo latioribus, humeris prominulis, rotundatis, rude seriatim foveatis, interstitiis alternis costulatis, uniseriatim conferte granulatis, interstitiis intermediis sparse granulatis, apice rotundatis; corpore infra pedibusque dense squamosis, squamis elongatis albidis intermixtis. Long. 6–7½ lin.

Hab. New South Wales (Bombala).

Rhinaria caliginosa.

R. oblonga, nigra, pallide fusco-squamosa, setulis raris intermixta; fronte subquadriverrucosa; rostro ultra basin recto; funiculo clavaque brevioribus; prothorace subremote granulato, et valide punctato; scutello elevato, obovato; elytris basi prothorace fere duplo latioribus, humeris paulo prominulis, rotundatis, seriatim foveatis, interstitiis magis æqualiter elevatis, subremote granulatis, apice rotundatis; corpore infra pedibusque ut in præcedente. Long. 5–6 lin.

Hab. Bombala.

These two species may be placed near *R. granulosa*, Fhs.; the first may be distinguished by its rough foveated elytra, and the second by the interstices being all more or less equally elevated. The following differs in colour and in the peculiar character of the rostrum.

Rhinaria myrrhata.

R. oblonga, nigra, supra squamulis fulvo-aurantiacis sat dense, prothorace excepto, vestita; fronte ut in *R. foveipenni*; rostro brevi, supra dimidio apicali late longitudinaliter excavato, fundo excavationis bisulcato; antennis fulvo-squamulosis, clava nigra; prothorace sat confertim granulato, disco nigro, sparse squamuloso; scutello elevato, scutiformi; elytris prothorace fere duplo latioribus, humeris prominulis, rotundatis, seriatim punctatis, interstitiis elevatis, præsertim alternatis, his confertim, alteris remote seriatim nitide granulatis, basi et paulo pone medium colore saturatiore atro-maculato notatis; corpore infra pedibusque squamulis pallidioribus tectis. Long. $4\frac{1}{2}$–6 lin.

Hab. South Australia.

DEMYRSUS.

Rostrum tenuatum, arcuatum, prothorace longius; *scrobes* antemedianæ, obliquæ; *antennæ* breviusculæ; *funiculo* brevi, articulis quatuor ultimis valde transversis; *clava* magna, oblonga, tomentosa. *Oculi* ovati, subtus approximati, grosse granulati. *Prothorax* subtransversus, lateribus rotundatus, basi bisinuatus, lobis ocularibus distinctis. *Scutellum* parvum. *Elytra* suboblonga, prothorace latiora. *Pedes* minusculi; *femora* incrassata, infra subdentata; *tibiæ* intus flexuosæ, apice unguiculatæ; *tarsi* subtenues, articulo tertio bilobo, quarto elongato; *unguiculi* simplices. *Pectus* excavatum, apice profunde emarginatum. *Coxæ* anticæ modice sejunctæ. *Metasternum* modice elongatum. *Abdomen* segmentis 3–4 brevibus.

The insect described below has a strong resemblance to *Meleus Megerlei*; but, notwithstanding the pectoral cavity, which might suggest a relationship to one of the Apostasimerous groups, its general characters, particularly of the tibiæ and the antennæ, the latter resembling those of *Aclees*, Schön., point to the Hylobiinæ. The separation of the anterior coxæ is a character found also in *Pissodes*, *Seleuca*, &c.

Demyrsus meleoides.

D. ovatus, niger, setulis squamisque piliformibus, plerumque fuscescentibus, subvariegatim vestitus; rostro apicem versus nitide castaneo; funiculo clava vix longiore, articulo primo cæteris longiore, sed breviusculo; prothorace apice quam basi multo angustiore, creberrime punctato, in medio longitudinaliter carinulato; elytris striato-punctatis, interstitiis alternis costato-elevatis, confuse fusco-irroratis, singulis pone medium, suturam approximata macula rotundata ochracea notatis; corpore infra nigro-castaneo, punctis unisetulosis adsperso; pedibus sparse setulosis. Long. 5–$5\frac{1}{2}$ lin.

Hab. New South Wales (Sydney).

Cydmæa.

Rostrum subtenuatum, arcuatum, lateribus basi striolatum; *scrobes* antemedianæ, obliquæ, ab oculis paulo desinentes; *scapus* oculum haud attingens; *funiculus* 7-articulatus, articulo primo crassiore; *clava* distincta. *Prothorax* subconicus, basi lateribusque rotundatus, lobis ocularibus leviter productis. *Elytra* breviter obovata vel subcordata, prothorace latiora. *Pedes* mediocres; *femora* incrassata, mutica; *tibiæ* breves, anticæ arcuatæ, intus haud dentatæ, apice mucronatæ; *tarsi* breves, art. tribus basalibus gradatim latioribus; *unguiculi* simplices. *Mesosternum* latum; *metasternum* breviusculum. *Processus* intercoxalis latum, subtruncatum. *Abdomen* breve, segmentis 3–4 brevibus; *sutura* prima recta. *Corpus* squamosum.

This is one of the many undescribed forms belonging to the Erirhininæ which is perhaps best approximated to *Erirhinus** itself, but differs in habit, which is that of *Tychius*, and well differentiated by the breadth of the mesosternum and the consequent remoteness of the coxæ of the intermediate legs. The delicately raised longitudinal lines, and their corresponding grooves on the basal half of the rostrum, are also a good character.

Cydmæa bimaculata.

C. breviter elliptica, nigra, squamis niveis sejunctim, subtus densius, vestita; antennis, tibiis tarsisque fusco-ferrugineis; rostro nigro, prothorace breviore; funiculo articulo secundo primo paulo breviore, cæteris gradatim brevioribus; prothorace latitudine haud longiore; scutello parvo, esquamoso; elytris subcordatis, humeris paulo callosis, striato-punctatis, singulis in medio macula conspicua rotundata subnigra notatis. Long. $1\frac{1}{3}$ lin.

Hab. South Australia (Gawler).

Very like our *Ellescus bipunctatus*, but broader.

Cydmæa luctuosa.

C. breviter elliptica, atra, sat dense nigro-squamulosa, niveo-maculata, *scil.* maculis duabus inter oculos, una utrinque basi prothoracis, una humerali, una fasciæformi pone medium elytrorum, sutura postice etiam nivea; rostro tenuiore, nigro; antennis fusco-piceis; funiculo sparse niveo-piloso; prothorace angustiore; scutello inconspicuo; elytris subcordatis, humeris parum callosis, indistincte striato-punctatis; corpore infra pedibusque sejunctim niveo-squamulosis. Long. 1 lin.

Hab. South Australia (Gawler).

* The type of this genus is *E. æthiops*, Fab. (Schön. Disp. p. 229), not *E. nereis* (as given by C. G. Thomson, Skand. Col. i. p. 136). *Dorytomus*, Steph. (Ill. iv. p. 82) is differentiated by the absence of ocular lobes, femora unidentate beneath, &c.

Cydmæa pusilla.

C. breviter elliptica, atra, plagiatim nigro- et niveo-squamosa; capite rostroque nigris, inter oculos et basi rostri niveis; antennis ferrugineis; prothorace subtransverso, basi lateribusque niveo; elytris subcordatis, striato-punctatis, ante medium posticeque plus minusve nigris; corpore infra pedibusque niveo-squamulosis. Long. $\frac{2}{3}$ lin.

Hab. South Australia (Gawler).

This species differs, *inter alia*, from the preceding in the indeterminate patches of black and white, the latter being in excess, and mingling at the edges more sparsely with the former. The following is of a beautiful golden green; but I can find nothing to warrant its separation generically.

Cydmæa viridula.

C. ovata, nigra, squamulis aureo-viridibus omnino tecta; rostro longitudine prothoracis, apicem versus gradatim paulo latiore, basi excepta nigro; antennis flavo-ferrugineis; prothorace subtransverso, lobis ocularibus fere obsoletis; scutello inconspicuo; elytris prothorace sat valde latioribus, utrinque leviter rotundatis, lineatim albo-setosulis, inter lineas squamulis in seriebus duabus sejunctim ordinatis; abdomine sutura prima in medio paulo arcuata; tibiis tarsisque ferrugineis squamulis piliformibus adspersis. Long. $1\frac{1}{3}$ lin.

Hab. Western Australia (Fremantle).

Rhinotia elytrura.

R. elongata, atra, fronte inter oculos, prothorace vitta laterali pubescente elytrisque, apicibus exceptis, aurantiacis; rostro prothorace sesquilongiore, parum arcuato, nitido; antennis subbasalibus, articulo ultimo lanceolato; prothorace nitide fusco-nigro, vittis exceptis, denudato, subrude punctato, supra pone medium transversim impresso, basi longitudinaliter anguste canaliculato; scutello parvo, rotundato, nigro; elytris costulatis, parce pubescentibus, basi antrorsum valde productis, seriatim conferte punctulatis, interstitiis in certa luce quasi granulatis, sutura postice aliquando nigra, apicibus acuminato-productis; abdomine in medio nitido, lateribus segmentorum striga obliqua albo-pilosa notatis; femoribus anticis infra bispinosis. Long. 6 lin.

Hab. Queensland (Wide Bay).

This species has bispinose anterior femora, as in the genus *Isacantha*, on which account it was separated by Hope from *Pachyura*; both differ from *Rhinotia* by their elytra gradually enlarging and rounded behind. The following is closely allied to *R. hæmoptera*, Kirby, but, *inter alia*, has narrower and less granulated prothoracic ridges.

Rhinotia venusta.

R. lineari-elongata, atra, superciliis, prothorace, vittis duabus medianis exceptis, elytrisque aurantiaco-pilosis; rostro prothorace longiore; antennis in medio rostri insertis, articulo ultimo oblongo-(vix triangulari-)acuminato; prothorace dense aurantiaco-piloso, in medio lineis duabus elevatis granulatis munito, inter eas longitudinaliter modice depresso; scutello transverso, elevato, nigro; elytris prothorace haud latioribus, apicibus rotundatis, subseriatim conferte punctatis, sutura postice aliquando nigricante; corpore infra nitide nigro, sternis albo-pilosis; abdomine segmentis quatuor ultimis utrinque macula albo-pilosa ornatis. Long. 6 lin.

Hab. Queensland (Rockhampton).

Balaninus Mastersii.

B. (♀) ellipticus, niger, sat dense albo-squamosus, plagis denudatis interruptis exceptis; rostro testaceo-piceo, tenuissimo, corpore manifeste longiore, apicem versus arcuato; antennis quinta parte basin versus rostri insertis, funiculo articulis duobus basalibus, primo longissimo, conjunctim scapo longioribus, tertio quarto breviore, reliquis tertio æqualibus, obconicis, clava ovali, quam articulo præcedente paulo longiore; prothorace transverso, utrinque pone apicem paulo ampliato-rotundato, disco nigro denudato, linea mediana lateribusque exceptis; scutello subquadrato; elytris oblongo-trigonatis, striato-punctatis, singulis plaga ante medium, alteraque versus apicem plus minusve denudatis; corpore infra pedibusque dense albo-squamosis; femoribus posticis corpus superantibus, longe pedunculatis. Long. 2¼ lin.

Hab. Queensland (Port Denison).

What I take to be the male has a much shorter rostrum, the antennæ inserted beyond its middle, the scape nearly as long as the funicle, the third joint of the latter very short comparatively, shorter legs, &c. This and *B. amœnus*, Fab., are the only two species I have seen of this cosmopolitan genus from Australia. Mr. Wallace obtained more than twenty new species in the Malayan archipelago.

OCHROPHŒBE.

Rostrum tenuatum, basin versus gradatim crassius, arcuatum; *scrobes* antemedianæ, ad marginem inferum oculi currentes. *Antennæ* graciles; *scapo* brevi, oculum attingente; *funiculo* articulis ultimis breviter obconicis; *clava* ovata, distincta. *Oculi* mediocres, rotundati, tenuiter granulati, ad basin rostri approximati. *Prothorax* subconicus, basi rotundatus, lobis ocularibus nullis. *Elytra* ovata, prothorace paulo latiora. *Pygidium* obtectum. *Pedes* mediocres; *femora* fortiter incrassata, mutica: *tibiæ* intus flexuosæ, apice mucronatæ; *tarsi* breviusculi; *unguiculi* simplices. *Coxæ* anticæ rotundatæ, modice sejunctæ. *Processus* intercoxalis truncatus. *Abdomen* segmentis 3–4 brevibus. *Corpus* squamulosum.

The sole exponent of this genus is a small insect resembling *Sibinia potentillæ*, and not very different from *Derelomus*, but not pubescent like the latter.

Ochrophœbe uniformis.

O. elliptico-ovata, supra modice convexa, flavo-testacea, squamulis albis, antennis rostroque exceptis, omnino sejunctim vestita; rostro prothorace cum capite manifeste longiore, nitido, basi squamuloso; antennis quarta parte basin versus rostri insertis, funiculo articulo primo paulo elongato, reliquis gradatim brevioribus; prothorace longitudine haud latiore, utrinque leviter rotundato; scutello valde transverso; elytris striato-punctatis, interstitiis planatis; unguiculis nigris. Long. $1\frac{1}{4}$ lin.

Hab. West Australia (Champion Bay).

Lœmosaccus dapsilis.

L. latiusculus, ater, elytris figura magna X-formi læte aurantiaco-pilosa ornatis; rostro prothorace sesquilongiore, fere recto, omnino subæqualiter crebre punctato; antennis subpiceis, funiculo art. primo haud incrassato, secundo vix longiore; oculis supra subapproximatis; prothorace confertim punctato, pone apicem linea longitudinali abbreviata impresso; scutello subtriangulari; elytris subparallelis, fortiter striato-punctatis, interstitiis planatis, exterioribus posticisque granulatis; corpore infra pedibusque nigris, nitidis, punctis minutis, singulis squamula alba gerentibus, subremote adspersis; femoribus anticis muticis. Long. $3\frac{1}{2}$ lin.

Hab. South Australia?

I obtained this fine species, which is the only example I have seen, from the collection of Mr. Wilson, of Adelaide, and am ignorant of its precise locality. Its size and rostrum will readily distinguish it.

Lœmosaccus longimanus.

L. oblongus, rufo-brunneus, capite nigro; rostro breviusculo, sat crasso, basi carinulato, creberrime punctulato, apice antennisque rufo-testaceis, funiculo articulo primo crassiore, secundo breviore, clava elongata; oculis subapproximatis; prothorace brunneo, disco nigro, confertissime punctulato, pilis sulphureis adsperso; scutello fere inviso; elytris prothorace vix latioribus, sulcato-punctatis, interstitiis planatis, tenuiter granulatis, parce flavido-pilosis, macula magna communi infra scutellum e pilis condensatis effecta; corpore infra sat dense pallide griseo-squamuloso; pedibus rufo-testaceis, anticis elongatis. Long. $1\frac{3}{4}$–2 lin.

Hab. Queensland (Wide Bay).

A well-marked species, somewhat like *L. notatus* in coloration, but scarcely half as broad proportionally, and with fore legs rather longer and more slender in comparison than in other species.

Læmosaccus narinus.

L. breviusculus, niger, sparse albido-pilosus; rostro brevi, basi compresso, in medio manifeste arcuato; antennis subpiceis, clava nigra, funiculo articulo primo crasso, secundo longiore, clava magna funiculo vix breviore; oculis ampliatis, supra modice approximatis; prothorace creberrime punctulato, in medio longitudinaliter sulcato, lobo scutellari elevato et nonnihil dense griseo-piloso, basi profunde ample bifoveato; scutello conspicuo, valde transverso; elytris brevibus, prothorace latioribus, sulcato-punctatis, interstitiis planatis, granulatis; corpore infra nigro, sat dense albo-squamuloso; pedibus breviusculis, anticis manifeste majoribus; tibiis anticis valde compressis, fere rectis; tarsis rufo-piceis. Long. $1\frac{3}{4}$ lin.

Hab. South Australia (Port Lincoln).

This species may be placed after *L. ustulus*, but it is considerably stouter, with the anterior tibiæ strongly compressed, and not curved, except at the base.

Læmosaccus cryptonyx.

L. suboblongus, niger, maculatim flavo-pilosus; rostro breviusculo, recto, subremote punctulato; antennis testaceo-ferrugineis, funiculo articulo primo crassiusculo, clava nigricante; oculis supra subapproximatis; prothorace confertim punctulato, sexmaculato, maculis aliquando plus minusve contiguis; scutello triangulari; elytris prothorace paulo latioribus, parallelis, profunde striato-punctatis, interstitiis convexis, tenuiter granulatis, macula basali, fasciaque postica indistincte ornatis; pedibus brevibus, testaceo-ferrugineis, femoribus, apice excepto, nigricantibus; tibiis brevissimis, compressis; tarsis articulo ultimo minuto. Long. $1\frac{1}{3}$–$1\frac{2}{3}$ lin.

Hab. King George's Sound.

A small species, differentiated from all others known to me by its minute claw-joint lying deep in the fissure of the two lobes of the preceding one. The coloration varies according to the amount of hairiness; and this depends chiefly, perhaps, as is frequently the case in other instances, on the freshness of the individual.

Melanterius vinosus.

M. ovalis, squamosus; capite piceo, fronte valde convexo, crebre punctulato; rostro tenui, elongato, ferrugineo, basi subconfertim punctulato; antennis pallide ferrugineis; clava breviter ovata, acuminata; prothorace longitudine latitudini æquali, utrinque rotundato, nigro, reticulato-punctato, punctis oblongis, squamigeris; scutello distincto; elytris ovatis, rufo-piceis, maculatim silaceo-squamosis, sulcato-punctatis, punctis elongatis, subremotis, interstitiis leviter carinulatis, humeris haud prominulis, apice rotundatis; corpore infra pedibusque piceis, vage squamigero-punctatis. Long. 3 lin.

Hab. South Australia.

Melanterius cinnamomeus.

M. ovalis, rufo-ferrugineus, squamosus; rostro tenui, æqualiter punctulato; antennis testaceis; prothorace subtransverso, utrinque rotundato, crebre punctulato, punctis unisquamigeris; scutello scutiformi; elytris subtrigonatis, sulcato-punctatis, interstitiis latis, subplanatis; corpore infra pedibusque disperse niveo-squamosis. Long. $2\frac{1}{3}$ lin.

Hab. Champion Bay.

These are two very distinct species, differing in sculpture and coloration from the three hitherto described.

Melanterius servulus.

M. niger, subnitidus; rostro ferrugineo, nitido; antennis rufo-testaceis; prothorace creberrime punctulato; elytris sulcatis, punctis elongatis angustis impressis, interstitiis fortiter carinatis ex fere impunctatis; corpore infra nitido, remote squamoso-punctato; pedibus ferrugineis, squamulis filiformibus argenteis adspersis. Long. $1\frac{3}{4}$ lin.

Hab. King George's Sound.

Allied to *M. porcatus*, Er., but smaller, the prothorax very closely punctured, the intervals forming a sort of reticulation, and the elytra with long narrow punctures in their grooves.

XVIII.—*On some Recent Researches in Vegetable Physiology.* By M. Marc Micheli*.

In the present state of our knowledge we can scarcely expect brilliant discoveries or works to make a great noise in the world. This may be the case in the infancy of a science; but the task which we have to fulfil is essentially different. Our predecessors have laid down the great principles; and in a general way we may say that science rests upon firm and solid bases which nothing can overturn. What remains for us is deep and minute investigation; we must not neglect any detail, however minute it may appear. It is only by following this course, which is perhaps more arid and which, from afar,

* Translated by W. S. Dallas, F.L.S., from the 'Bibliothèque Universelle, Archives des Sciences,' tome xlii. pp. 105–134, October 1871.

may appear more ungrateful, that the scientific men of the present day will succeed in perfecting the work which has been commenced, and introduce into the sketch which has been handed down to us the finish of a perfect picture.

These general reflections, which I believe to be true for all the sciences, apply particularly well to vegetable physiology.

The principal features of the life of plants are known to us; and we can nearly follow the different phases of development from the first vital movements of the germinating seed to the moment when the products of vegetation are accumulating in the fruit and thus preparing a new generation.

But if the general outlines are known, how many details are still wanting! how many phenomena which escape us, at all events in part! how many questions to be solved!

The number of those who devote themselves to this task is great; and if we wish to give a sketch of the present state of science, we are only embarrassed to choose in the midst of the materials which present themselves on all hands. All nations assist in the work, but none so much as the Germans. Since the time of De Candolle vegetable physiology has shown a tendency to naturalize itself in Germany; and although we can cite among the naturalists belonging to other nations many names which are advantageously known to us, it is nevertheless to the Germans that we must give the honour of most of the very modern discoveries, and of those which have most contributed to give the science its present form and tendencies.

Whilst the works are numerous, their very form renders them difficult to analyse; many may be said to be only accounts of extremely minute experiments which it is impossible to depict in broad lines. We must not expect to find in them striking results of a kind to open up new horizons. Some only confirm already-known facts; others introduce slight modifications of these without changing their general character.

I.

At the base of physiological researches we shall always find those which treat of the relation of the plant and of light, and particularly of the interesting and varied part played by chlorophyl in vegetable life.

Professor Sachs was the first to indicate the curious and unexpected phenomenon of a diminution in the intensity of the colour of chlorophyl under the direct influence of the sun's rays*. In other words, if a portion of the leaves is sheltered by a screen of some kind, it soon contrasts by its darker colour with the other parts, which are exposed to the sun.

* Physiologie végétale, trad. Franç. p. 16.

The cause of this phenomenon has exercised the sagacity of physiologists; and it has finally been recognized that this change of colour was only apparent, and that it resulted from certain movements performed by the granules of chlorophyl in the interior of the cell.

The first observation of this kind is due to M. Famintzin*, author of numerous investigations upon light and vegetation. He observed that in the leaves of certain mosses (*Mnium*, sp.) the granules of chlorophyl group themselves during the day in the cells along the horizontal walls or those parallel to the surface. During the night they execute a movement of retreat and place themselves along the walls perpendicular to the surface. This phenomenon is exclusively due to the influence of light; heat has nothing to do with it.

Of the different rays the most refrangible alone have the faculty of drawing the chlorophyl towards the surface. The most luminous rays produce the same effect as complete darkness.

These results being once known, the same subject was taken up and treated more profoundly by M. Borodin†. He studied a great number of plants, both cryptogamous and phanerogamous. Among the latter he especially paid attention to those whose transparent tissues rendered observation easy (*Callitriche*, *Stellaria*, *Ceratophyllum*, and *Lemna trisulca*). He recognized three different phases in the phenomenon. Like M. Famintzin, he saw the chlorophyl place itself along the horizontal walls under the influence of light, and retire in darkness: but he likewise remarked that too ardent a sun exerts the same action as darkness; under the influence of its rays the granules of chlorophyl quit the horizontal walls and move towards the perpendicular ones. This action fully suffices to explain the changes of colour indicated by M. Sachs. In fact in diffused light the chlorophyl covers the horizontal walls (or those which alone strike our eyes), and the leaf thus appears darker. In the open sun or in obscurity these same walls, being almost completely deprived of chlorophyl, of course give us the impression of a lighter tint.

With regard to the effect of the different regions of the spectrum, M. Borodin perfectly agrees with his predecessor.

Researches of the same kind have also been made by M. Prilleux‡ upon the leaves of a moss (*Funaria hygrometrica*).

* Pringsheim's Jahrb. für wiss. Botanik, Bd. v. p. 49.

† Mélanges Biologiques tirés du Bull. de l'Acad. Imp. de St. Pétersb. tome vii. (1869) p. 50; and Bot. Zeit. 1869, No. 38.

‡ Comptes Rendus, 1870, tome lxx.

His results agree in all respects with those of the two naturalists above mentioned.

Lastly, M. Roze* concludes some investigations of the same kind by saying that these movements of the granules of chlorophyl must be accompanied by a displacement of the whole protoplasmic mass. The anatomical relations of the different parts of the cell render this, so to speak, necessary and evident.

By taking up similar researches, Dr. B. Frank† has discovered an entirely new property of chlorophyl, a property the importance of which cannot be well appreciated except by his subsequent investigations. According to Dr. Frank, the granules of chlorophyl unite to all the other characteristic features of their already complicated organization a marked tendency to move in the interior of the cell to the side which is most illuminated, exactly as zoospores do when placed in a plate near a window. To ascertain this phenomenon we must of course have recourse to plants with rather large cells, such as are often presented by aquatic plants. The first observations were made on leaves of *Sagittaria sagittifolia*, a plant of which was grown near a window. The general distribution of the granules of chlorophyl during the day and night at first followed strictly the laws laid down by MM. Famintzin and Borodin; but as the unilateral illumination was prolonged the aspect of affairs changed, and the granules of chlorophyl showed a more and more marked tendency to accumulate on the most strongly illuminated side of the cell.

The same facts were reproduced in the cells of the prothallium of various ferns and in the leaves of a moss, the *Mnium rostratum*, Schwægr. The position, direction, or orientation of the cells has no influence upon the phenomenon, which is equally well manifested in all cases, in diffused light as well as in the sun's rays. With regard to the different regions of the spectrum the author was unable to make any marked distinction. In a general way, diminution of the intensity of the light renders the phenomenon less striking and sometimes irregular; it is, however, always manifested, whatever may be the colour of the luminous rays.

Dr. Frank thought he could associate this displacement of the grains of chlorophyl with peculiar protoplasmic currents. Perhaps this work will become the origin of interesting observations upon the relations of light to the intracellular currents, phenomena which are still very imperfectly known.

As we are speaking of movements, we may indicate in

* Comptes Rendus, 1870, tome lxx.
† Botanische Zeitung, 1871, No. 14.

passing the observations of M. Bert* on those of the so-called sensitive organs in coloured light. These are the only researches upon this subject with which we are at present acquainted. According to this author, plants of *Mimosa pudica* kept in the dark died at the end of twelve days, having lost all sensibility after the seventh. Other individuals of the same species were enclosed in lanterns of coloured glass, which was, as far as possible, monochromatic; and the following is a summary of the results obtained:—

In green light the plants died in sixteen days; sensibility persisted for twelve days.

In violet light the plants lived three months without any development, and then perished; sensibility persisted to the end.

In blue light the plants continued to live without development; they constantly retained a certain degree of sensibility.

Lastly, in yellow and red light the plants not only live but become slightly developed; they retain their sensibility.

If we now approach the important subject of the decomposition of carbonic acid and the assimilation in the grains of chlorophyl, we shall find that here also some advances have been made, and we shall have to refer to works of greater importance.

It is a fact that often presents itself in the history of the sciences, that the first observers, perhaps carried away by the charm of discovery and by the desire to render it as evident as possible, give a somewhat too absolute value to the results which they have obtained, and it is only at a later period and by little and little that the facts appear in a perfectly correct light. Thus it was formerly regarded as a perfectly positive law that the most luminous rays of the spectrum alone acted in the phenomenon of assimilation, a different part being assigned to the more refrangible rays. In other words, the action of light upon chlorophyl seemed to be directly opposite to its influence upon chloride of silver. Repeated and more profound researches have already greatly modified this notion. We shall now endeavour to give an exact idea of the state of the question by rapidly going through the various works which have come to our knowledge. We shall simply follow the chronological order, leaving entirely on one side the questions of priority which, as a matter of course, have sprung up.

The first in point of date is M. Gregor Krauss†, one of the most accurate of observers, and author of several important treatises. He resumed the investigations of M. Famintzin

* Comptes Rendus, 1870, tome lxx.

† Pringsheim's Jahrb. vii. p. 511.

upon the production of starch in coloured light, and expresses himself in opposition to the assertion of that author, that no trace of starch is produced under the influence of the blue rays.

M. Krauss has followed the experimental methods indicated by M. Sachs, in seeking the smallest traces of starch in the tissues, and employed, as a coloured medium, the large double bells also invented by that eminent observer. The interval between the two bells is filled with a solution of bichromate of potash for the least refrangible part of the spectrum, and with a solution of ammoniacal oxide of copper for the more refrangible rays.

Different aquatic and terrestrial plants vegetated successively in these apparatus (*Spirogyra*, *Funaria hygrometrica*, *Elodea canadensis*, *Lepidium*, &c.). The result was constantly the same; in the three bells employed (with white, yellow, and blue light) starch was formed. The only difference between them was one of proportion and promptitude. Thus in white light and in the sun the first traces of starch were visible in five minutes; in blue light, only an insolation of several hours was capable of producing an appreciable effect.

The temperature also exerted a certain influence, but only in the proportion in which it acts upon vegetation in general. When the heat is greater, vegetation is more active, and it is therefore very natural that a greater quantity of starch should be produced. But this effect is not due to a direct intervention of the caloric element in the phenomenon; for the production of starch, although very slight, is still appreciable at a temperature at which most of the other functions are suspended.

A check experiment, made, by means of the balance, upon cotyledons of *Lepidium* and *Linum*, showed, by a notable augmentation of weight, that the starch was formed in them from the elements, and that it was not a product of transformation.

M. Prilleux* has taken up the idea that the effect attributed by his predecessors to the refrangible rays themselves was rather due to the diminution of the luminous intensity. In the experiments of M. Famintzin upon *Spirogyra*, he says, the light which traverses the solution is so feeble that it is incapable, by itself, of producing a marked effect. According to this author, the assimilant faculty of the leaf is proportional to the illuminating-power of the rays which it receives.

* Comptes Rendus, 1870, tome lxx. p. 521; Ann. des Sci. Nat. 5e sér. tome x.

He operated with a solution of ammoniacal sulphate of copper, not too much concentrated, and exposed his apparatus to the full light of the sun or to the focus of a powerful lens illuminated by a strong petroleum lamp.

M. Baranetzky* has resumed this subject, finding that M. Prilleux had operated upon very thin layers of liquid, which allowed too many rays to pass, this naturally invalidating his results. He employed ammoniacal oxide of copper and protochloride of iron, which, in layers of 25 millims. thickness, divided the spectrum pretty accurately into two more and less refrangible halves, but each endowed with nearly the same illuminating-power. The results were exactly the same; with an equality of luminous intensity, the number of bubbles of oxygen evolved during the act of assimilation was the same. This applies also to the greening of etiolated chlorophyl, and to the destruction of the colouring principle in an alcoholic solution of chlorophyl under the influence of the luminous rays. Heliotropic curvatures alone evade this law, and are manifested only under the influence of the blue or neighbouring rays.

The following is the mode in which, in the present state of our knowledge, M. Baranetzky proposes to describe the action of light:—

a. The decomposition of carbonic acid or assimilation, the formation of chlorophyl, and the destruction of the colouring principle are phenomena solely dependent on the degree of luminous intensity.

b. Heliotropic curvatures, the periodical movements of organs, the currents of protoplasm, and the changes of place of the grains of chlorophyl are executed only under the influence of the most refrangible rays.

On the decomposition of carbonic acid in the leaves, Dr. Pfeffer has published a work† which is perhaps the most complete that we possess on this subject. From the perfection of the methods employed, and the care with which the experiments were conducted, this work will always continue to be of very great value. The conclusions, although not so clear and precise as those of MM. Prilleux and Baranetzky, are nevertheless in the same direction, and tend to give the preponderance to the illuminating-power in the direct action of the luminous rays. He expresses them in the following terms:—

"The rays of the spectrum perceptible to our eyes are the

* Botan. Zeitung, 1871, No. 13.

† Arbeiten des Botanischen Instituts in Würzburg, Cahier i., 1871.

only ones which can become the cause of the decomposition of carbonic acid. The rays endowed with the most considerable illuminating-power (the yellow rays) exert of themselves an influence equal to that of all the others taken together. The most refrangible rays possess only a much less marked action. To each spectral colour there belongs a certain degree of activity in the phenomenon of assimilation, a degree which remains the same whether the rays act isolatedly upon plants, or whether their action is combined."

To arrive at the greatest possible exactitude, M. Pfeffer passed over the different methods which consist either in counting the bubbles of gas or in measuring the quantities of gas which have escaped from a plant vegetating under water. He adopted the method of M. Boussingault, who made his plants vegetate in a closed vessel, the atmosphere of which contained known quantities of carbonic acid. As coloured liquids he employed chromate of potash, ammoniacal oxide of copper, aniline red, orselline, aniline violet, and chlorophyl, and also, in order to observe the effect of the obscure heat-rays, a very concentrated solution of iodine in sulphide of carbon. We cannot, however, describe the apparatus and experiments; for these details we must refer the reader to the memoir itself.

We may say, only, that from the commencement of his investigation M. Pfeffer foresaw that the effects of the two halves of the spectrum separated by the chromate of potash and the ammoniacal oxide of copper represented, when taken together, a total nearly equal to the action of white light. This was already a great step made towards the idea of the predominant action of the luminous intensity. It is in consequence of this observation that M. Pfeffer, by employing sometimes monochromatic liquids, sometimes liquids which only excluded one or two spectral colours, has succeeded in nearly determining the assimilant power of each ray. If in white light chlorophyl decomposes 100 parts of carbonic acid, the isolated rays give the following numbers :—

Red and orange	32·1
Yellow	46·1
Green	15·0
Blue, indigo, violet	7·6
Total	100·8

We may therefore truly say that the action of the combined light represents the sum of the partial actions which the isolated rays would exert. The knowledge of these numbers enables the author to construct the curve of assimilation. This curve, which is nearly parallel to the curve of luminous intensity, attains its culminating point between the Fraunhofer lines D and E. On the other hand it has nothing to do with the curve of calorific intensity, which follows a totally different course.

Finally the author was led to confirm his results by data as to the augmentation of weight acquired by plants under the influence of the different regions of the spectrum. These data are derived from unpublished experiments by Prof. Sachs; their author has ascertained that even in blue light there is an increase of weight, which is certainly very slight, but greater than it appears at the first glance, since we must take into account the loss of solid material due to respiration. In yellow light the increase of weight represented 35 per cent. of what it would have been in white light.

The study of the diffusion of gases in the interior of the plant seems to be naturally connected with that of the conditions under which assimilation is performed; but although the results of such researches belong to pure physiology, the course by which we arrive at them, and the experiments and apparatus employed, all belong rather to the domain of physics. The most difficult problems of molecular physics are implicated in the questions which have to be solved. Therefore we shall confine ourselves to indicating, *en passant*, a very important and complete work upon this subject from the pen of M. N. J. C. Müller*, still in course of publication in Pringsheim's 'Jahrbücher für wissenschaftliche Botanik.' We shall only say that the author adopts the idea that, in the normal state of a membrane, the solid nuclei (formed of cellulose substance and mineral incrustations) and the liquid layers which surround them (molecular theory of Nægeli) always leave between them free spaces, actual pores.

Before quitting the subject of the exchanges of gas between plants and the circumambient atmosphere, we may mention two other observations, due to French naturalists.

M. van Tieghem † has observed the well-known phenomenon of aquatic plants which, although incapable of producing any current of bubbles of gas under the influence of diffused light, set them free in abundance as soon as they are struck by the rays of the sun; but what he has remarked that is new, is that this effect does not cease immediately with the insolation. A

* "Untersuchungen über die Diffusion atmosphärischer Gase in der Pflanze," Pringsheim's Jahrb. vols. vi. & vii.

† Ann. des Sci. Nat. 5e sér. tome ix. p. 269.

plant of *Elodea canadensis* which had received the rays of the sun for three hours, continued to produce currents of gaseous bubbles in diffused light, and did not stop until nine hours afterwards, when the night had already long come on. In another experiment, an insolation of one hour produced gaseous currents which were continued for three entire hours in complete darkness. According to these observations, therefore, the vegetable tissues are in a manner endowed with the property of storing up the solar light. Such a phenomenon as this may enter into the group of those which are designated under the name of phosphorescence.

M. Barthélemy* has investigated the function of the cuticle (that uniform layer which in general clothes the epidermis of plants) in accordance with the principles of Graham with regard to colloids. He has arrived at the conclusion that, in the exchanges of gaseous molecules between the plant and the atmosphere, the oxygen and carbonic acid pass especially through the cuticle (upper surface of the leaves), whilst the nitrogen makes a way for itself through the stomata (lower surface).

To the phenomena which the action of the luminous rays give rise to in the plant, those which originate in the absence of these same rays are most naturally related. It is by this title that a curious work by M. Krauss† on the causes of the deformation of etiolated plants figures here. These changes are well known, and present themselves under two apparently very different forms; certain organs, and especially the limbs of the leaves, when in the dark, undergo a complete arrest of development, and are far from acquiring their normal dimensions; others (for example, the internodes of the stems) become, on the contrary, much more elongated than usual, and attain dimensions several times exceeding their normal size.

These apparently irreconcilable anomalies depend upon entirely different properties of the tissues.

The etiolated leaves are arrested at the point at which, under normal conditions, they would have begun to receive the luminous rays—that is to say, at their issue from the scales of the bud. From this moment a normal leaf is called upon to suffice for itself; starch soon makes its appearance in the cells whose position brings them first into relation with the luminous rays—that is to say, in those of the teeth, nervures, &c. It is upon this starch that all the subsequent growth of the leaf depends; that which is enclosed in the interior of the

* Ann. des Sci. Nat. 5e sér. tome ix. p. 287.

† Pringsheim's Jahrb. vii. p. 209.

older tissues is of no use to it. In darkness no starch is prodnced; aud it is therefore not surprising that development is arrested. This view is so accurate that certain cotyledons destined to display a foliaceous structure stop growing in darkness at the moment when they ought to issue from the ground, although their cells are still full of the sugar or oil which was accumulated in the seed.

The exaggerated length of the internodes is due to very different causes, and is related to the phenomena of tension which always intervene in stems between the medulla, or active part, on the one hand, and the ligneous and cortical cells, or passive parts, on the other.

From an anatomical point of view the etiolated internodes are distinguished by presenting all the characters of very young internodes just issuing from the bud; the thickening of the walls of the ligneous and cortical cells which characterizes adult stems is here completely absent. This thickening, indeed, is related, by bonds which are not yet very exactly understood, to the presence of leaves on the internode. In darkness, the leaves not being developed, the cells retain the primitive thinness of their membranes.

This being understood, the elongation of the etiolated stems is easily explained, thanks to the intervention of two factors. In normal stems the medulla has always a tendency to elongate; it is the peripheral layers that arrest it; in young stems these are subjected to a tension strong enough to cause them to shorten considerably when they are isolated. But in proportion as their walls become thickened the resistance becomes more effective, and we see this in the fact that their contraction when they are separated from the rest becomes less and less. In darkness their walls do not thicken, and nothing is opposed to the elongation of the medullary cells. This is the first factor.

With regard to the pith itself, M. Krauss has already shown, in a former work*, that it has the property of elongation solely by the interposition of aqueous molecules between the cellulose molecules. This interposition may take place in the etiolated as in the normal plant; the pith is therefore the only part of the plant which continues to *grow actively* in the dark. This growth is precisely the second factor of the elongation of the internodes; and by combining it with the absence of resistance in the peripheral layers, we can understand that considerable results may be produced.

By the side of the effects of light, the investigation of those of temperature quite naturally finds its place.

* Botan. Zeit. 1867, Nos. 17, 18.

With regard to the degree of cold which living plants are able to support, M. Goeppert of Breslau* calls attention to the fact that the lowest temperatures ascertained in the polar regions ($-40°$ to $-52°·6$ F.) only relate to a very restricted number of plants. Those whose stem is not sufficiently high to pass the layer of snow are under very different conditions. Sheltered under a screen which is a bad conductor of heat, these plants are subjected to a temperature which hardly falls below 28°·4 F. But if the snow protects them from too sharp a cold, and becomes the indispensable preserver of plants in high latitudes and on the mountains, their development is none the less arrested. The plants best known as flowering in winter, *Helleborus fœtidus* and *niger* and *Bellis perennis*, cease growing as soon as the temperature is low; they merely do not suffer from frost: a half-opened flower may be completely stiffened by the cold for several days; but as soon as the thaw comes, it resumes its development.

In our latitudes, the heat of summer, by heating the soil, may exert a certain influence upon winter vegetation. In the arctic regions this is not the case: the soil, always frozen, does not retain any heat; all must come from the sun; and it is thus that we sometimes see plants (willows, rhododendrons) frozen in their lower parts, and bearing at the extremities of their branches leaves and expanded flowers.

It must not be supposed that a plant because it is frozen is for this reason protected from the deleterious influence of a sharper cold. Each species can bear a certain diminution of temperature: some may, without injury, be completely frozen and afterwards thawed; but for each there exists a certain minimum which cannot be passed without producing fatal consequences. However, M. Goeppert, who has devoted himself for many years to the study of the relations of temperature and vegetation, gives us hopes of more ample details upon this curious subject.

It has often been asked, at what moment do frozen cells perish? at their freezing or their thawing? It is difficult to give an answer to this; and direct experiments are almost impossible. It is evident that all the cells which may freeze or thaw several times without injury only perish when the thawing takes place under unfavourable circumstances; it is a well-known matter of experience that if, after a cold night, the temperature rises gradually and the sky remains cloudy, many plants, even young delicate shoots, recover perfectly. If, on the contrary, the sun causes too rapid a thaw, the evil acquires

* Botan. Zeit. 1871, Nos. 4 & 5.

very different proportions. But a multitude of plants occur under very different conditions, and perish as soon as their cells have felt the attacks of frost. At what precise moment do they die? M. Goeppert * cites in connexion with this an observation (an isolated one, it is true, but still curious) which seems to prove that it is the direct action of cold, the frost itself, that kills delicate plants. Two tropical Orchideæ, *Phajus grandifolius* and *Calanthe veratrifolia*, contain considerable quantities of indigo in their flowers. This substance, as every one knows, is colourless in living plants, and only becomes blue after their death, by a phenomenon of oxidation. The flowers of these two plants are of a fine white colour; but it is only necessary to rub them a little hard with the hand to bring out in them the natural tint of indigo. Cold produces exactly the same effect: as soon as the flowers are frozen, no matter to what extent, their corollas immediately become deep blue; and this colour persists after thawing. In this case, at least, the cells have been killed by the direct action of cold.

One of the most characteristic features of the cells which have suffered from frost is the modification of their endosmotic properties: they lose their turgescence, and the liquid which they contain escapes through their walls without the least effort. M. Sachs has sought the explanation of these facts in the modifications which the molecular structure of the membrane suffers under the influence of thaw. If this comes on suddenly, the shock destroys the existing molecular equilibrium. This would be an effect similar to that which we observe under analogous circumstances in white of egg or starch-paste. After thawing, these two substances no longer present any thing but a spongy mass without consistency, allowing the liquid which they contained to escape under the smallest pressure.

M. Prilleux † has opposed this opinion, which presupposes, according to him, the formation, in the invisible pores of the membrane, of icicles, which, by their fusion, would overthrow the molecular equilibrium. Now the properties of capillary spaces, and the difficulty of causing water to freeze in them, are by no means favourable to this theory. The properties of the frozen cells being exactly the same as those of cells which have passed through boiling water, M. Prilleux proposes to seek the explanation of the phenomenon in the alteration of the protoplasm, and not of the membrane. It is, in fact, upon the diosmotic properties of the primordial utricle that the separation of the different liquids enclosed in the different cells

* Botan. Zeit. 1870, No. 24.

† Bull. Soc. Botan. de France, 1869, xvi. p. 91.

depends. When life no longer exists, then the acids mix with the bases, and the coloured substances spread through the tissues. The simple fact of the death of the protoplasm would therefore suffice, according to M. Prilleux, to explain all the properties of the frozen cells.

As to the sheets of ice which are often seen during the winter at the surface of stems or beneath the epidermis, these originate, according to the same author *, from the water of constitution of the membranes. Each molecule retains around it, by the forces of attraction with which it is endowed, a liquid layer of a certain thickness; under the influence of cold, the force of attraction diminishes, and a part of the liquid flows away and becomes frozen at the surface.

[To be continued.]

XIX.—*Observations on the Systematic Relations of the Fishes.* (Abstract). By Prof. Edward D. Cope †.

I. Preliminary.

The system of fishes, as at present adopted in America, is the result of the labours of many naturalists, but chiefly of Cuvier, Agassiz, Müller, and Gill. Without going into the history of the subject at present, it will be proper to point out the principal modifications of Cuvier's system introduced by his three successors. The orders of Cuvier were:—the Chondropterygii, Malacopterygii, Acanthopterygii, Plectognathi, and Lophobranchii.

Professor Agassiz, under the name of Placoids, adopted the first division; the second he called the Cycloids, the third Ctenoids, and then created a fourth order under the name of Ganoids, which should embrace a portion of Cuvier's Chondropterygii (the Sturgeons), a portion of the Malacopterygii Abdominales (the Bony Gars &c.) and the two last orders of Cuvier. Professor Müller, following with a still more complete anatomical investigation, especially into the soft parts, discerned three subclasses in Cuvier's Chondrostomi, which he named the Leptocardii (Lancelet), Dermopteri (Lamprey &c.), and the Selachii (Sharks &c.). In the then recently discovered *Lepidosiren* he saw a fourth subclass, Dipnoi.

Having instituted an investigation of Agassiz's Ganoid order, in an able memoir he purged it of the Plectognath and

* Bull. Soc. Botan. de France, 1869, xvi. p. 140.

† From the Association Number of the 'American Naturalist.' Communicated by the Author.

Lophobranchiate divisions, which are obviously not related to it. These, with the Malacopterygians and Acanthopterygians, he erected into a sixth subclass, the Teleostei. This subclass, containing the greater part of existing fishes, embraced six orders, viz.:—Acanthopteri (Cuvier's Acanthopterygians), Anacanthini (new, for the cod family &c), Pharyngognathi (new, for fishes with connate inferior pharyngeal bones), Physostomi (Malacopterygians of Cuvier, nearly); Plectognathi and Lophobranchii of Cuvier. The great number of facts in the anatomy of fishes added by Müller constitute him the father of modern ichthyology.

Professor Gill, in 1861, adopted many of the divisions of Müller, and rejected some; others were newly proposed. But four subclasses were recognized:—the Dermopteri, which includes also Müller's Leptocardii; the Elasmobranchii, equivalent to Müller's Selachii; the Ganoidei, including here Müller's Dipnoi; and the Teleostei. Six orders were attributed to the last subclass, which were quite different from those of Müller.

Subsequent to this publication, important contributions to the system have been made by Kner, Lütken, Gill, Huxley, &c., which will be noticed at the proper time.

The writer, having been engaged in an examination of the osteology of the bony fishes, and general anatomical studies of the whole, has proposed to point out some further modifications of the received system, which he believes will render it a closer reflection of nature. There are some portions of the skeleton which have been to a great extent overlooked in seeking for indications of likeness and difference of types; and the estimation in which many known characters are held may be much altered on the study of extended material. The skeletons on which the present study is made are one thousand in number—two hundred belonging to the Academy of Natural Sciences of Philadelphia, and eight hundred to the writer, being the collection made by Professor Joseph Hyrtl, the distinguished anatomist of Vienna. This collection has long been known to anatomists in Europe as the most beautifully and reliably prepared in existence, and as valuable as any for study, on account of the fulness of the representation of the various types.

II. Special on the Ganoids.

Recurring to Müller's system, the writer adopts, as characterized beyond dispute, his subclasses or orders of Leptocardii, Dermopteri, Selachii, and Dipnoi, and confines himself at present to the recent Ganoidei and Teleostei. I have shared in the doubts occasionally expressed by ichthyologists as to the essential distinction of these latter divisions; and an examination into the osteology, with reference to this point, confirms the doubts raised by a study of the soft parts. As is well known, Müller distinguished the Ganoidei by the muscular bulbus arteriosus containing numerous valves, and the connexion of the optic nerves by commissure rather than by decussation. He added several other characters, knowing them, however, to be shared by various other orders and subclasses; and I have selected the only two which seemed to be restricted to the division. Their restriction to it, however, is only apparent; and Kner points out that the peculiarity of the optic commissure is shared by some Physostomi, and that the difference between the number and character of the valves of the bulbus in *Lepidosteus* and *Amia* is quite as great as that existing between *Amia* and some of the Physostomi. After an examination of the skeleton, it is obvious that in this part of the organism also there is nothing to distinguish this division from the Teleostei of Müller. It is true that each of the genera referred to it possesses marked skeletal peculiarities; but they are either not common to all of them, or are shared by some of the Physostomi. If, on the other hand, we compare these genera with each other, differences of the greatest importance are observable, which at once distinguish two divisions—one represented by *Polypterus*, the other by *Lepidosteus* and *Amia*.

In the first place, the basal radii of the pectoral fins of *Polypterus* are observed to be excluded from articulation with the scapular arch by the intervention of three elements, which form a pedicle or veritable arm for the fin. In *Lepidosteus* and *Amia* the radii are sessile on the scapular arch, as in ordinary fishes. The ventral fins present a like difference; the basal radii are long and four in number in *Polypterus*. In the other two genera they are absent, excepting one rudimental ossicle on the inner basis of the fin (two in *Lepidosteus*), precisely as in the Physostomous families Mormyridæ, Catostomidæ, &c. If we examine the branchial apparatus, we find an undivided cerato-hyal, three branchio-hyal arches, and no inner and but two outer bones of the superior branchio-hyals, present in *Polypterus*. In *Lepidosteus* and *Amia* we have the double cerato-hyal, four branchio-hyal arches, with four outer and four superior elements, characters of the typical Teleostei. The maxillary bone of *Polypterus*, instead of being free distally, as in fishes generally, is united with an ectopterygoid and with bones representing, in position at least, postorbital and malar. In the other genera the relations of the maxillary are as in osseous fishes.

The Sturgeons (Acipenseridæ) agree with *Amia* &c. in all of these points but one, differing only in having the superior cerato-hyal and several of the superior branchio-hyals cartilaginous. The one point of distinction is the extension of the basal radial supports of the ventral fin all across its basis, as in *Polypterus.* The pectoral fin is, on the other hand, much as in *Lepidosteus.* Thus the Sturgeons combine in this one respect the features of both divisions. Both the basal cerato-hyals are cartilaginous in this family; the superior only is cartilaginous in *Polypterus*, *Lepidosteus*, and *Amia*; while both are ossified in the old Teleostei, except in the Eels. In these the inferior is cartilaginous, while the superior is co-ossified to the cerato-hyal. Thus in one unimportant character *Polypterus* agrees with its former associates, but differs more from others of them (the Sturgeons) than from the bony fishes.

Another character of both *Lepidosteus* and *Amia* betokens a certain relationship to *Polypterus*, viz. the complexity of the mandible, especially in the possession of a coronoid bone. But here, again, *Acipenser* only possesses an osseous dentary, while *Gymnarchus* and *Gymnotus* have the angular and articular bones distinct from the dentary, wanting the coronoid and opercular. In most bony fishes the angular is not distinct.

It is thus evident that the subclass Ganoidei cannot be maintained. It cannot be even regarded as an order, since I will show that *Lepidosteus*, *Acipenser*, and *Amia* are all representatives of distinct orders. I hope also to make it evident that *Polypterus* should be elevated to the rank of a subclass or division of equal rank with the rest of the fishes and with the Dipnoi already adopted.

The question may be discussed as to whether naturalists are correct who regard the fishes as representing, variously, from two to four classes. One of these (the Ganoidei) having been already disposed of, it remains to consider the claims of the remainder, viz. the Elasmobranchii (Sharks), Dipnoi, and typical fishes.

If we examine the points in which the whole taken together differ from the Batrachia and other classes above it, we find that these are confined chiefly to the structure of the limbs and the hyoid apparatus. The typical fishes present, however, other important peculiarities, viz.:—1, the existence of two or three distinct bones in the suspensor of the mandible, instead of one; 2, the attachment to these of the opercular bones; 3, the absence of pelvic bones; 4, the suspension of the scapular arch to the cranium; 5, the large development of the pterotic

(Parker, *mastoid* of Cuvier and Owen) is characteristic of bony fishes.

The types of variation in the first point, only distinguish groups of subordinate rank. Thus the suspensor of the mandible in the typical fishes consists of the hyomandibular stapes, quadrate (metapterygoid or incus), symplectic, and mesopterygoid (*quadrato-jugal*, Müller; *quadrate*, Huxley, Elem. Comp. Anat.). In the Mormyridæ, Siluridæ, Polypteridæ, and others, the symplectic is absent; in the Eels of several families both it and the metapterygoid are wanting, reducing the suspensorium to a rod of two pieces. This condition exists in many of the Rays; in others and in the Sharks the inferior element is wanting (Müller, Stannius). An important modification is exhibited by *Chimæra*, where the hyomandibular, which alone exists, is continuous with the cartilaginous cranium, not being separated by the usual articulation.

As to the opercular bones, all are wanting in the Elasmobranchs (Sharks and Rays), while the typical fishes possess four, viz. præoperculum, operculum, suboperculum, and interoperculum. In many of these, however, the suboperculum is wanting; and in the Sturgeons and many Eels there is no præoperculum. In *Polyodon* the interoperculum is also wanting. In *Lepidosiren* the operculum and interoperculum are rudimental. In respect of this point also, the divisions indicated are of subordinate value. As regards the development of the pterotic bone, its history is not yet sufficiently made out to enable us to understand its value. It does not exist in those with cartilaginous cranium (Elasmobranchii). The Elasmobranchs are well known to have the scapular arch suspended freely behind the cranium, as in higher Vertebrates. It is not always attached to the cranium, on the other hand, among true fishes; for in the Eels it is quite as in the Sharks, and the spinous-finned *Mastacembelus* presents the same features.

The characters presented by the pelvic bones and limbs seem to be of higher import. Thus all the bony fishes and Sturgeons lack all the pelvic elements. In the Sharks and Rays they are also wanting; but two elements on each side appear in the Holocephali (*Chimæra*) according to Leydig and Gegenbaur. In *Lepidosiren* a large median pelvic cartilage exists; but which element it represents is unknown. This is evidently a character of high significance. As to the limbs, the peculiarities of *Polypterus* have been pointed out above. They mean nothing less than the development of the elements of the arm and leg of the higher Vertebrata which intervene between the point of articulation and the distal segments in *Polypterus* and the Sharks and Rays. In the former the distal segments are articulated exclusively to the extremities of the proximal pieces, which thus resemble, as well as represent, humerus and femur, and render the limb pedunculated. The proximal pieces are not continued distally, however, into the representatives of the main axis, which, as demonstrated by the admirable studies of Gegenbaur, consist, after humerus, of radius, tarsals and metatarsals, and thumb; in the hind limb, of the line of the tibia and inner toe. This continuation is observed in the Elasmobranchii, where, however, the divergent segments extend along the sides of the proximal pieces to near, in some Rajidæ quite to the articulation with the scapular arch. In the true fishes, including some of the old Ganoids already considered, the divergent rays always reach this articulation, while the number of proximal or basal pieces is diminished. These pieces have been called by Gegenbaur the metapterygium (humerus), mesopterygium, and propterygium—the first being axial, the second and third being divergent from it. In *Polypterus* the propterygium and mesopterygium are largely developed; in Sharks and Rays the propterygium is sometimes small, sometimes wanting, while in the true fishes the propterygium and mesopterygium are both wanting, excepting in *Amia*, *Lepidosteus*, and the Sturgeons, where a cartilaginous mesopterygium exists, according to Gegenbaur. This author finds it rudimental in young Salmonidæ and Siluridæ. Lastly, in the true fishes the distal elements of the axis of the limb are wanting, just as in *Polypterus*.

In Dipnoi, on the other hand, we have this axis complete or rather with greatly multiplied distal segments, and with or without lateral radii. In the Australian *Ceratodus* Günther finds numerous lateral series on both sides of those of the axial row. Hence the limb of this order is considered by Owen the simplest or primary type; and this proposition is abundantly confirmed by the beautiful researches of Gegenbaur. The foundation laid by this author for the history of the genesis of limbs will ever be a landmark in the history of *modern theories of creation* (see his memoir, "Ueber das Skelet der Gliedmaassen der Wirbelthiere im Allgemeinen," &c., Jenaische Med. Zeitschr. vol. v. p. 397).

Important as are the characters that distinguish the several groups indicated by the different types of structure of the limbs and pelvis, they do not seem to me to warrant their recognition as classes equivalent to those of the six already pointed out. Taking them together, there is a greater coherence also in the structure of the brain and circulatory systems than would be the case with any other two of the classes adopted above. The peculiarities of the limbs, important as they are, are nearly related in the want of specialization of their parts, seen in the Batrachia and other classes—the differences consisting rather of number and position of similar parts. The pelvis of the Dipnoi might be regarded as of primary importance but for its existence in the Holocephali, whose limbs, again, are so near those of the shark.

It remains, therefore, to adopt the Linnæan and Cuvierian class Pisces, and to grant as subclasses the groups of Holocephali, Selachii, and Dipnoi. There remain as subclasses the groups typified by *Polypterus* on the one hand and the true fishes on the other. The first has been already distinguished in its external characters by Professor Huxley, who again brought light out of obscurity when he established his "third suborder of Ganoids, the Crossopterygidæ." This division is, in my estimation, a natural one, and to be elevated to a rank equivalent to that of each of the three above named, being the only part of the original division of Ganoids of Müller entitled to it. Professor Huxley defined it as follows :—

"Dorsal fins two, or, if single, multiplied or very long; the pectoral and usually the vertical fins lobate; no branchiostegal rays, but two principal, with sometimes lateral and median jugular plates situated between the rami of the mandible; caudal fin diphyocercal or heterocercal; scales cycloid or rhomboid, smooth or sculptured."

Of the above characters, that which relates to the lobate fins is the essential one, and is the expression of the external appearance produced by the structure of the bones of the limbs already pointed out by Gegenbaur. The dorsal fins of some families, it is true, possess a remarkable structure; but in *Phaneropleuron* (Huxley) and some others they appear to be nearly like those of the Dipnoi. The absence of branchiostegal rays is important, but is shared by the Sturgeons. The jugular plates appear to exist in *Polypterus* alone among recent fishes, though several, as *Amia*, *Elops*, *Osteoglossum*, &c., possess a median one. Nevertheless its nature would not lead one to anticipate its being a constant feature in any group of high rank; at least such is our usual experience with dermal bones. The structures of the skin and scales given by Huxley are very subordinate.

The remaining division answers, then, to the Teleostei and Ganoidei of Müller, minus *Polypterus*. The name Teleostei cannot be preserved for this division, owing to its entire want of coincidence with that division of Müller, as well as from the fact that the cartilaginous Sturgeons must be included in it.

I propose, therefore, to call it the Actinopteri. The character of the five subclasses will then be as follows :—

Class Pisces.

The hyomandibular bone continuous with the cartilaginous cranium, with a rudimental opercular bone. Two distinct pelvic bones on each side. Derivative radii sessile on the sides of the basal bones of the limbs, separated from the articulation. *Holocephali.*

Hyomandibular bone articulated with the cranium ; no opercular or pelvic bones. Derivative radii sessile on the sides of the basal bones of the limbs, rarely entering articulation. *Selachii.*

Hyomandibular bone articulated, with rudimental opercular bones ; a median pelvic element. Limbs consisting of the axial line only, commencing with the metapterygium, and with multiplied segments. *Dipnoi.*

Hyomandibular articulated, opercular bones well developed, a single cerato-hyal ; no pelvic elements. Limbs having the derivative radii of the primary series on the extremity of the basal pieces, which are in the pectoral fin metapterygium, mesopterygium, and propterygium. *Crossopterygia.*

Opercular bones well developed on separate and complex suspensorium ; a double ceratohyal, no pelvic elements. Primary radii of fore limb parallel with basilar elements, both entering the articulation with scapular arch. Basilar elements reduced to metapterygium and very rarely mesopterygium. Primary radii of posterior limbs generally reduced to one rudiment. *Actinopteri.*

III. On the Actinopteri.

In determining the primary types of this subclass, we return to some characters already mentioned, in which they approximate to the Crossopterygia, and, adding others, follow the various divergences to their specialized terminations.

Thus in *Acipenser* and allies the ventral fins possess a complete series of basal radial bones, and the pectorals each a large mesopterygium. In *Amia* and *Lepidosteus* the mesopterygium is small, and the basal radii of the ventrals are reduced to their lowest number. In none of them are the basihyals fully developed. Most of the Eels retain a character which we have only observed heretofore in the Selachii.

We pass by a number of the lower fishes before we find the mandibular arch furnished with a symplectic. One of the most important modifications, which is more or less coincident with a number of others, is that which formed the basis of Bonaparte and Müller's order of Physostomi. The presence of the ductus pneumaticus, which characterizes it, is always associated with the abdominal position of the ventral fins and with cycloid scales, and mostly with the presence of the precoracoid arch, the entrance of the maxillary bone into the border of the mouth, and the non-separation of the parietal bones by the supraoccipital. Yet none of these characters are precisely associated at the point of change in each; for there are physostomous fishes with separated parietals and ctenoid scales (some Cyprinodontidæ), and there are Physoclysti with abdominal ventrals. Nevertheless three prominent types stand out in the Actinopteri—the Sturgeons or Chondrostei, the Physostomi, and the Physoclysti, which may be considered tribes.

An entire series of basilar segments of the abdominal ventral fins; no branchiostegal rays. *Chondrostei.*

Basilar segments of ventrals rudimental, position of fins abdominal, parietal bones usually united; branchiostegal rays; swimming-bladder connected with the stomach or œsophagus by a ductus pneumaticus. *Physostomi.*

No ductus pneumaticus; parietal bones separated by the supraoccipital; ventral fins usually thoracic or jugular; no basilar segments. *Physoclysti.*

Chondrostei.

There are two orders in this division, as follows:—

A precoracoid arch; no symplectic bone; premaxillary forming mouth-border; no suboperculum, nor præoperculum; mesopterygium distinct; basihyals and superior ceratohyal not ossified; interclavicles present; no interoperculum or maxillary; branchio-hyals cartilaginous. *Selachostomi* (the Paddle-fish).

Similar to the last, but with interopercle, maxillary bones, and osseous branchio-hyal. *Glaniostomi* (the Sturgeons).

The first order embraces the single family of *Spatularidæ*, the second that of *Acipenseridæ*. In both the chorda dorsalis persists, the tail is heterocercal, and the osseous cranium is little developed. The basal and radial elements of the limbs, with the coracoids, are not ossified.

Physostomi.

The following key will express the leading features of the orders of this division:—

I. A precoracoid arch.

A. A coronoid bone.

Maxillary in many pieces; vertebræ opisthocœlian. 3. *Ginglymodi* (the Bony Gar).

Maxillary not transversely divided; vertebræ amphicœlian. 4. *Halecomorphi* (the Dogfish).

AA. No coronoid bone.

* No symplectic bone.

Pterotic simple; anterior vertebræ with ossicula auditus; supraoccipital and parietals coossified. 5. *Nematognathi* (the Catfishes).

Pterotic annular, including a cavity closed by a special bone; parietals distinct; vertebræ simple. 6. *Scyphophori* (the *Mormyri*).

** Symplectic present.

Anterior vertebræ coossified, and with ossicula auditus. 7. *Plectospondyli* (the Suckers &c.).

Anterior vertebræ similar, distinct, without ossicula auditus. 8. *Isospondyli* (Herring &c.).

II. No precoracoid arch.

A. Scapular arch suspended to cranium.

* A symplectic.

Pterotic and anterior vertebræ simple; parietal separated by supraoccipital. 9. *Haplomi* (Pike &c.).

Anterior vertebræ modified; parietals united; pectoral fins. 10. *Glanencheli* (Electric Eel).

** No symplectic.

Anterior vertebræ simple; a præoperculum and maxillary; no pectoral fins. 11. *Ichthyocephali* (Java Eels).

AA. Scapular arch free behind the cranium.

* A præoperculum.

A symplectic; maxillary well developed; no pectoral fins. 12. *Holostomi* (Symbranchi).

No symplectic; maxillary lost or connate; pectoral fins. 13. *Enchelycephali* (Eels proper).

** Præoperculum wanting or rudimental.

No symplectic, maxillary, or pectoral fins, no pterygoid. 14. *Colocephali* (Murænæ).

Of the above orders the Haplomi (Pike &c.) approach nearest the Physoclysti of the families Ophiocephalidæ and Atherinidæ, and the Holostomi of the family Symbranchidæ to the Physoclyst family of Mastacembelidæ. The affinities between these families are in both cases so close as to render the distinction of the primary divisions in question hardly worth preserving.

The complete development of the support of the caudal fin is seen in many members of this tribe, while in others it remains in its primitive condition. Among Physoclysti it is nearly always complete, though in a few (Trichiuridæ &c.) it remains larval. In the first development of the vertebral column in fishes it forms a straight axis. The fin is represented by a fold of the integument which extends equally round its extremity. In this membrane the rays are developed, and in many fishes they remain thus equally distributed. In this case the caudal vertebræ remain in a straight line to the extremity, and we have a termination such as is seen in *Lepidosiren* and the eels. This form of tail may be called the *isocercal*.

If, now, the radii, basal or distal, acquire a greater development on the lower side of the column, those on the upper side remaining rudimental, it will be necessary that such enlarged portion should strike the water in the plane transverse to the longitudinal axis of the body, in order that the weight of the body be propelled with the least expenditure of force. This will necessarily cause the distal vertebræ, or end of the chorda dorsalis, to be turned upward, so that the inferior rays of the fin shall be brought as near to the vertical line of the superior as possible. This is the type of tail known as the *heterocercal*, as called by Agassiz.

We find among the Physoclysti that the lower rays of the fin are more and more strengthened, and the hæmal spines which support them are more and more enlarged; consequently the end of the column is more curved upwards, as seen in *Amia*. The superior rays and neural spines are also strengthened, and the inferior so extended upwards as to pass round the extremity of the column and come into contact with them. And now the vertebral centra are successively atrophied from the extremity. Counting from the extremity to the bases of the first supports of the outer rays of the caudal fin above and below, we find that ten vertebræ remain in the tail of *Notopterus*. In the Hyodontidæ, Albulidæ, Elopidæ, Alepocephalidæ, and Salmonidæ there are but two left, while one only appears in the Osteoglossidæ, Aulopidæ, Lutodiridæ, Butyrinidæ, Coregonidæ, Clupeidæ, and Chirocentridæ. In most other families, especially of Physoclysti, the last one has disappeared, and the numerous hæmal arches are arranged like radii diverging upwards and downwards from the last caudal vertebra. In the highest groups, as Pharyngognathi &c., they become coossified, and the tail has completed specialization. This is the type called *homocercal* or *diphyocercal* by later writers.

These types are thus plainly stages in the development of this member, the first and second being simply arrests of development of the last. Thus the young salmon commences with an eel-like vertebral column, or is *isocercal*; it presently, by the upward curvature of the column and unequal development of the caudal fin, becomes *diphyocercal*, but ceases to grow before it has quite accomplished this stage. The *Polypterus*, the Eels, *Gymnarchus*, and other fishes ossify the vertebræ in the isocercal stage. The heterocercal type is seen in the Chondrostei, where the vertebræ never ossify. In *Lepidosteus* and *Amia* they ossify in this stage.

I further specify the characters of the orders of Physostomi and the families they contain in the paper itself.

PHYSOCLYSTI.

The following is an analytic synopsis of the orders. They all have the parietals entirely separated by the supraoccipital, and lack the precoracoid; the symplectic is present, except in *Ostracium*, where it is not ossified.

A. Scapular arch not suspended from the cranium.

Superior branchio-hyals and pharyngeals developed; inferiors and maxillary distinct. 15. *Opisthomi.*

AA. Scapular arch suspended from the cranium.

1. *Ventral fins abdominal.*

Branchial arches well developed, the bones present, except fourth superior pharyngeal; third much enlarged; inferior pharyngeals distinct. 16. *Percesoces* (Mullet &c.).

Third and fourth superior pharyngeals much enlarged, inferior pharyngeals coossified. 17. *Synentognathi* (Soft Gar).

Superior branchio-hyals and pharyngeals reduced in number; inferiors separate; interclavicles present. 18. *Hemibranchii* (Pipe-fishes).

Superior branchio-hyals and pharyngeals and basal branchiohyals wanting; gills tufted. 19. *Lophobranchii* (Sea-horse).

2. *Ventral fins thoracic or jugular.*

First vertebra united to cranium by suture; epiotics united behind supraoccipital; basal pectoral radial bones elongate. 20. *Pediculati* (Goose-fish &c.).

Posterior cephalic region normal, anterior twisted so as to bring both orbs on one side; inferior pharyngeals distinct. 21. *Heterosomata* (Flounders).

Cranium normal; the premaxillaries usually coossified with the maxillaries behind, and the dentary with the articular; pharyngeal bones distinct. 22. *Plectognathi* (File-fishes).

Cranium normal; bones of the jaw distinct; inferior pharyngeal bones distinct. 23. *Percomorphi* (Perch).

Cranium normal; bones of the jaws distinct; third superior pharyngeal much enlarged, articulating with cranium; inferior pharyngeals coossified. 24. *Pharyngognathi* (Burgall, Parrot-fish).

These orders will be more fully defined, and the families which are referable to them pointed out.

IV. General Observations.

In tracing the affinities of the Physostomi, I have pointed out the relation between the Chrondrostei and the Nematognathi, and between the Halecomorphi and the Isospondyli. The first named of each of these pairs are the structural, and probably genetic, predecessors of the second. The series commenced with the Catfishes may be continued into the Mormyri and then to the families of the Plectospondyli, where the series with altered vertebræ and with ossicula auditus terminates. The Characins, however, have considerable affinity to the Isospondyli, especially in the type of their branchial bones. From the latter group we pass to the Haplomi, and thence to the Physoclyst groups. The eel-like groups form a special line. The Glanencheli have cranial characters of the groups with modified vertebræ, with fins of the more typical eels. The latter show a steady approach in some points to the conditions characterizing the Chondrostei. The loss of the maxillary, of opercular bones, and of pharyngeal elements reminds one of these; but in the loss of the premaxillary and great development of the ethmoid, in the Colocephali, we have features quite unique. The vertebral position of the scapular arch is the only shark-character they possess; while, on the other hand, the Holostomi are undoubtedly related to the *Mastacembelus*, a real Physoclyst with spinous dorsal fin. These relations are as yet entirely inexplicable.

The affinities among the Physoclysti are more clear. Omitting the genus just mentioned, we find the four orders with ventral fins to form a true series, with a Synentognath variation, terminating in the greatly degraded order of Lophobranchii. The Percesoces give us our nearest connexion with the groups with abdominal ventral fins, and lead at once to the Percomorphi. From this centre radiate many lines of affinity. One leads from the Chætodontidæ, through the Acroneuridæ, to the Plectognathi, by the similarity in the arrangement of the posttemporal and forms of the pharyngeal apparatus. An important division of the Percomorphi has the basis cranii simple and the branchials reduced above, viz. the Scyphobranchii. The Cottidæ are the most generalized family of this group, and lead, on the one hand, to the Triglidæ of the Distegi, with which they are generally arranged, and, on the other, to the Blenniidæ. Some of the latter elongate the basal pectoral bones considerably, and lead to the Batrachidæ on the one side, where the number of these bones is increased, and on the other to the Pediculati, where the number is diminished. To these groups the Anacanthini and Heterosomata are less allied.

The third upper pharyngeal bone has already presented an increase of mass and use in the first orders of Physoclysti with ventral fins. Among the Percomorphi the same increase makes its appearance by little beginnings in some Sciænidæ. It is quite noteworthy in most of the Carangidæ, a group whose separation from the Scombridæ by Günther is supported by this part of their organism. Through forms not now specified, approach to the Pharyngognathi is made. Here the pharyngeals are modified into a mill-like structure, which is least specialized in the Embiotocidæ, and most so in the Scaridæ.

MISCELLANEOUS.

Osteology of the Solitaire.

To the Editors of the Annals and Magazine of Natural History.

Gentlemen,—In a paper on the osteology of the Solitaire of Rodriguez, communicated by my brother, Mr. Edward Newton, and myself to the Royal Society, and published in the 'Philosophical Transactions' for 1869, there occurs the following passage relating to the remains of that bird which had previously come to the notice of naturalists:—

"In addition to these *eighteen* specimens, we are informed that in 1860 or 1861 a tibia, the shaft of a tarso-metatarsal, and some fragments of the shaft of a femur, all of which belonged to the Solitaire, were sent to Professor Owen by M. Bouton, of the Museum at Mauritius; but the fate of these specimens is unknown to us."

In a paper published a few days since in the 'Transactions of the Zoological Society' (vol. vii. part 7. p. 519, note) Professor Owen quotes the above-cited passage, and then, after printing a letter from the late Mr. James Morris, accompanying the specimens to which the information we had received referred, states what they really were, and continues as follows:—

"They were returned to the Museum at Port Louis, Mauritius. The first and sole evidence of Messrs. Newton's interest in these fragments reached me with their memoir. Any previous inquiry would have, at once and most readily, received the reply given in the present note."

Professor Owen makes this statement in error. Some time before our memoir was finished, and therefore before it reached him, my brother and I made personal and explicit inquiry of him as to the fate of these bones, concerning which we were naturally anxious to know whether we had been correctly informed. His "reply" was so vague as to compel us to be content with the guarded expression we used. It will be seen that the "reply" he has now given is not more satisfactory. It shows, indeed, that two of the three bones or fragments which we had been informed were sent by M. Bouton had reached Prof. Owen, had been rightly recognized by the former and "returned" by the latter; but it says nothing as to their "fate," which remains as "unknown to us" now as it was then. One thing is certain—that on search being made last August in the Museum at Port Louis, they were not forthcoming.

Fully appreciating the terms of general approbation in which Professor Owen has been pleased to mention our paper, the carelessness as to the fate of these particular specimens, whatever may have been their number or condition, which he imputes to my brother and myself is so great that I need not apologize for troubling you with the assurance that it has no foundation in fact.

I remain, Gentlemen,
Your obedient Servant,
ALFRED NEWTON.

Athenæum Club, Pall Mall,
January 10, 1872.

Tapirus villosus.

The British Museum has received from Mr. Buckley a series of specimens of different ages of *Tapirus villosus* from the Cordillera of Ecuador. The adult male is black, closely covered with rather short hair; the young is covered with abundance of longer hair; the young is marked with broad grey streaks more or less confluent or united into short grey lines. The nasal bone of the adult is elongate.—J. E. GRAY.

A Letter concerning Deep-Sea Dredgings, addressed to Prof. BENJAMIN PEIRCE, *Superintendent, United States Coast Survey.* By LOUIS AGASSIZ.

Cambridge, Mass., December 2, 1871.

MY DEAR FRIEND,—On the point of starting for the Deep-Sea Dredging-expedition, for which you have so fully provided, and which I trust may prove to be one of the best rewards for your devotion to the interests of the Coast Survey, I am desirous to leave in your hands a document which may be very compromising for me, but which I nevertheless am determined to write in the hope of showing within what limits natural history has advanced toward that point of maturity when science may anticipate the discovery of facts.

If there is, as I believe to be the case, a plan according to which the affinities among animals and the order of their succession in time were determined from the beginning, and if that plan is reflected in the mode of growth and in the geographical distribution of all living beings, or, in other words, if this world of ours is the work of intelligence and not merely the product of force and matter, the human mind, as a part of the whole, should so chime with it, that, from what is known, it may reach the unknown; and if this be so, the amount of information thus far gathered should, within the limits of errors which the imperfection of our knowledge renders unavoidable, be sufficient to foretell what we are likely to find in the deepest abysses of the sea, from which thus far nothing has been secured.

I will not undertake to lay down the line of argument upon which I base my statement, beyond what is suggested in the few words preceding—namely, that there is a correlation between the gradation of animals in the complication of their structure, their order of succession in geological times, their mode of development from the egg, and their geographical distribution upon the surface of the globe. If that be so, and if the animal world designed from the beginning has been the motive for the physical changes which our globe has undergone, and if, as I also believe to be the case, these changes have not been the cause of the diversity now observed among organized beings, then we may expect from the greater depth of the ocean representatives resembling those types of animals which were prominent in earlier geological periods, or bear a closer resemblance to younger stages of the higher members of the same types, or to the lower forms which take their place now-a-days. And to leave no doubt that I have a distinct perception of what I may anticipate, I make the following specific statement.

It lies in the very nature of these animals that, among Vertebrates, neither Mammalia nor Birds can exist in deep waters; and if any Reptiles exist there, it could only be such as are related to the extinct types of the Jurassic periods, the Ichthyosauri, Plesiosauri, and Pterodactyles; but even of these there is very little probability that any of their representatives are still alive. Among the Fishes, however, I expect to discover some marine representatives of the order of Ganoids of both the principal types known from the secondary zoological period, such as Lepidoids, Sauroids, Pycnodonts, Cœlacanths, Amioids; and *Glyptolepis*-like species may even be looked for. Among Selachians some new representatives of Cestraciontes or Hybodontes may be forthcoming, connecting the latter more closely to *Odontaspis*. I also look forward to finding species allied to *Corax*, or connecting this genus with *Notidanus*, perhaps also Jurassic-like forms. Among Chimæroids we may expect some new genera more closely related to the extinct types of that family than those now living. Among ordinary fishes I take it for granted that *Beryx*-genera may be added to our list, approaching perhaps *Acanus*, or rather *Sphenocephalus*; also types allied to *Istieus*, to *Anenchelum*, and to *Osmeroides*, *Elops*, and *Argentina*. *Dercetis* and *Blochius* may also come up. Species of all classes of the animal kingdom which have been very rarely met with by fishermen and naturalists are likely to be found in the deepest waters, in which neither hooks nor nets are generally lowered. Nothing is known concerning the greatest depth at which fishes may live. Upon this point I hope to obtain positive data.

The Mollusks will, no doubt, afford a rich harvest of novelties, among which some may be of the deepest zoological interest. It stands to reason that a variety of Nautiloid Cephalopods may be discovered when *Nautilus* proper and *Spirula* are so rarely found alive; and among new forms there may be those combining characters of *Argonauta* with features of *Nautilus*; some may even be coiled up like *Turrilites*. Belemnitic Squids would appear natural. Among Gasteropods we may look for high-spired *Natica*-like types, for representatives of *Actæonella*, *Avellana*, and the like—for small Volutoids of the tertiary and cretaceous types, for Rostellarias, even for Nerinæas, and more particularly for forms intermediate between *Firula* and *Cypræa*. Among Acephala I should expect a variety of Myacea approaching those described in my monographs of that family from the jurassic and cretaceous formations, such as *Ceromya*, *Corimya*, *Circomya*, *Goniomya*, *Myopsis*, &c., with *Panopæa* and *Pholadomya*, and others recalling perhaps also *Cardinia*, *Gresslya*, or Cardiacea more closely related to *Conocardium* than the living species, perhaps leading to *Opis*, or *Trigoniæ* of extinct types akin to *Myophoria*, with *Pachymya*, *Diceras*, *Grammisia*, *Inoceramus*, *Pterinea*, *Monotis*, and *Posidonia*. Rudistes should take the place of oysters; and the harvest of Brachiopods should be large.

Among Crustacea it is natural to suppose that genera may be discovered reminding us of *Eryon* or of *Pemphyx*, *Gampsonyx*, or some Amphipods, and Isopods aping still more closely the Trilobites than *Serolis*, or Limuloids approaching that extinct family. The classification, embryology, and order of succession of Echinoderms is now so well known that it is perhaps still more easy to anticipate the character of discoveries in this branch of the animal kingdom than in any other. I expect, confidently, to find Spatangoids approaching *Holaster*, *Toxaster*, *Ananchytes*, *Hemipneustes*, or *Metaporhinus*, and others akin to *Dysaster*, Echinolamps approaching *Pygurus*, Nucleolites tending to *Clypeus*, Galerites like *Pyrina* or *Globator*, &c. &c., and, again, Cidarids akin to *C. glandifera* and *clavigera*, with *Glypticus*-like species, and *Codiopsis*, *Cœlopleurus*, *Cyphosoma*, and *Salenia*.

Among Starfishes the types of *Goniaster* and *Luidia* are likely to prevail, with simple-rayed Euryaloid genera, and among Crinoids a variety of genera reminding us of *Pentremites*, *Marsupites*, *Pentacrinus*, *Apiocrinus*, and *Eugeniacrinus*.

The question of the affinities of Millepora will probably receive additional evidence; and genera connecting more closely the Rugosa and Tabulata with one another and with the Acalephs may be expected in the shape of branching Heliopores and the like.

With the monograph of Pourtales upon the deep-sea corals before me, it would be sheer pretence to say any thing concerning the prospect of discovering new representatives of this or that type. His tables point them out already.

But there is a subject of great interest likely to be elucidated by our investigation—the contrast of the deep-sea faunæ of the northern with those of the southern hemisphere. Judging from what

Australia has already brought us, we may expect to find that the animal world of the southern hemisphere has a more antique character—in the same way as North America may be contrasted with Europe, on the ground of the occurrence in the United States of animals and plants now living here, the types of which are only found fossil in Europe.

A few more words upon another subject. During the first three decades of this century, the scientific world believed that the erratic boulders which form so prominent a feature of the surface geology of Europe had been transported by currents arising from the rupture of the barriers of great lakes among the Alps, or started from the north by earthquake-waves.

Shepherds first started the idea that within the valleys of Switerland these huge boulders had been carried forward by glaciers; and Swiss geologists (Venetz and Charpentier foremost among them) very soon proved that this had been the case. This view, however, remained confined to the vicinity of the Alps in its application, until I suggested that the phenomenon might have a cosmic importance, which was proved when I discovered, in 1840, unmistakable traces of glaciers in Scotland, England, and Ireland, in regions which could have had no connexion whatever with the elevation of the Alps. Since that time the *glacial period* has been considered by geologists a fixed fact, whatever may have been the discrepancies among them as to the extent of these continental masses of ice, their origin, and their mode of action.

There is, however, one kind of evidence wanting to remove every possible doubt that the greater extension of glaciers in former ages was connected with cosmic changes in the physical condition of our globe. All the phenomena related to the glacial period must be found in the southern hemisphere with the same characteristic features as in the north, with this essential difference, that every thing must be reversed: that is, the trend of the glacial abrasion must be from the south northward; the lee side of abraded rocks must be on the north side of hills and mountain-ranges, and the boulders must have been derived from rocky exposures lying to the south of their present position. Whether this is so or not has not yet been ascertained by direct observation. I expect to find it so throughout the temperate and cold zones of the southern hemisphere, with the sole exception of the present glaciers of Tierra del Fuego and Patagonia, which may have transported boulders in every direction. Even in Europe, geologists have not yet sufficiently discriminated between local glaciers and the phenomena connected with their different degrees of successive retreat on the one hand, and the facts indicating the action of an expansive and continuous sheet of ice moving over the whole continent from north to south. Unquestionably the abrasion of the summits of the mountains of Great Britain, especially noticeable upon Schiehallion, is owing to the action of the great European ice-sheet during the maximum extension of the glacial phenomena in Europe, and has nothing to do with the local glaciers of the British Isles.

Among the facts already known from the southern hemisphere are the so-called rivers of stone of the Falkland Islands, which attracted the attention of Darwin during his cruise with Captain Fitzroy, and which have remained an enigma to this day. I believe it will not be difficult to explain their origin in the light of the glacial theory; and I fancy now they may turn out to be nothing but ground moraines, similar to the "Horsebacks" of Maine.

You may ask what the question of drift has to do with deep-sea dredging? The connexion is closer than may at first appear. If drift is not of glacial origin, but the product of marine currents, its formation at once becomes a matter for the Coast Survey to investigate; and I believe it will be found in the end that, so far from being accumulated by the sea, the drift of the lowlands of Patagonia has been worn away to its present extent by the continued encroachment of the ocean in the same manner as the northern shores of South America and of Brazil have been. . . . . .

Hoping some, at least, of my anticipations may prove true,

I remain, ever truly yours,

Louis Agassiz.

—*Bulletin of the Museum of Comparative Zoology at Harvard College, Cambridge, Mass.*, vol. iii. (Communicated by the Author.)

On the Fecundation of the Crayfish. By M. S. Chantran.

Hitherto we have been in uncertainty as to the question whether in the crayfish the fecundation of the ova takes place in the interior of the body of the female or on the outside of it. I think I have determined that it is on the outside that this phenomenon takes place; and the following are the conditions.

In my note read to the Academy on the 4th of July 1870 *, I stated that the male deposited his fecundating material, in the form of spermatophora, upon the plates of the caudal fan and on the plastron of the female, and that the period of the oviposition varied from the second to the forty-fifth day after the copulation.

When the moment of oviposition arrives, the female raises herself upon her feet, and then her abdominal appendages secrete for several hours a very viscous greyish mucus; then she lies upon her back, and bends her tail towards the opening of the oviducts, so as to form a sort of chamber, already noticed by Lereboullet, in which, during the following night, the ova are collected as they are expelled from the genital organs. In different females this expulsion lasts from one to two hours. The ova, which are always turned so as to present their whitish spot or cicatricula above, as if to receive more easily the influence of fecundation, are thus immersed in the greyish mucus, which in a manner binds the false legs and the margins and extremity of the tail to the thorax, and which assists in bounding the pouch or chamber above mentioned, in which a certain quantity of water is enclosed with the ova and the mucus. Immediately after oviposition we may detect in this mucus and water the presence of spermatozoids † precisely similar to those which are contained in

* See Ann. & Mag. Nat. Hist. ser. 4. vol. vi. p. 265.

† Here they are mixed with pale yellowish drops and a certain num-

the spermatophores attached to the plastron, and derived from them. These spermatozoids are thus in direct contact with the ova, and in the midst of the vehicle which facilitates their penetration. Fecundation, then, is accomplished in this chamber—that is to say, outside the genital organs of the female.

M. C. Robin, who has been kind enough to ascertain these facts with me, has also seen that the spermatozoids which are found in contact with the ova in the chamber which I have just described are similar to those seen in the genital organs of the males and to those in the spermatophores attached to the thorax. They are in the form of flattened cells, with 5–7 rigid immovable cilia starting from their contour, and with a barrel-shaped projection about their middle. During the first two days following the oviposition, these spermatozoids, which are very abundant around the ova and in the mucus, become spherical and pale, and remain motionless; in the following days they wither, and also become smaller, darker, and irregular. Lastly, when, after the fixation of the ova, the excess of the mucus has completely disappeared in consequence of the pressure exerted by the incessant contractions of the abdomen (which takes place in a variable period of from eight to ten days after the oviposition), those spermatophores which still remain attached to the plastron consist of small, white, coriaceous filaments, either isolated or mutually adherent; they no longer show any thing but a central cavity, in which the microscope reveals only a few more or less withered spermatozoids. The wall of these spermatophores retains its thickness, and remains, as before, composed of a concrete, striated, tenacious mucus.—*Comptes Rendus*, January 15, 1872, tome lxxiv. pp. 201, 202.

Baptisia perfoliata, *the Arrangement and Morphology of its Leaves.*

In a paper sent by Mr. Ravenel to Prof. Gray, and read by him at the last meeting of the American Association for the Advancement of Science, the character of the torsion of the stem by which the foliage on summer shoots becomes unilateral is explained. It had been hastily supposed by the present writer that the leaves were five-ranked, and became one-ranked by a continuous torsion of the stem. Mr. Ravenel points out that the phyllotaxis of the plant in question is really of the two-ranked order, which inspection of the growing shoots makes abundantly clear, and that they become one-ranked by the alternate twisting of the successive internodes right and left; *i. e.* one twists to the right, the next as much to the left, the next in the opposite direction, and so on, thus bringing the leaves into a vertical position all on one side of the horizontal branch. It occurred to Mr. Ravenel that this vertical position of the leaves was correlated with the remarkable alternate torsion of the axis—namely, that the leaves on the reclining branches were adjusting themselves so as to present their two faces as equally

ber of granulated rounded globules, isolated or united in little masses, which do not exist in the cavity of the spermatophores, where the spermatozoids alone are to be found.

as possible to the light, as is done by those of the compass plant in a different way, and that it was therefore probable that the stomata would be found to be as numerous on the upper face of the leaf as on the lower. A microscopic examination proved the correctness of Mr. Ravenel's conjecture; the stomata are about equally numerous on the two faces. Whether the leaves take a vertical position because the stomata occupy both surfaces, or whether the stomata are so distributed because the leaves stand edgewise to the zenith, is a question. The fact is, that the two are thus correlated, and such correlation is ordinarily essential to the well-being of the plant. It may be remarked, however, that the stomata do not manifestly appear until the leaf is pretty well developed, also that this distribution of the stomata is peculiar to the species in question; at least the leaves of *B. australis* and *B. leucantha*, which retain their horizontal position, are provided with stomata only on their lower face. The question next arises whether *B. perfoliata* really differs in its normal phyllotaxis from its congeners. We find that it does not, that in *B. australis*, *leucantha*, and *alba*, and in *B. perfoliata* likewise (these being all the species at present cultivated in the Cambridge Botanic Garden), the arrangement of the leaves at the base of the main stem is of the tristichous order, but that after the first or second cycle, especially on the branches, this changes to the distichous order. The difference between *B. perfoliata* and its congeners, therefore, is not in the normal arrangement of the leaves, but in the fusion of the axis and the distribution of the stomata, adapting the foliage to its vertical position.

The form of the leaves in *Baptisia perfoliata* is remarkably peculiar. Most of the species have trifoliate leaves and a pair of stipules; this has to all appearance a simple and entire perfoliate leaf and no stipules. It is, however, a natural supposition that the apparently simple leaf consists either of a pair of stipules, or of such stipules and a leaflet connate into a rounded disk. This supposition Mr. Ravenel has just now had the good fortune to verify, by finding some abnormal shoots of *B. perfoliata*, one of which is in our possession. Most of its leaves are cordate-clasping rather than perfoliate, and with or without a retuse or emarginate apex, some almost two-parted so as to represent pretty obviously a pair of stipules, and one of like conformation but with an obvious terminal leaflet in the sinus! Mr. Ravenel remarks that this is a manifest step toward his own *B. stipulacea*; but it hardly invalidates that species, although the inflorescence and legume of the two are quite alike.—Prof. Asa Gray in *Silliman's American Journal*, Dec. 1871.

On a new Micrometric Goniometer Eyepiece for the Microscope. By J. P. Southworth.

After a few experiments by Dr. H. T. Porter and myself, we have succeeded in making an eyepiece micrometer and goniometer which equal in accuracy and surpass in simplicity and cheapness any we have seen; and we have used those of some of the best makers in this country. The objection to the eyepiece micrometers in use is the want of boldness in the division-lines, which makes them fatiguing and hurtful to the eyes. To overcome this objection, we were led to experiments in making micrometers by the aid of photography, which have resulted in success. The steps of the process are these :—

1st. A scale of 100 heavy Indian-ink lines, about $\frac{1}{6}$ of an inch apart, are drawn on a dead white surface of Bristol board. The lines marking every ten divisions are 6 inches long and extend one inch each side of the scale; those marking every five divisions are 5 inches long, and extend half an inch beyond the scale; the remaining lines are 4 inches long.

2nd. By photographic process for copying engravings, a negative is taken, on which the scale equals about 2 inches in length, and is intensified by mercuric chloride and potassium cyanide.

3rd. With a copying-camera and lens for taking transparent positives for the magic lantern, a transparent positive of this negative is taken on micrometer glass, reducing the scale to the length of half an inch. In this the lines are $\frac{1}{200}$ of an inch apart. After intensifying, washing, and drying, a cover of thin glass is cemented on with Canadian balsam, and the slide cut to fit the slit in the micrometer eyepiece. It can also be mounted with a spring and micrometer screw, like Jackson's micrometer. In our micrometer the lines appear to stand out in relief, and are jet-black, while the spaces between them are translucent enough to admit of the accurate measurement of the details of minute algæ and fungi to the $\frac{1}{25000}$ of an inch.

Regarding the goniometer :—

1st. A circle, about 18 inches in diameter, is drawn with Indian ink, divided into degrees. The centre is indicated by a dot, and one diameter is drawn. Every five and ten degrees are indicated by longer lines than those indicating single degrees. Every ten degrees of each quadrant is numbered, from 0 to 90.

2nd. A negative 2 inches in diameter is taken by the process referred to above; and from this a transparent positive is taken on a circle or micrometer glass cut to fit the tube of the microscope. It is covered with a circle of thin glass cemented with balsam, and mounted to fit the tube at the focal point of a positive eyepiece. A cobweb is drawn across the diameter of the lower lens. When a crystal is to be measured, the stage is moved till the apex of the angle coincides with the centre of the goniometer, and the diameter with one side. The eyepiece is now turned till the cobweb crossing the diameter at the centre coincides with the other side of the angle. Now the number of degrees of the angle can be read at the circumference. The advantage of this over the ordinary microscopic goniometers is, that in ours the angles of the crystal and the degrees of the goniometer are on the same line of sight within the tube of the microscope, while in the ordinary goniometer the degrees are marked outside the tube. The photographic processes by which the above are made can be learned by consulting any of the standard works on photography, under the sections that treat of copying engravings and taking transparent positives.—*Silliman's American Journal*, Dec. 1871.

THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[FOURTH SERIES.]

No. 51. MARCH 1872.

XX.—*On the Horns, Viscera, and Muscles of the Giraffe; with a Record of the post mortem Examination of two Specimens killed by a fire.* By Dr. JAMES MURIE, F.L.S., F.G.S., &c.

[Plates VII. & VIII.]

THOSE desiring information respecting the vast amount of literature devoted to the genus *Camelopardalis* I would refer to the "Recherches Historiques, Zoologiques, Anatomiques et Paléontologiques sur la Girafe"*, by Profs. N. Joly and A. Lavocat of Toulouse. They not only give a chronological list from the time of Moses downwards, but in addition three plates, facsimiles from the ancient Egyptian monuments and old engravings; then follows a very good anatomical memoir.

The skeleton of this abnormal ruminant has been ably described and figured by many leading zoologists,—Pander and D'Alton, Rüppell, Cuvier, St. Hilaire, Owen, De Blainville, Gervais, &c. &c. The fullest accounts of the soft parts of its anatomy are in the original monograph of Prof. Owen † and the "Recherches" above spoken of; but upon certain parts of its internal structure Drs. Cobbold ‡ and Crisp § and others have supplied interesting observations.

Withal it may be asseverated that a quarter of a century ago, when comparative anatomy held less sway than at present, and in spite of the then scarcity of this great creature, its entire organization was much better worked out than that of many very common animals. Till recently a few points have been disputed, or at least opposing observations not harmo-

* Mém. de la Soc. des Sci. Nat. de Strasbourg, 1846, tome iii.

† Trans. Zool. Soc. vols. ii. & iii.

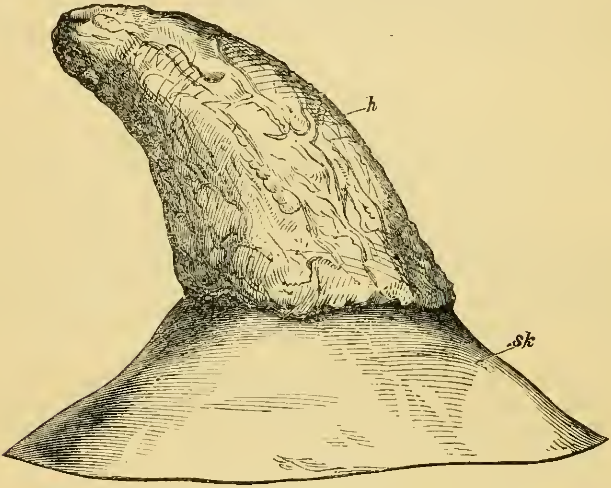
‡ Ann. Nat. Hist. ser. 2. vol. xiii. (1854) &c. § Proc. Zool. Soc. 1864.

niously adjusted, to effect which is one of the intents of this communication.

1. *Early and late Stages of Growth of the Lateral and Median Horns.*

All writers have been unanimous in according to the giraffe possession of two short elevations from the summit of the head, which in general have gone by the name of horns, though covered with hairy skin, like other parts of the body. To the early naturalists their nature was conjectural; but ultimately, when critically examined, their more or less solid bony structure became evident.

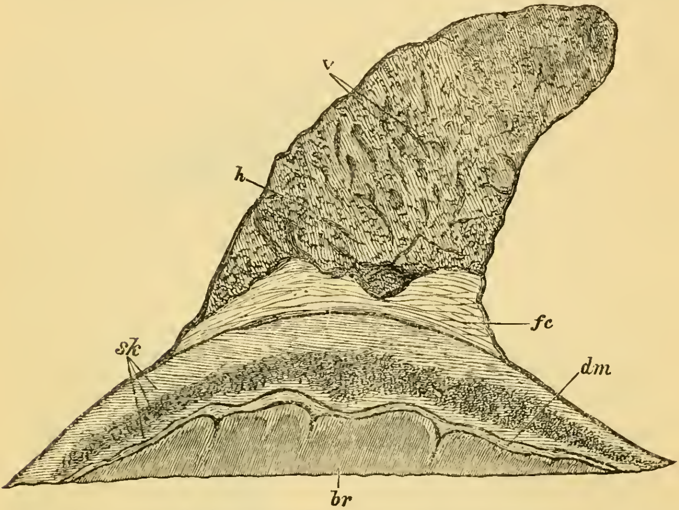
Fig. 1.



Sketch of the posterior horn of the young (2 months) male giraffe, seen from the outside and with the skin removed, of natural dimensions: *h*, the osseous elongation or horn; *sk*, portion of the skull.

The question then arose whether they were most like the antlers of deer or the core of the horns of antelopes, goats, and oxen, &c. Towards the former, objection was raised that they were persistent and not annually deciduous; towards the latter, that they were not porous or canaliculate, neither was their covering horny. Hence, separated from either class, the problem arose, what was the relation of the giraffe's horns to the bones beneath. A few naturalists promulgated the idea that the pair of posterior prominences were prolongations of the frontal bone; but more accurate observers detected that this was not the case. Although in very aged animals they are pretty firmly soldered to the cranium, still in younger specimens their junction by a tough base is looser, so that, on maceration, they drop off. This led to their being acknowledged as bony epiphyses, not apophyses of the cranium; and, moreover, their situation or implantation over the coronal suture excluded them virtually from the cervine, bovine, and and antilopine category. The best sectional views that I know of, showing the constitution of these appendages and their relation to the skull itself, are those of Owen* in an animal nine days old, and of Joly and Lavocat† in the adult.

Fig. 2.



A mesial longitudinal section of the same horn, its soft basal substance, and portions of the frontal bone and brain: *h*, osseous substance of the horn; *v*, vascular channels penetrating the same; *fc*, fibro-cartilaginous matrix; *sk*, the bony tables and diploë of the skull; *dm*, dura mater; *br*, brain.

So far the opinion of the majority tallies with the fact of the giraffe's pair of rear horns being primarily epiphysial, ultimately coalescing with the bone beneath, so that trace of separate origin is with difficulty recognized. It rests with me to place on record additional demonstrative evidence of the early relation of these horns to the skull in an animal two months old. The accompanying woodcuts (figs. 1 & 2) are quite as suggestive and more explanatory than long de-

* Trans. Zool. Soc. vol. iii. p. 26, pl. 2. fig. 4.

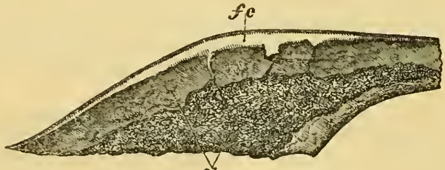
† *Op. cit.* pl. 9. figs. 1 & 2.

scription. The second clearly establishes intervention of fibro-cartilaginous matrix between the skull and the partially porous osseous substance of the horn. The first brings out the rough irregularly çhannelled exterior.

The existence of a third or median horn in the giraffe has likewise been a subject of controversy among anatomists. By some this peculiar middle frontal elevation has been regarded as but an osseous eminence, and not representative of an abnormally placed additional horn. Other authorities have not hesitated to class it as analogous to the rearmost pair, though developed over the sagittal suture, and short and squat. My colleague Dr. Cobbold * has been at some pains to collate the statements of several excellent zoologists and anatomists, which sustain his independent observation—viz. that the anterior median prominence of the giraffe's skull, situate at the junction of the nasals and prefrontals and over the sagittal suture, is a separate independent structure, analogous therefore to the so-called hinder horns.

The proofs of its separate ossification and, therefore, epiphysial nature, which I advance in support of those who maintain such a view, rest chiefly on two specimens—one a section of the skull of the young animal already referred to (*vide infrà*), the other a completely ossified cap removed from the cranium of an adult. In the calf stage, complete absence of bone or germ of ossific centre is indubitable, a thickening of the periosteum alone denoting the future position of the subsidiary piece in question. My sketch from the fresh specimen (fig. 3), whilst substantiating Dr. Cobbold's observation on the immature giraffe, more clearly displays the structural condition of the parts than in his diagram (*l. c.* p. 15).

Fig. 3.



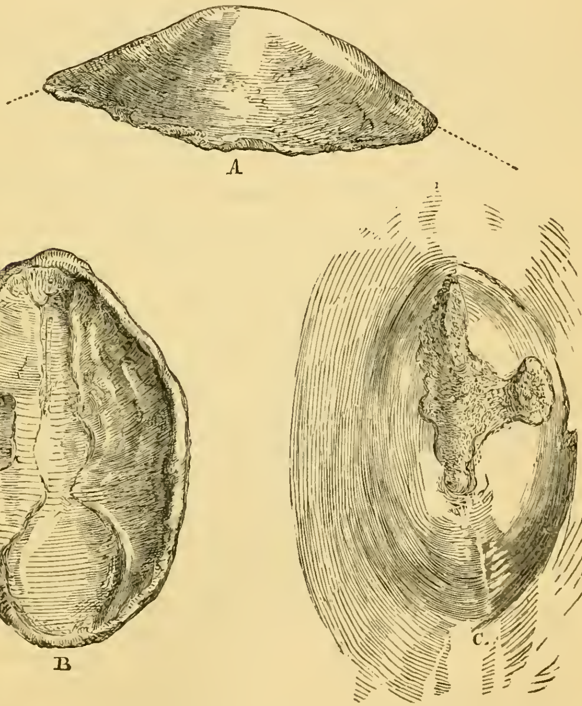
Longitudinal vertical section of the mid fronto-cranial bone and superincumbent fibro-periosteal covering of the young ♂ giraffe, nat. size. It illustrates the rudiment or basal matrix of the as yet undeveloped third horn: *fc*, fibroid or semicartilaginous periosteal thickening upon which the future so-called horn is established; *sk*, portion of the skull just in front of the brain.

* The Intellectual Observer, Aug. 1862, p. 12, with a plate and woodcut.

In my second example, from a female eleven and a half years old, the so-called third horn was a distinct cap of bony material fixed to the fronto-nasal elevation and lying directly over the longitudinal suture. It was oval in figure, convex above and concave below; and its anterior edge reached to about 6 lines behind the most forward portion of the nasal elevation. The cap accurately fitted the skull-contour, being adherent thereto by a dense cartilaginous-like periosteum, 0·15 inch at its thickest part. The representations A and B in fig. 4 give the precise shape of the piece as seen in profile and inferiorly.

Considerable force was required to remove it, so adherent was the fibro-plastic material to the skull. In effecting this,

Fig. 4.



Separated third or median horn of the ♀ giraffe, 11 years 7 months old, in two aspects and of natural size. A, right lateral view; the dotted lines indicate the skull-contour; B, its interior; C, sketch of portion of the frontal bone wherefrom the third horn springs. The triradiate roughened exostosis corresponds to the hollows within the cap, B.

part of the periosteum on each side of the cranial suture was torn off along with it, and the bone beneath partially exposed. I did not notice any special vascular structures at the points of union. From the skull, however, there projected a triradiate rough exostosis, which was adapted to corresponding hollows in the interior of the osseous cap or horn (*vide* C and B, fig. 4). I have found the respective sizes of the third horn in aged animals of the two sexes to be, in inches and decimals:—

	♂	♀
Extreme length	5	2·2.
„ breadth	3	1·3.
Greatest height	3	0·6.

2. *The Ligamentum nuchæ.*

For several reasons this most remarkable body of contractile tissue in the giraffe has been looked upon with an eye of wonder as well as curiosity. Its immense length, volume, and resiliency give it a conspicuous character, added to which it is unique in the ultimate fibre being striated.

In 1846 my late valued friend Prof. Quekett announced the discovery* of the above-mentioned microscopical structure, carefully noting (as was his wont) that whilst the outer portion of the ligament possessed the peculiarity in question, yet fibres from the centre were deficient in transverse markings, and, on the contrary, exhibited an occasional linear stripe, as if tubular. It has since been asserted by other observers (Dr. Cobbold †, I believe, for one) that the ligamentum nuchæ of *Camelopardalis* is deficient in the attribute of transverse striæ. For my own part, I can say that, examined in the fresh condition, the ligament does contain the varieties of tissue demonstrated by Quekett. But I may also mention another curious circumstance—to wit, that having had an opportunity of testing the matter at issue by re-examination of a portion of Quekett's original ligament ‡, I was surprised to find no indication of striated fibres whatsoever. Might one infer therefrom that long preservation in spirit destroys the said character of this yellow elastic tissue? and does the un-

* Trans. Microsc. Soc. of Lond. vol. iii. p. 45, pl. x. figs. 3, 4, striate, and figs. 5, 6, non-striate condition.

† Paper quoted, in the 'Annals' for 1854, p. 488.

‡ On the demise of the worthy Professor, a great many of his specimens from which sections had been cut passed into the hands of Mr. Norman, the microscopist, to whom I am indebted for the chance of investigating the point, besides his testimony as to correctness.

equal distribution of striate and non-striate fibrillæ in the ligament explain the (supposed rather than real) discrepancy of competent observers?

En passant I may refer to figs. 6 & 7, Pl. VIII. as illustrating transverse sections of the giraffe's ligamentum nuchæ, respectively from the shoulder and neck. These are of natural dimensions, and from the fresh subject, the peculiarities of the pieces being wide distinction in size and shape.

3. *Observations respecting the Viscera.*

The thoracic organs in the several specimens coming under my scalpel quite agreed with the published descriptions of such—this even to the disposition of the fleshy columns in the ventricles of the heart*. In the juvenile male there was no cardiac ossicle present, as Dr. Crisp† has already stated was the case in the young creature dissected by him. This fact helps to bear out the general rule applicable to ruminants; viz. the bony structure developed at the base of the heart is coincident with the age of the individual; in other words, its full size is contemporaneous with the fully adult condition.

The abdominal viscera, examined in each case with some care, corroborated in the main what has been noted by previous observers. I shall mention such variation as seems worthy of record.

There was no trace of a gall-bladder in any of the animals examined by me. Indeed notification of only two instances of such a viscus in the giraffe, met with by Gordon ‡ and Owen §, is to be found in the anatomical history of this animal—a weighty argument in support of Owen's suggestion that its absence is the rule or normal condition. As to the liver, it weighed 3 lbs. 2½ ozs. in the male calf, and 11 lbs. 10 ozs. in the mother, in the former the dimensions being 11 inches by 8½ inches, and in the latter 17 inches by 14 inches in diameter, and 3 inches thick—thus corresponding closer to Crisp's than to Owen's or Cobbold's data.

With regard to the length of the alimentary canal, which has been made the subject of dissentient remarks by Dr. Crisp‖ *versus* Owen, Joly, and Lavocat, it may not be out of place for me to register my observations, and, in comparing notes, see wherein discrepancies lie.

* Owen, *l. c.* p. 229. † Proc. Zool. Soc. 1864, p. 269.

‡ Buffon, Hist. Nat. Supp. t. vii. p. 348. § *Loc. cit.* p. 228.

‖ Proc. Zool. Soc. 1864, p. 64.

Table containing Proportional Measurements of three out of four Animals examined by me.

	♂ of 2 months.		♀ 11 years 7 months.		♂ 21 years 3 months.	
	ft.	in.	ft.	in.	ft.	in.
Length of the œsophagus	5	0	6	2	8	4
„ „ four stomachs..	2	3	5	9	6	8
„ „ small intestines	82	3	130	6	132	8
„ „ large intestines	19	5	83	0	92	4
Total length of alimentary tract	108	11	225	5	240	0

The length of the cæcum, which has been included with the large intestines in the above, was 19, 21, and 18 inches in the three respectively.

As far as I can read the evidence, the animal dissected by Joly and Lavocat, which had an alimentary tract equivalent to 211 English feet, appears to offer a fair sample; or it may be very slightly under the average of what obtains in the adult but not aged giraffe. Owen's admeasurements of a female and male about three years old, and a male of four years old, taken *seriatim*, yield 136 feet 4 inches, 133, and 124 feet. Crisp gives 254 feet in a female of eighteen years, 209 feet in a young male, and 107 feet 11 inches in a specimen two months old, besides acquiescing in my measurements of the ♀ (*vide* tab.), =225 feet 5 inches*. It is due moreover to Prof. Owen to state that he does not include in his calculations the prolongation of the œsophagus and four stomachs.

Now, if we take into consideration the records of measurements of the *primæ viæ* of both young and old animals given by the several observers, including the present table, it follows that the extent of the alimentary canal of the giraffe (as verily that of other mammals) is in direct and relative proportion to their age—a fact which in most respects would modify any charge of error against either party.

To the published accounts of the generative organs in both sexes I can only annotate as subjoined. Ovary 2·7 inches long by 1 inch broad, and as much thick. A dark-coloured corpus luteum, 0·5 inch in diameter, lay imbedded in the pinkish stroma of the right ovarium; its edge had just reached the free surface of the latter. The remains of a similar corpus luteum, lately burst, existed in the left ovarium; and close beside it there was a second, smaller one, 0·3 inch in diameter. The vagina answered to Owen's description; but the distance

* See Crisp's second contribution, Proc. Zool. Soc. 1866, p. 564.

from the urethra to the os tincæ was about 9, and the diameter 4·7 inches. Uterus 10 inches long. Each cornu was relatively wide, and a foot long following the curve. From the slightly enlarged and wavy appearance of the cotyledons, and the increased vascularity of the right horn, I believe gestation had occurred on that side. The sacculated condition of the broad ligament lodging the ovarium was well displayed.

4. *Muscles, their adaptation to the long flexible neck and slender limbs**.

Professor Owen's summary of the more important features of the myology, and MM. Joly and Lavocat's list of head and pharyngo-laryngeal muscles, with fair survey of those of the body and legs, render it unnecessary for me to describe the whole of the musculo-tendinous structures, which nevertheless I minutely dissected. In the English memoir, excepting the under surface of the tongue, no figures of the fleshy parts are given. Whilst three myological plates accompany the Strasbourg "Recherches," the views are of such a diversified kind, regionally separate, that one fails to comprehend the beautiful muscular symmetry bestowed upon this towering ruminant. My object, therefore, is, by a rapid revision, to indorse and supplement the labours of these authors, and by a carefully executed profile drawing of the animal in life-like attitude, with some additional sketches, to depict such striking myological peculiarities as heretofore have not been illustrated.

The function of the cephalo-humeral in the giraffe is elevation and protraction of the fore limb; or it may be that, when the shoulder and leg are fixed, the strain can be applied to the lower moiety of the neck, and thus drag it downwards. As the French authors very neatly put it, "Cette disposition défavorable à l'action musculaire, est tout en faveur de la rapidité et de l'étendue des mouvements, par suite de la longueur des bras de levier sollicités." I can corroborate their account of the attachments, viz. its being fixed to the processes on the sides of the fifth and sixth vertebræ of the neck, whence from being narrow it broadens into a great sheet covering the

* I take this opportunity of expressing my admiration of some myological and other casts, coloured and of the natural size, in the anatomical galleries of the Jardin des Plantes, Paris. I may cite:—three layers of the neck-muscles of the giraffe; intestines, cæcum, &c. of the same animal; a varied myological and visceral series of the hippopotamus (classic, as being the original of Gratiolet's splendid monograph); the same of the chimpanzee, sheep, horse, kangaroo, jaguar, besides many other vascular and glandular peculiarities of the elephant, llama, ostrich, &c.,—all testimony to that vigorous zeal for anatomy so characteristic of the French school.

shoulder sidewards and in front, with an insertion into the humerus and sternumwards. I may add, however, that superiorly, where moderately tendinous, its short bifurcation embraces a portion of the intertransversales cervicis; lower down, at the root of the neck, it is thick, massive, and fleshy, again inferiorly thinning into glistening aponeurosis stretching as a wide semilune in the axillary region, and, along with the pectoralis major, being finally inserted into the anterior middle line of the humeral shaft, nearly its whole length. In the long-necked alpaca I have found this muscle well nigh identical, excepting less volume over the shoulder; but in sheep and oxen it is duplex and proceeds to the skull.

My dissections confirm the Toulouse Professors' assertion of there being but a single trapezius, as in cattle and the Camelidæ. Owen describes a double portion, the first of which undoubtedly applies to the cephalo-humeral—a view which of late* he seems inclined to admit. In the giraffe the trapezius barely passes into the neck, and is even still shorter in *Auchenia pacos*. These two forms therefore differ from the generality of heavy-necked Ruminantia and Perissodactyla, where it stretches forwards very considerably.

Between our English anatomist and the two French savants there is a further difference of opinion concerning the presence of a rhomboideus. The latter deny its existence. My own dissection of several specimens substantiates Owen's statement; as he observes, it is remarkable for its shortness. In one old fleshy male I made a memorandum of its being much stronger than as figured in Pl. VII. In this case the spinal origin reached from about the seventh cervical to the third dorsal vertebra, or equivalent to 8 inches measured along the ligamentum nuchæ.

The elevation of the shoulders causes the fibres of the latissimus dorsi to be more obliquely set upwards than in ordinary ruminants, the diagonal line of force corresponding. It forms serrations with the four hindmost ribs, and goes to the humerus along with the teres major. The only peculiarity worth mentioning in the sacro-lumbalis and longissimus dorsi is that the latter massive muscle appears double, the upper half being tendinous. The spinalis dorsi has unusual width, on account of the length of the dorsal spines; the ligamentum nuchæ partially overlaps it for six or seven of the dorsal vertebræ. As the semispinalis reaches the neck (s. colli), it becomes much reduced in bulk, corresponding therefore to the nuchal slenderness—its highest tendon, as in other mammals, being

* Anat. and Physiol. of Vertebrates, vol. iii. p. 42.

fastened to the axis, but here to the salient posterior end. The interspinales, intertransversales, and rotatores are each fleshy.

Prof. Owen has not failed to recognize, as conducing to the elastic spring of the fore part of the trunk on its bony columns, how it is slung, through the serratus magnus, to the large terminal scapular cartilage, besides a third of the bone itself. There are serrations to the eleven anterior costæ; the two rearmost are the highest; and the first is attached to the vertebral process of the head of the first rib.

Each of the writers mentioned calls attention to the powerful development of the scaleni. Owen recognizes four, and Joly and Lavocat three masses. I have found the undermentioned disposition:—The s. anticus arises from the transverse processes of the third and fourth cervical vertebræ, and with two thick equal-sized bellies proceeds down the neck, and is inserted singly, but muscularly, into the first rib. What I consider the s. medius has origin by a very strong tendon from the transverse process of the last cervical vertebra. It divides as it goes to the ribs into two strong muscular bellies. The deepest and dorsal one is inserted into the first rib about its middle; the other, longer belly reaches much lower down, being fastened by a tendon upon both the first and second ribs. The s. tertius (or s. posticus) is a wider, flatter muscle than the preceding, and, springing from the sixth cervical, is inserted into the articular end of the first rib by a broadish bifid insertion. Superficial to this, and in a measure seeming almost a portion of the serratus magnus, is a little round fusiform muscle partly attached to the first rib. Above, it terminates in a long tendon, which goes to the transverse process of the sixth cervical. I presume this offshoot of the s. tertius is the same which Gurlt* terms cervicalis descendens in *Ovis*.

Under the name of "transversal des côtes (costo-sternal)" a fair-sized muscle is mentioned which I also have found and take to be what now goes by the denomination of supracostal. It simulates continuance of the scalenus anticus, but commences by tendon at the first rib, going on fleshy to the third, and by aponeurosis to the sixth. Whilst the levator anguli scapulæ seems but a continuation of the serratus magnus, yet, as Owen notes in the neck, it has a trifid division. The lowest portion, springing from the seventh cervical, is fleshiest and most massive; the two other slips, with tendons of origin from the fifth and sixth vertebræ, conform to the upward thinning of the neck.

The rest of the nuchal muscles of the giraffe are a perfect

* Anat. Abbild. der Haus-Säugethiere, pl. 33. fig. 3.

model of adaptation to purpose; and, just as in the long thin legs, tendons replace flesh where power has to be transmitted with at the same time diminution of volume in the member. In the neck, however, another function has to be subserved, viz. graceful flexion of this seven-jointed piece of the spine. To accommodate, then, all wants, and still retain the ruminant type, the ordinary superficial muscular layer appears to be absent, and the deeper ones cut into bands ending in long tendons—a method of subdivision which combines concentration of force, tenuity of figure, and pliancy.

What Joly and Lavocat name splenius (*l. c.* p. 92) I regard as trachelo-mastoid, their complexus as a biventer cervicis. The splenius is wanting, and the complexus a very diminutive muscle. The longus colli has normal attachments, but is extraordinarily subdivided into what seem to be separate muscles (*vide* Pl. VII. fig. 3 & Pl. VIII. fig. 4).

The singular felicity with which Prof. Owen describes and comments on the very long ribbon-like muscles passing between the sternum, hyoid bone, and thyroid cartilage requires no commentary. Neither do the short fleshy bundles of the hyo-laryngeal apparatus, fauces, and tongue. Joly and Lavocat give a full list of those of the eye, ear, and face, which correspond in nearly every particular with those of other ruminants, notably the slender-jawed deer and antelope tribe.

The majority of the muscles of the fore leg are explicitly treated in the Strasbourg memoirs; my addenda, then, have reference to moot points or imply variation. In one old male I observed a somewhat duplex condition of the deltoid. Besides the usual elongate diamond-shaped fleshy belly, a broad expanse of tendon covered the infrascapular region, and, inferiorly fleshy, was inserted into the humeral neck behind the first division.

The muscle denominated triceps has five divisions in the giraffe, according to the Toulouse Professors—their first head, "le long extenseur de l'avant-bras (long scapulo-olécranien)" unquestionably answering to what is now ordinarily known as the dorso-epitrochlear, being derivative of the latissimus dorsi minus scapular origin.

Teres major and minor are mentioned as being united; but I have found them tolerably distinct. The former, of goodly size, joins the latissimus dorsi four inches from the humerus, the two passing underneath the fibres of the short coracobrachialis. The t. minor, well defined, has an insertion outside the humeral head into a pit above where the deltoid is fixed, the second head of triceps passing underneath it. The supra- and infraspinati are typical of the Ruminantia, each full and fleshy-bodied; the first mentioned, besides its bifid tendinous insertion along with the infraspinatus on the external humeral tuberosity, has a division almost worthy of specific identification. In the sea-lion (*Otaria*)*, where even greater differentiation obtains, I have named it, from position, episubscapularis. In the giraffe (*vide* Pl. VIII. fig. 5, *Eps*) a view looking down on the upper rim of the scapula shows that the muscular fibres of the supraspinatus towards the glenoideum divaricate, and the abnormal portion passes inside the tendon of the biceps; overlying subscapularis and coraco-brachialis, it is inserted by tendon upon the internal tuberosity of the humerus.

I concur with the French authors in their interpretation of the pectorales, limited to p. major and p. minor.

The biceps, as the authors of the joint memoir note, is inserted by tendinous-like fascia into the ulnar neck, but besides sends an aponeurotic expanse, partially intermingled with the supinator longus, to the proximal end of the cannon bone, equivalent to the fascia of the forearm in man. I likewise agree in there being a double-bellied coraco-brachialis, the longer fusiform portion reaching almost to the intercondyloid fossa, the shorter flatter division proceeding only to the humeral neck. The brachialis anticus has an ulnar insertion immediately below the biceps.

I need not enlarge on the remaining long extensors and flexors of the fore limb, which MM. Joly and Lavocat have already accurately described.

As regards the abdominal parietes, these, *cæteris paribus*, are relatively short; for the great depth and capacious enclosure by the ribs limit considerably the loose abdominal area. The form of the body of the giraffe is indeed remarkable in this respect. Whilst a certain amount of superficial strong elastic fascia obtains, lending support to the fleshy wall, this falls far short of the development attained in the Pachydermata.

In the male giraffe, as in the domestic bull, the "musculus præputialis" has a considerable expanse of fleshy fibres.

The psoas magnus and p. parvus are separate and well represented. Iliacus double, part springing from the iliac fossa and part from the first sacral vertebræ, the psoas magnus tendon and lumbar plexus of nerves coming between.

The pelvo-caudal muscles are tolerably well represented (Pl. VII. fig. 3). What appears to be the ilio-coccygeus (or perhaps inner division of ischio-coccygeus) is a broadish fleshy plane which springs from the inside of the pelvis close

* Trans. Zool. Soc. vol. vii. p. 557.

to the ischial spine and forwards to behind the acetabulum; crossing to the tail, it is attached laterally and below to the first and second caudals. Superficial to it is the ischio-coccygeus, about equal in volume. This, which Joly and Lavocat * say is absent, I find comes by a tendinous origin from the great ischiatic ligament, and, proceeding inwards with considerable obliquity, is inserted into the transverse processes of the three anterior caudal vertebræ. The infra- and sacro-coccygeus, the levator caudæ internus and externus respectively cover the under and upper surfaces of the sacro-coccygeal bones, each vertebra being supplied by tendon, as is usual. The intertransversarii diminish in the ratio of the size of the bones.

The musculo-tendinous levers of the hind limb have not been touched on by Owen; but this deficiency is amply compensated by the foreign workers.

The tensor vaginæ femoris has a considerable mass of muscular fibres above; but below these merge into a very strong elastic fascia lata, covering the groin and thigh to the knee-joint.

In the pelvic region of apes the designation "scansorius" has been applied to one of the muscles, as indicative of its supposed influence in their climbing movements. It appears, however, to be represented in the giraffe by an almost distinct anterior portion of the pyriformis. It arises from the middle of the anterior edge of the ilium, and is inserted outside the great trochanter, lower than the gluteus minimus and g. medius attachments.

Joly and Lavocat say, "Le grêle antérieur [gracilis] des monodactyles n'existe pas." I did not note its presence. As they indicate rather than describe, a sartorius and pectineus are both well represented, the latter being a short thickish muscle. The rectus femoris is very thick indeed, and single in origin. The vastus externus exceeds it in volume, being literally of immense proportion, whilst the v. internus is only half the size of the latter. The crureus is both fleshy and strong; but its most noteworthy point is that the outer portion rolls round the femur, and in this presents a striking resemblance to the brachialis anticus of the fore limb—a fact suggesting their homology. I found two adductores; the French anatomists give only one; for their "long adducteur de la jambe" is veritably the sartorius. My ad. longus springs fleshy from the brim of the pelvis, passes under Poupart's ligament, and is fixed to the middle third of the femoral shaft. The ad. magnus, bulkier, comes from the ascending horizontal rami pubis and proceeds the whole length of the linea aspera.

* *Loc. cit.* p. 95.

A portion of the obturator internus appears to pass through the obturator foramen, therefore resembling in a degree what Mr. Mivart and I found in *Hyrax**, wherein we named a muscle which pierced the foramen obturator tertius.

The biceps femoris is double-headed and very fleshy; its anterior portion has coarse fibres, directed obliquely forwards and downwards. The semimembranosus is another very bulky muscle, the semitendinosus less so. In an old male the gastrocnemius had attained great fulness of proportion; both heads were strongly muscular, particularly the inner one. The Toulouse Professors remark that the plantaris is absent; but in the animal last spoken of I certainly met with it. Arising by a short tendon from the outer side of the linea aspera, its muscular belly terminates above the middle of the tibia. The continuation of its lower tendon winds round the inner side of the gastrocnemius, and, superficial to it at the os calcis, spreads out and has an attachment on each side.

The inferior tendon of the tibialis anticus is relatively very thick; and the extensor communis digitorum I observed to be double-bellied, these lying in close apposition. MM. Joly and Lavocat also mention two muscles; but, as they say, one "est l'extenseur propre du doigt interne," a muscle (the ex. long. pollicis) which I met with independent of the duality of belly above spoken of. They allude to but one peronæus: I satisfied myself of there being two, the smaller being situated most anteriorly. The disposition of the other flexors of the leg and foot corresponded pretty well with the description given by the authors of the "Recherches." Their remarks upon the mechanism of action of the leg-muscles and tendons are very appropriate.

5. *Autopsy of two Animals killed through a fire.*

A few years ago a fire accidentally broke out at night in the giraffe-house of the Zoological Gardens. Three animals were occupants—an old male, and a female with her young about two months old. It was in the stall of the latter that combustion had set up, their bedding of straw and part of the boards being consumed before attention was drawn to the casualty. When entered, the atmosphere of the building was stifling through smoke. The male giraffe was got out safely to the adjoining yard; but the young one and her dam succumbed speedily amongst the smoky fumes and smouldering embers of the scorching straw. As no record of the autopsy has hitherto been published, it therefore forms a fit appendix to the present anatomical communication.

* Proc. Zool. Soc. 1865, p. 348.

The following appearances were noted on examination of the dead bodies of the two animals sixteen hours after the accident.

In the old female, during the short interval which had elapsed after death, the abdomen had become immensely swollen, in fact almost incredibly distended, by the evolution of gaseous material. The tongue protruded considerably out of the mouth, and was partially discoloured by fragments of charred straw. The eyeballs appeared as if starting out of their sockets, and were intensely bloodshot. There was protrusion and puffiness of the rectum and external organs of generation; and these parts exhibited signs of incipient decomposition, although the weather was agreeable and cool.

The hair on the right side of the body, that on which the animal had fallen, was slightly singed. All four limbs were in a similar condition; but the main part of the left side of the body and the neck were scarcely superficially injured.

On making an incision into the abdomen, an enormous volume of horribly smelling fœtid gas escaped: this came partly from the general visceral cavity, and partly from the paunch, which latter was perforated when the outer parietes were transfixed.

All the digestive cavities contained more or less semidigested food; and the intestines were also abundantly filled with fæcal substances. The animal had consumed its evening meal just previously to the fatal accident; and this circumstance, along with the manner of death, sufficiently accounted for the rapid decomposition of the tissues.

The liver and spleen were gorged with blood; both were dark-coloured and unusually soft. Decomposition of their tissues had already commenced. Though firmer than the above, the kidneys were far softer than natural, and intensely congested. The right cavities of the heart and the great veins leading thereto were all distended with black sanguineous clots. Lungs filled with bloody fluid and much bad-smelling gas. The submucous tissue of the bronchi and trachea were everywhere injected; but the latter organ, at its upper end and all around the region of the glottis, was very much infiltrated with discoloured bloody-tinged fluid.

The entire venous system was unnaturally injected; but on the skin being taken off, a still more remarkable feature was noticed, viz. the surface of the flesh streamed with blood oozing everywhere from the lacerated venous oscula.

In the young male, whilst the body exteriorly had suffered greater damage from the burning straw, the death-throes had evidently been of a less violent kind. The skin of the body was more singed throughout than that of the mother; but the legs and especially the hoofs were very severely injured; of the latter, the right hind one was quite loose, from the intense heat. The tongue did not protrude; but the eyes were bloodshot and staring.

There was less swelling of the abdominal cavity than in the older animal; and the viscera of the thorax and abdomen, though gorged, contained but a moderate quantity of effused blood. The submucous tissue around the glottis and trachea did not exhibit such an amount of infiltration. In the first and fourth stomachs, milk, partly curdled, existed in plenty.

The sum of the morbid appearances bore testimony to the fact that death in each case had resulted from asphyxia, hastened doubtless by the shock and pain endured from the burning straw beneath them.

6. *Conclusions.*

The gist of the present paper, then, when put in the form of propositions, resolves itself somewhat as follows:—

1. Agreement with those who look upon the posterior pair of bony pedicels on the summit of the giraffe-skull as extraneous ossific centres adherent primarily in the manner of epiphyses.

2. Concurrence in testimony of the naso-frontal eminence being also epiphysial, developed after the same fashion, and therefore identical in nature with the posterior bony elevations.

3. If the term horn holds good, then the giraffe is tricorned. But zoologists are divided in their opinions respecting the precise homology of the said appendages in relation to other ruminants. De Blainville * regarded them as equivalent to the deer's pedicels; and I infer from what Is. Geoffroy Saint-Hilaire † says, that he looked upon them as representatives of the horn-cores in the Bovidæ. Dr. Gray's definition ‡ draws them towards the latter; yet he justly appreciates difference. Withal, is it not possible that his fourfold separation of "coleocera," "komecera," "dermocera," and "epochocera," distinguishing respectively the Bovidæ, Antilocapridæ, Giraffidæ, and Cervidæ, may be but textural shades of kind of but one organic homologue? Pedicel, core, and osseous epiphysis would then stand in unison, and antler and horn (bony, corneous, or hairy) present identity. In all ruminants, then, whether less or more developed, the osseous base necessarily would be

* Comptes Rendus de l'Institut, 1837. † *Ibid.* p. 55.
‡ Ann. & Mag. Nat. Hist. 1866, vol. xviii. p. 326.

equally persistent, the superficial appendage or covering deciduous within narrow or wider limits. Do not the fossil Ruminantia reveal forms of intermediance which fill many an hiatus of our apparently trenchantly separate living fauna?

4. That the ligamentum nuchæ is composed of both transversely striped and non-striate fibres, unequally distributed; and that there is a probability of the former losing their characteristic differentiation when long preserved in spirit.

5. That the discrepancies of length in the alimentary canal are explicable on the grounds of age and sex; and the presence of a gall-bladder is of such unfrequent occurrence that it may be classed as an anomaly.

6. The muscles of the limbs and body closely assimilate to those of Ruminantia generally; but those of the neck and front of the shoulder present modifications in harmony with or adapting them to the exigencies of a long slender neck, &c.

EXPLANATION OF THE PLATES.

Plate VII.

Fig. 1. Upper surface of the skull, with the pericranium on it, of the old female giraffe, seen somewhat in front, and showing the relative position of the three horns: 3, the anterior median one.

Fig. 2. Side view of pelvic bones and tail-muscles: *l*, ischiatic ligament; *Ilc*, ilio-coccygeus; *Isc*, ischio-coccygeus; *Sc*, sacro-coccygeus; *Lce* & *i*, levator caudæ externus and internus.

Fig. 3. Profile of the giraffe in the attitude of walking, designed to show a dissection of the upper muscular layer throughout the body, neck, and limbs, in the natural position. Lettering as follows:—*Z*, zygomaticus; *Bu*, buccinator; *Ma*, masseter; *Lsp*, levator superioris proprius &c.; *Cn*, compressor nasi; *Pgl*, parotid gland; *Co*, complexus; *Oi*, obliquus internus; *Tms*, trachelo-mastoid; *ln*, ligamentum nuchæ; *Las*, levator anguli scapulæ; *Stm*, sterno-mastoid (or s.-maxillaris); *Mh*, mylohyoid &c.; *a*+*v*, carotid artery and vein; *Itc*, intertransversalis cervicis; *tr*, trachea; *lc*, longus colli; *Sh*, sterno-hyoid; *Ch*, *ch**, cephalo-humeral; *Tz*, trapezius; *Rh*, rhomboideus; *Lad*, latissimus dorsi; *Dep*, dorsi epitrochlearis; T^1, T^2, T^3, triceps; *Is*, infraspinatus; *D*, deltoid; *Sl*, supinator longus, and *Ecr*, extensor carpi radialis; *Pma*, pectoralis major; *Ba*, brachialis anticus; *P. lo*, palmaris longus; *Fcr*, flexor carpi radialis; *Fcu*, flex. carpi ulnaris; *Fs & pd*, flexor sublimis et profundus digitorum; *Ecd*, extensor communis digitorum; *Abp*, abductor pollicis; *Ecu*, ext. carp. ulnaris; *Eo*, external oblique; *Tvf*, tensor vaginæ femoris; *Gmx*, gluteus maximus; *Bf*, biceps femoris; *Ve*, vastus externus; *Ga*, gastrocnemius; *So*, soleus; *Fld*, flex. long. dig.; *Pb*, peronæus brevis; *Pl*, peronæus longus; *Eld*, ext. long. dig.; *Ta*, tibialis anticus; *Sm*, semimembranosus; *Po*, popliteus; *Vi* & *Rf*, vastus internus and rectus femoris; *Sa*, sartorius; *Admg*, adductor magnus.

Plate VIII.

Fig. 4. Reduced sketch of the deep muscles on the lower surface of the neck, showing how they adapt themselves to the elongate character of the vertebræ and slender nuchal region generally. The numerals I. to VII. are placed opposite the cervical vertebræ. *R. a. ma*, rectus anticus major of right side; *R. a. mi*, rectus anticus minor of left side; *lc*, longus colli; *m*, muscular bellies interwoven with each other.

Fig. 5. Semidiagrammatic view of the scapular muscles seen from above or on their narrow upper edge: B, biceps tendon where passing over head of humerus; *I.s*, infraspinatus tendon; *S.s*, supraspinatus muscle; *Ep. s*, episubscapularis; *S*, superior border of subscapularis.

Fig. 6. A transverse vertical section of the spinal elastic ligament and muscles at the second dorsal vertebra.

Fig. 7. Similar slice of the ligament at the seventh cervical, both nat. size, from old ♂: *ln*, *ln**, ligamentum nuchæ; *m*, muscle in section; *v*, vascular channels.

XXI.—*Descriptions of two new Species of Humming-Birds.* By John Gould, F.R.S. &c.

Heliangelus micraster, Gould.

Bill black; on the forehead a band of glittering green; crown of the head, all the upper surface of the body, and the shoulders bronzy green; chest and flanks of the same hue, but rather brighter; centre of the abdomen mottled brown and green; on the throat an exceedingly lustrous spot of orange-scarlet, exceeding in brilliancy the colouring of the same part of any other member of this beautiful genus yet discovered; wings purplish brown; four central tail-feathers bronzy green, the remainder black; thighs brown; under tail-coverts white; feet dark brown, nearly black.

Total length $3\frac{3}{4}$ inches; bill $\frac{3}{4}$, wing $2\frac{1}{4}$, tail $2\frac{1}{8}$, tarsi $\frac{1}{4}$.

Habitat. St. Lucas, near Loxa, in Ecuador.

Remark. I have in my collection two specimens of this new bird, one of which is much brighter and finer than the other. They were collected in the locality above mentioned, by one of Mr. Clarence Buckley's hunters. In size this species is much smaller than any other member of the genus, even than *Heliangelus mavors*. My specimens differ also from all of them in the absence of a white or buff band across the chest, in which respect they assimilate to *H. Parzudaki*, but not in the forked tail and other respects. I think it probable they are somewhat immature, and that, beautiful as they are, fully adult examples will be still finer.

Chlorostilbon pumilus, Gould.

Bill black; crown and the whole of the under surface glittering bronzy green, with a wash of blue on the chest; back and upper tail-coverts green, becoming somewhat brighter on the latter than on the former; wings purplish brown; feet reddish brown.

Total length $2\frac{3}{4}$ inches; bill $\frac{5}{8}$, wing $1\frac{5}{8}$, tail $1\frac{1}{8}$, tarsi $\frac{3}{16}$.

Habitat. Citado and Pallatanga, in Ecuador.

Remark. Except in being of much smaller size, this little species is very like the black- and stout-billed *Chlorostilbon melanorhyncha*, which, in my 'Introduction to the Trochilidæ,' I have, as I now believe, erroneously placed as synonymous with *C. chrysogaster*, a bird inhabiting countries further north than Ecuador. The *C. pumilus* is also very nearly allied to the *C. assimilis* of Lawrence, but differs from that species in being still smaller, and in having a shorter and less deeply forked tail.

XXII.—*Investigations upon the Structure and Natural History of the* Vorticellæ. By Dr. Richard Greef.

[Continued from p. 112.]

External Habit of the Vorticellæ.

In general terms the external form of the individual Vorticellan animals may be described as cup-, urn-, or bell-shaped, to which latter, as the most suitable conception, the whole group is indebted for the name of bell-animalcules (*Glockenthierchen*) conferred upon it by Ehrenberg, and for the cognate denominations of tree-bells (*Carchesium*), column-bells (*Epistylis*), operculum-bells (*Opercularia*), double-bells (*Zoothamnium*), &c. According to former notions this denomination would be still more suitable, since, as is shown by nearly all the older descriptions and figures, it was supposed that the animals were hollowed like bells or cups, and furnished with cilia only on their free margin. Subsequent observations, however (first made by Ehrenberg), showed that the anterior mouth of the bell was closed by a more or less circular disk clothed with cilia, and that it was only behind this disk that a canal led, through a lateral buccal orifice, into the body of the bell, which was filled with contents, *i. e.* solid.

The anterior *ciliated disk*, or the *rotatory organ*, is externally surrounded by a broad, membranous seam, the so-called *peristome*. When the rotatory organ expands, the peristome becomes reverted, like a cushion, and is then surmounted by the extruded ciliated disk, which is frequently upon a short neck, and at the same time separated from it by a furrow (Pl. XIII. figs. 2, 6, &c.). This separation, however, occurs more or less distinctly in the different species; nay, it may be almost entirely wanting, as for example in *Epistylis flavicans*, in which the ciliated disk appears to pass directly and without any distinctly perceptible furrow into the reverted seam of the peristome (Pls. XV. & XVI.).

The body of the Vorticellæ usually exhibits towards the middle a bellied protuberance, the anterior part being constricted behind the peristome, whilst the posterior end tapers rapidly into a wedge-shaped point. In this case the form is short and stout; but in other species the body appears elongated and without any perceptible swelling in the middle, gradually narrowing backwards from the wide, open, reverted margin of the peristome, like a tall cup or a champagne-glass. Between these two extremes, however, leaving out of consideration the changes of form produced in the same individual by the different states of contraction, we find the most multifarious transitions, sometimes most nearly approaching the bellied bell-shape, sometimes the elongated funnel-shape.

The characters of form here referred to, and the denominations of bells, funnels, cups, &c. adopted for them, of course apply only so long as the animalcules have unfolded their rotatory organ and peristome. When the ciliated disk is retracted within the body, the peristome, which was previously reverted outwards, lays itself like a cover over the former, consequently covering the whole anterior part of the body. This cover, then, in form and destination completely resembles a muscular sphincter, which, moreover, acquires a radiated appearance by means of the folds of the peristome and the cilia lying beneath it (Pl. XII. fig. 1 &c., Pl. XIII. fig. 4, Pl. XIV. fig. 6, Pl. XV. fig. 1 &c.). In these cases, of course, the form of the body is not like that of a bell or funnel, but clavate, pyriform, or even spherical.

Of the known Vorticellæ, only two genera appear to possess freedom of locomotion, namely *Astylozoon* and *Gerda*; the latter, however, which seems to have been as yet very imperfectly investigated, is limited in this faculty, or rather in the habit of constant free locomotion, as the members of this genus are characterized by Claparède and Lachmann as "Vorticellines sessiles," although in them a true adherent organ is entirely deficient. The other Vorticellæ are all fixed, either seated upon attached peduncles (*Vorticella*, *Carchesium*, *Epistylis*, *Zoothamnium*), or non-pedunculate and attaching themselves as parasites upon the soft surfaces of animals (Mollusca) by means of an organ like a sucking-disk at the posterior extremity of the body. The pedunculate *Vorticellæ* either sit singly upon simple stalks* (which in this case are always

* We here follow, for the present, the systematic arrangement of Stein, who, as already explained, has excluded from the Vorticellinæ the Ophrydinæ, among which we certainly meet with simple forms with rigid peduncles (e. g. *Cothurnia*).

contractile), and are only transitorily united two upon one stalk during division (*Vorticella*), or the stalk rises, by continual and generally dichotomous division, into an arborescent form, upon the terminal ramifications of which the individuals are united into a colony which is usually very numerous. The peduncles of these stock-forming Vorticellæ are either contractile (*Carchesium*, *Zoothamnium*) or rigid (*Epistylis*, *Opercularia*). The mode of ramification of the stock is very multifarious, and is often characteristic of the different genera and species; so that it might with advantage be made use of for systematic discrimination. A remarkable difference of this kind in the ramification of the peduncle is presented, for example, in the accompanying figures, between *Epistylis flavicans* (Pl. XV. fig. 1 &c.) and the *Zoothamnium* discovered by me in the North Sea (Pl. XIV. fig. 6 &c.). Whilst in *Epistylis flavicans* a regular dichotomous ramification ascending from the stem occurs, in the *Zoothamnium* in question the shortly pinnate branches are placed alternately upon a common shaft. Between these two very different stock-formations there are, however, a number of others, which, as already remarked, are more or less characteristic of the general habit of the species under consideration. These, however, are almost exclusively confined within the dichotomously expanded tuft- or umbel-form; the alternating branch-form has as yet been observed only in stocks of marine *Zoothamnia**.

With regard to this latter genus a remarkable peculiarity must here be mentioned, which is also characteristic of its external habit, namely the frequently very remarkable difference in size of the individuals of the stocks. Individuals may attain five or six times the size of the others, or even still more; and these then, especially when they are closed, project from the majority of smaller individuals like lumps. Sometimes there are only one or a few of these lumps, but sometimes a comparatively large number (Pl. XIV. fig. 5). They may, however, be entirely deficient†; but this, according to my observations, must be regarded as exceptional in the marine forms in question. We shall revert hereafter to this form of

* These alternating stocks were first observed by Ehrenberg in a species discovered by him in the Red Sea, and named *Zoothamnium niveum* (Die Infusionsth. &c. p. 289, pl. 29. fig. 3), then by Claparède and Lachmann in *Zoothamnium alternans* from the North Sea on the Norwegian coast (Etudes sur les Infusoires, ser. 1, p. 103, pl. 2. figs. 1–4), and finally by myself in the form which I frequently saw at Ostend and other places on the North Sea (Pl. XIV. figs. 6 & 7), which is probably identical with *Z. alternans*, but perhaps also with *Z. niveum*.

† It is very remarkable that in *Zoothamnium arbuscula*, nothwithstanding the numerous examples which he examined, Stein entirely missed the lump-like animals, which Ehrenberg observed and figured in this species.

Zoothamnium, and especially to the possible relation of the lump-like animals to reproduction.

We have already indicated that, with the exception of *Astylozoon* and *Gerda*, all the Vorticellæ present only attached representatives. This attachment, and with it a limitation of locomotion, is certainly their ordinary mode of life, which governs the essential systematic character. But probably all the Vorticellæ, and certainly most of them, pass temporarily into a free life-stage, by forming the so-called hinder circlet of cilia, separating themselves from their peduncle, and swimming about freely in the water for a time, until they again attach themselves by secreting a peduncle, and at the same time very quickly lose the posterior circlet of cilia, the essential attribute of their freedom. This separation takes place either on the occasion of their division, as is always the case in *Vorticella*, as one of the divisional buds must quit the peduncle which is only intended for one individual, or particular individuals of a stock, usually when injured and disquieted in their ordinary conditions of life, spontaneously quit the colony to seek their fate elsewhere.

External Covering and Musculature.

All the Vorticellæ possess an external, hyaline and homogeneous skin, which is pretty strong in many species, which covers the whole body, passes posteriorly into the sheath of the peduncle when the latter is present, and affords the axis of the peduncle access to the base of the body, and anteriorly wraps round the peristome, clothes the ciliated disk, and is continued into and lines the nutritive canal. This skin may be brought into view in the living animals by suitable magnifying-power, but also, and generally still more distinctly, by means of various reagents (acetic acid, solution of potash, &c.), to which it offers considerable resistance. By the addition of colouring materials or iodine, also, it becomes very distinct, as it remains untouched by them and contrasts with the contents, which are rapidly and intensely coloured, and it then appears as a colourless hyaline border at the limits of the body.

Probably in all Vorticellæ this skin exhibits a regular *transverse striation* running round the whole body; and this is often so fine and close that it is detected only by a high power and close examination; sometimes, however, it shows stronger outlines. This striation has already been seen and described by Ehrenberg, and after him by many others; and with a little experience it cannot be confused with other coarser folds, also appearing in transverse rings, which are chiefly produced by sudden contraction after previous compression; for this constant, regular, and fine striation of the skin may be seen when the animal is most fully extended, even under artificial compression, and, indeed, then often most distinctly. This difference and the fact that we have only to do here with the abovementioned normal fine striation are of some importance, and at least merit being specially indicated here. Stein, in his most recent work on the Infusoria*, gives an interpretation of these striæ of the skin, with which, from my present observations, I cannot agree. Thus, after admitting, in correction of his previously opposite opinion, the presence of muscles in the Infusoria, founded upon W. Kühne's investigations upon the peduncular muscle of the Vorticellæ†, he thinks that, as a complement to this, the cutaneous striæ observed in many Infusoria (especially the Stentors, Spirostomes, &c.) must be interpreted as the body-muscles. It deserves to be indicated here that this opinion was distinctly expressed by Ehrenberg, who says (at p. 260 of his 'Infusionsthierchen'), in characterizing the family of the Vorticellinæ, "In some (*Vorticella*, *Carchesium*, *Opercularia*) longitudinal and transverse muscles are recognized"; and further (on p. 261), in the description of the genus *Stentor*, "The organs of motion are the innumerable cilia of the surface, together with the frontal circlet of cilia as a more special capturing organ. Visible longitudinal striæ of muscular fibres lie at the base of the longitudinal rows, but at the front circular striæ." Further, in the introduction to the "Explanations of the class Polygastrica," he says:—"Muscles can, however, be seen. These, in *Stentor*, distinctly form the base on which cilia stand, forming cloudy longitudinal striæ or spirals, &c." From all these statements it is clear that Ehrenberg regarded as muscles the same structures that Stein has recently done. We can less distinctly learn from them Ehrenberg's opinion as to the purpose of these muscles—namely, whether they are merely regarded as body-muscles which execute the contractions of the body, or as serving for the movement of the cilia—which latter notion Stein justly characterizes as erroneous with reference to our present knowledge of ciliary movement, whilst he at the same time points out that in the Infusoria generally the striation of the body and the ciliation stand in no causal connexion. The system of striæ of the Infusoria has also been interpreted by others in Stein's way and more or less completely described, as by O. Schmidt‡, who has already expressly claimed his share in it, and also by Kölliker§ and others. Excellent observations

* Der Organismus der Infusionsthiere, Abth. ii. p. 23.

† Archiv für Anat. &c. 1859, p. 824. See also the other important memoirs on the irritability of the muscles &c. in the same volume, pp. 213, 314, & 748.

‡ Archiv für mikrosk. Anat. iii. p. 391.

§ Icones histiol. p. 14.

by Lieberkühn* upon the same subject will be referred to hereafter in the closer consideration of this striation and its interpretation as muscles.

In the first place, however, we must turn once more to the above-described transverse striation in the skin of the Vorticellæ.

In the further exposition of his views, Stein applies the interpretation of the body-striæ as muscles also to the cutaneous striæ of the Vorticellæ, under which he comprehends, as his whole description shows, the above-mentioned more or less regular, fine, transverse striation. He says it is an "apparent transverse annulation; in reality it has a spiral arrangement." Moreover, if I have rightly understood the statements relating to it, the outer skin is not the real bearer of these striæ, but they are covered by the former, the so-called *cuticula*. This cuticula fulfils, with regard to the body or muscular striæ lying beneath it, the part of a sarcolemma, but envelopes them only in part—that is to say, chiefly externally and (in the longitudinal striæ) to the right and left, whilst within they are coherent with the internal sarcode of the body.

As regards the present admission by Stein of a special muscular system in the Infusoria, we can only welcome it as an essential step in advance. It seems to me that, even without the provisional morphological evidence, it must have been assumed, *à priori*, that the sudden, jerking, and convulsive movements such as we see in many Infusoria (for example, in *Spirostomum*, *Stentor*, and the Vorticellæ) could not be effected by mere formless sarcode, but only by already differentiated contractile structures—in other words, by muscular elements. Where, in those organisms in which the movements are effected only by the contractions of the formless protoplasm (therefore in the Rhizopoda and creatures like the Rhizopoda), do we find the sudden and convulsive movements of the Infusoria? In all these forms, whether they are independent or only represent states of development, the movements always appear rather in the form of a slow, uniform, and gradual flowing and creeping, the so-called amœboid movements. Although, therefore, in general the assumption of separate muscular elements in the Infusoria appears to be perfectly justified, we cannot in the special case declare our agreement with the interpretations which Stein now puts forward for the body-muscles of the Stentors, Spirostomes, &c., as also for the Vorticellæ.

* Arch. für Anat. &c. 1857, p. 403, note.

In the first place, notwithstanding many observations directed to this point, I have been unable to convince myself that the fine external transverse striation of the body already repeatedly mentioned really has a spiral course. Stein, indeed, seems only to have examined a single species as to this point, namely *Vorticella microstoma*, from which, perhaps not without warrant, he deduces the same character for the other Vorticellinæ which are furnished with striæ. In this *V. microstoma*, however, he finds "a distinct spiral arrangement;" but the ascent of the spiral is so small that the striæ deviate but little from the horizontal direction, and therefore produce the impression of a simple transverse annulation. From this admission, however, it seems to me to follow that the decision whether the striæ in question have a spiral or an annular arrangement cannot be made so easily as Stein's statements would lead one to suppose. For my own part, at any rate, I have hitherto not only been unable to detect the spiral arrangement of these striæ, but have always obtained only the impression of a regular transverse annulation, even in those forms in which the striæ have comparatively broad interspaces between them. In this inquiry I have chiefly directed my attention to the course of the striæ on the conical base of the Vorticellan body and to the anterior margin, especially when the rotatory organ was retracted into the interior of the body and the peristome covered it like a sphincter. At these two points, probably, it would be most easy to decide the question by seeking to detect the commencement or the end of the spiral line. But even here illusions may easily be produced, in consequence of the state of contraction or the position of the body at the moment. At any rate, as Stein himself admits, the ascent of the spiral, if it exists, is extremely small; so that, especially when the striæ are, besides, very fine, and follow closely upon one another (as in *Carchesium polypinum*), it can only be recognized with great difficulty by direct observation.

In the second place, also, I have hitherto been unable to convince myself that the transverse striæ of the Vorticellæ now under consideration stand in direct relation to the muscles, or rather, as Stein thinks, that these striæ are the muscles themselves; and this leads us, leaving the Vorticellæ out of consideration for the present, to a short examination of the very important question in our knowledge of the Infusoria, which has already been touched upon, of the body-muscles of these animals in general. This is the less to be dispensed with here, as Stein obtained his results with regard to the muscular striæ chiefly by observations on other Infusoria (*Stentor*, *Spirostomum*, &c.), and seems only to have transferred them from these to the Vorticellæ.

With regard to this, he says*:—"The striæ (of *Spirostomum ambiguum*) consist of a homogeneous soft mass, rendered cloudy by very densely packed, extremely fine granules, and are connected with each other by means of a hyaline, firmer, but much narrower intermediate substance, which is evidently a part of the cuticula. Of course the striæ are also clothed externally by the cuticula; but it is not here separately perceptible, because it clings most intimately to the cloudy substance of the striæ." Further on, recommending the blue forms of *Stentor cœruleus* as particularly favourable for the investigation of the body-striæ, he says of it:—"The striæ here, in the broadest part of the body in large and not perfectly extended individuals, form broad ribbon-like cords, more or less strongly convex externally, which make their appearance with particular distinctness in the blue Stentors, because they are of an intense blue or verdigris colour, whilst the narrower clear interspaces remain almost colourless. In their composition the striæ consist of a homogeneous, clear fundamental substance, which cannot be distinguished from the rest of the sarcode of the body; but in this there are imbedded, close together, innumerable very fine granules, which strongly refract light and in the blue Stentors have a blue colour. The more the animals shorten themselves or widen in one spot, the broader do the striæ become; on the contrary, if the body-part extends much in length, the striæ become converted into the finest lines: the substance of the striæ must therefore be a pasty mass which flows up and down, or, if it be preferred, a viscid fluid. Even in moderately contracted Stentors, and still more in those which have contracted themselves into a spherical or pyriform shape, the striæ may be seen throughout their whole length furnished with dark transverse lines lying close behind one another, by which the striæ acquire a striking resemblance to transversely striated muscular fibres, &c."

In what follows Stein then endeavours to demonstrate the accordance of the muscular striæ of the Infusoria thus constituted with the muscular fibres of the higher animals, especially by identifying the fine granules imbedded in the body-striæ with the disdiaclasts of the transversely striated muscles, as they, even by their "very regular accumulation in groups, produce a remarkably distinct transverse striation." Finally, in order to establish the relationship completely, it is maintained, as already remarked, that the cuticula enveloping the

* Der Organismus der Infusionsth. Abth. ii. p. 28.

body-striæ is analogous to the sarcolemma of the muscular fibres.

From the above it will be seen that the question about the muscles of the Infusoria is answered by Stein in great detail and very definitely; and if the answer were correct we should have made an essential step forward in the knowledge of the organization of the Infusoria. But my observations compel me to advance doubts with respect to the main points in Stein's statements. If we examine *Stentor cæruleus*, which is justly recommended by Stein for investigation with regard to the question before us, we see without any trouble the well-known regular longitudinal striæ running from before backward over the whole surface, and, indeed, alternately *a very narrow, pale, and perfectly homogeneous stria*, resembling a pale line or *furrow* drawn along the whole length, and *a broad ribbon-like stria*, in which *many fine granules* of various sizes are scattered, and which consequently, in contrast with the pale striæ, acquires a *cloudy* appearance. The broad cloudy bands thus appear to be enclosed and shut off from each other by the pale threads. According to Stein's view, above explained, the former represent the true muscles, whilst the pale lines are merely non-contractile connective substance, the cement which unites the muscular striæ with each other.

To me, however, all the characters seem to speak in favour of the reverse condition—namely, that the narrow pale striæ are the true muscles, and the broad cloudy bands form the connective substance. Lieberkühn* has already expressed this opinion with regard to the body-striæ of the Stentors; and the observations cited by him in support of it are so convincing that it cannot but appear surprising that Stein should briefly, and without sufficient reasons against them, set them aside for the benefit of his own theory. Lieberkühn, after mentioning the broad richly granular striæ of the Stentors, already described by Ehrenberg, says :—" But there is yet another system of striæ which behave like muscles, inasmuch as they are endowed with the property described by Edward Weber as belonging to muscles—namely, that in a state of repose they acquire a serpentine form, and extend themselves straight during contraction. They are sharply contoured fibres, free from granules, of about the breadth of the non-granular interspaces, beneath which they run in the direction of the long axis of the body; they are attached in front below the great circlet of cilia, and behind at the 'sucking-disk;' some of them unite during their course. The changes occur-

* Archiv für Anat. &c. 1857, p. 403, note.

ing during contraction are most distinctly seen when a colourless or slightly coloured Stentor lies exactly in such a position that one looks upon the circular sucking-disk; we then see, in a state of repose, all the separate muscles starting from its circumference in a serpentine form; but at the moment when the animal jerks itself together and therefore shortens itself, the serpentine form disappears entirely, and the muscles become straight. The straight muscles immediately begin to relax again, and to fall back into the serpentine form, and the Stentor again elongates itself."

Lieberkühn, therefore, interprets the pale striæ as sharply contoured muscular fibres, whilst Stein regards them as mere furrows formed by the cuticula, which have nothing to do with muscles, and which, under certain states of contraction, only apparently occur as "limpid fibres bounded by double contours," but in reality are portions of the cuticula folded in like a groove.

The decision of this point, however, seems to me not to be very difficult by careful and unprejudiced examination. If we once more examine our *Stentor cœruleus* we see that the two systems of striæ are certainly of completely different nature; the broad streaks consist of a softer mass, more or less darkened by imbedded blue pigment-granules, and the narrow ones of a firmer hyaline mass destitute of granules.

Now, as regards the substance of the broad streaks, in the first place we see in them, with the exception of the numerous irregularly scattered granules, no trace of special formative elements, or special structural conditions, and especially nowhere any *formation of fibres or cells*, either in the fresh state or after artificial treatment. What is there to compel us to regard these striæ as comparatively highly differentiated muscular substance, even comparable to the transversely striated muscles of the higher animals? According to Stein, the strongly refractive granules imbedded in the mass are to be considered to represent the enigmatical disdiaclasts of the transversely striated muscles. But with what justice, we must ask, can we regard the granules which occur in almost every thing that is called protoplasm, and indeed almost constitute a characteristic constituent of it, as equivalent to the disdiaclasts of the transversely striated muscular fibres? Where are the sarcous elements constituted by the disdiaclasts? Where are the true *muscular fibres*? How is the property of double refraction, which is characteristic of the disdiaclasts, demonstrated? And, lastly, where do we find a distinct longitudinal and transverse striation? Stein remarks that during strong contractions dark transverse lines are produced, by which the striæ acquire a striking resemblance to the transversely striated muscular fibres*. But is it not more natural to regard the dark transverse lines as having been produced by the granules being pushed together by pressure during the contractions, which are often sudden and strong, towards the crests of the transverse ridges or tubercles, and here grouped in more or less regular streaks? Moreover it is to be borne in mind that the transverse streaks in question make their appearance, especially in the anterior part of the body, in the neighbourhood of the peristome. Here, however, *actual circular lines* run round the whole body, perhaps representing special circular muscular fibres. We can therefore find nothing to justify us in regarding the broad striæ in question as muscular substance. It seems much more feasible to regard them as a part of the so-called *cortical layer* of the Infusorian body, which envelopes the muscles and other organs and fixes them in their places; to its signification in the Infusorian organism we shall revert more in detail hereafter. Moreover, for the granules made use of by Stein in his theory we have a purpose, which has already been pointed out, and seems to me to be satisfactory: they are the *bearers of the blue colouring-matter* which renders the *Stentor cæruleus* immediately recognizable, especially in the midst of the usually predominant society of the green *Stentor polymorphus*. They are, therefore, as Stein himself states, *pigment-granules* situated beneath the cuticula; and just as little as this property can be denied to them does it seem to me that any other one has been demonstrated for them.

Let us now turn to the second system of striæ, which run, in the form of clear narrow lines, alternately with the striæ just referred to, and, like these, along the whole length of the body, and which, as has already been explained, are regarded by Stein as the connective substance of his muscular streaks. They certainly at first produce the impression of clear, groove-like, cutaneous striæ which are stretched out between the dark streaks; but on more careful examination we find that *beneath each of these clear lines runs a powerful hyaline thread*, which, as we may ascertain most decidedly, can never be the expresssion of the "cuticula folded in like a groove." This is characteristically shown, in the first place, by the *tortuosity of the thread* in a state of repose already described by Lieberkühn, and which is particularly beautifully seen in the hinder part of the body. Against this Stein urges that the same thing occurs

* Stein has overlooked the fact that this transverse striation, to which he gives so much prominence, has been already observed and illustrated by Kölliker, with a figure (Icones histiol. p. 14, pl. 1. fig. 12), which leaves no doubt that Kölliker had before him exactly the same phenomenon as Stein.

also in the broad streaks, which are just as undulated and tortuous as the lines bounding them. This statement, however, depends upon an erroneous observation; for it is only the narrow filaments that have a truly serpentine course, passing right and left out of their lines and into the substance of the neighbouring soft and broad streaks, sometimes narrowing them to a very small space when the convexities of two convolutions approach each other, and sometimes widening them. By this means the broad streaks acquire rather a repeatedly sinuated, necklace-like appearance than a serpentine one. Is such an extended and regular approximated tortuosity of sharply contoured filaments such as we have before us in *Stentor* at all conceivable, except with the existence of actual filamentous structures? If the clear streaks were, as Stein thinks, only a part of the cuticula, and if the filaments were produced only by its folding, they could hardly follow so regularly serpentine a course without the production of folds on the other parts of the surface of the body, as the cuticula also covers the broad streaks. How, moreover, could the sudden disappearance of the loops of the filaments (that is to say, the shortening of the filaments during a sudden contraction of the body), already described by Lieberkühn, be explained? If they were in reality folds of the skin, must they not then exhibit more numerous and larger loops? Besides we may even see the clear narrow stripes of cuticula pass in a straight direction over the subjacent undulated filament, so that there can no longer be any doubt as to the presence and position of the latter.

A further argument against Stein's view is to be found in the *reticulate ramification of these filaments*, which is almost always observable at the posterior extremity of the body, two neighbouring filaments before attaining the posterior extremity becoming united into a single one, whilst the broad body-striæ enclosed by them go no further, but terminate in a wedge-shaped form in the angle of union. The filaments thus united then often divide again in their further course, and again amalgamate with other neighbouring filaments, and in this way form an actual reticulate ramification. The extremities of these filaments, whether reticulately united or running singly, always attain the posterior extremity of the body ("sucking-disk") and attach themselves there. But the broad bands neither form a network nor do they all reach the posterior extremity of the body; they frequently terminate before it without uniting with their neighbours, nay, often forming mere wedge-shaped pieces between the clear striæ. The broad bands form merely the partially enveloping connective substance of the clear threads, and not *vice versâ* as Stein thinks.

If a Stentor be carefully crushed under the glass cover, we see, as the contents of the body flow out, the filaments under discussion projecting here and there isolatedly from the edges, and are able to trace them thence continuously into the remaining body. At some points even the filaments are torn on this occasion, and we may then observe how their viscid hyaline substance contracts into thickened bacillar portions. By this the muscular filaments of the Stentors approach very closely to the axial filaments in the stems of the *Vorticellæ*, with which I should be most inclined to compare these structures as regards their whole appearance, behaviour, and consistence.

By other artificial methods also, especially by the addition of alcohol, we may ascertain the resistance and independence of the filaments, and that they by no means form a part of the cuticula.

It would, however, lead us too far from our present task if we were to cite any more details in support of our view. We believe that, from what has been stated, we may attain a conviction that it is not, as Stein believes, the broad, granular, longitudinal striæ, but the *narrow*, *clear*, *longitudinal lines* that form the body-muscles of the Infusoria.

We now revert to our Vorticellæ, and must, in the first place, again refer to the fine transverse striæ already mentioned (p. 199), to which, as may be remembered, Stein has ascribed (1st) a spiral course, and (2nd) the properties of muscular fibres. With regard to the first point we have already put forward our doubts, and stated that we think these striæ must be regarded as not spiral but circular, and consequently as annulations following closely one upon another. But in the second point also we cannot agree with Stein. The fine external transverse striæ of the Vorticellæ belong rather, in our opinion, to the external skin, and can by no means be brought, as Stein will have them, into connexion with the longitudinal or muscular striæ of the Stentors and Spirostomes. *The muscles* of the Vorticellan body are rather situated *beneath the transverse striæ*, and have, for the most part, a very different course from these, namely in the *longitudinal direction* of the body, just as is the case also in the other Infusoria. Of this we may best convince ourselves when we examine the hinder part of the body of a Vorticellan under careful compression. The longitudinal fibres, radiating forward from the conical base, make their appearance here very distinctly (Pl. XV. fig. 5 *g*, & Pl. XVI. fig. 1). They become still more perceptible when we are able to examine an animal separated from the peduncle in such a position that the base of the body is turned directly upwards towards the eye; the fibres are then seen radiating on all sides from the circular point of attachment of the peduncle. In this position of the animal, especially when, without being compressed, it rests with its opened anterior ciliated disk upon the glass plate and stretches its base upwards, we may also obtain, in certain positions, the clear view of a transverse section of the body (see Pl. XIV. fig. 8). At the outside there appears a *clear border* (*cuticula*), which is distinctly limited within ; then follows a circlet of *dimly shining corpuscles* (the *lumina of the muscular fibres*), and further in, again, a *clear zone* (*cortical layer*), which, as *parenchyma*, *entirely fills* the conical hinder part of the body, but becomes thinner anteriorly, and encloses the true *body-cavity*. Within the last clear layer of parenchyma we then see, in Vorticellæ with contractile peduncles, some dark corpuscles arranged in a circlet; these may be regarded as the fibres of the peduncular muscles radiating in the body.

If the body of a Vorticellan be gradually compressed until it is completely flattened, granules, all of the same size and in apparently regular arrangement, make their appearance beneath the cuticula. In general we seem to recognize a distinct longitudinal direction, corresponding to the course of the muscular fibres (Pl. XIV. figs. 1, 5) ; but it is very possible that this is an illusion, as the longitudinal fibres of the muscles appear at the same time and in the same place. Sometimes, also, especially during long-continued compression, it is difficult to ascertain that they have any definite direction. Whether they can be brought into connexion with the muscles, or whether they belong to the lower surface of the cuticula, or, lastly, to the cortical layer of the body, I cannot decide at present. These are, no doubt, the same structures already mentioned by Leydig *, and which appeared to him to have "quite the habit of nuclei." I admit that on viewing these peculiar corpuscles, their regular arrangement and their always definite size and limitation, I was frequently inclined to adopt the opinion of this distinguished naturalist, and to regard them as the nuclei of the cortical layer or of the muscles. But for this it is necessary, in the first place, to accept the supposition that nuclei and cells of such minuteness as the corpuscles in question really exist, which, although we cannot reject it out of hand, is yet by no means founded upon observation. Perhaps, however, further investigation, especially upon the development of the Vorticellæ, may furnish an answer to this question, which is by no means unimportant towards our conception of the structure and, through this, of the position of these animalcules.

* Lehrbuch der Histologie des Mensch. und der Thiere, pp. 16 & 125.

Besides the longitudinal fibres, we find in the ciliated disk and in the peristome circular fibres; but in these parts, also, I have been unable to make out whether they have a spiral course corresponding with that of the ciliary spiral.

To the skin and the above-described muscles a protoplasmic zone adheres within on all sides—the true *cortical layer* of the Infusorian body, which encloses and lines the whole internal space or *body-cavity*, upon the nature and signification of which we shall shortly go into detail. If a Vorticellan be slowly compressed under the glass cover, by abstraction of water we see, especially at the moment of its death, a distinct vesicular and often almost regularly polygonal marking (*Epistylis flavicans*) make its appearance beneath the skin. This belongs to the above-mentioned cortical layer of the body. Whether this vesicular arrangement of the protoplasm exists during life, or only makes its appearance after death, I have been unable to ascertain positively. In this cortical layer, and held by it in their position, are seated the principal organs of the body, namely the nucleus, the contractile vesicle, and the principal section of the alimentary canal, which we shall also consider more particularly hereafter.

Finally, I must here refer to the exceedingly peculiar structures situated beneath the skin, of which a passing mention has already been made, with the indication that they ought possibly to be regarded as urticating organs. I have hitherto found these organs only in *Epistylis flavicans*, and even here not constantly; in connexion with which, however, it must be remarked that very probably several species, or at any rate varieties, have hitherto been included under the above name. The bodies in question are *oval or pyriform*, *sharply contoured*, *shining capsules*, which almost always lie together in pairs, and apparently in the cortical layer (Pl. XV. figs. 5 *k*, 7, & 8). They are of great firmness, and present great resistance to caustic potash and the like; but if they are removed from the body and compressed, a *tolerably long and powerful thread springs forth from each of the capsules* (Pl. XV. figs. 7 & 8 *b*), and generally from the somewhat pointed end, which, in the above comparison, represents the stalk-end of the pear. The expelled thread usually forms several convolutions and loops, is motionless, and shows no special structural characters; by careful examination it may also be seen rolled up, apparently in a spiral, in the interior of the still closed capsule (Pl. XV. fig. 7 *a*). What is the interpretation of these structures? Are they proper to the Vorticellan body and formed in it? or are they foreign organisms which have penetrated into it? In the latter case they would perhaps represent a *parasitic fungus*, certainly deviating from all at present known; in the former I do not know how to interpret them, except as *urticating organs*, which would exhibit an extremely remarkable agreement with the urticating organs of the Cœlenterata. Although I am inclined to the latter view, I would leave the decision to further investigations, which should be directed especially to the genesis of these bodies. If it should prove that these structures are really urticating organs belonging to the Vorticellan body, this would be of the greatest importance to our knowledge of the structure of the Infusorian body, as these urticating capsules, considering their perfect agreement with those of the Cœlenterata, would undoubtedly be developed, like the latter, *from cells*.

[To be continued.]

XXIII.—*On the Nomenclature of the Foraminifera.* By W. K. Parker, F.R.S., and Prof. T. Rupert Jones, F.G.S.

[Continued from vol. viii. p. 266.]

Part XV. *The Species figured by Ehrenberg.*

Contents.

§ 1. Amongst the most enthusiastic observers and voluminous writers on Foraminifera Dr. Ch. G. Ehrenberg stands preeminent. By the end of the year 1838 he had reduced to order the multitudinous specimens of recent and fossil Microphytes and Microzoa which he had either gathered, with Dr. Hemprich, in the East or had received from numerous correspondents. Among the results is the Tabular Classification* of his Bryozoa (*Polythalamia*, *Gymnocoræ*, *Thallopoda*, and *Sceleropodia*), which, mingling Foraminifera and Polyzoa,

* Table opposite p. 120, 'Abhandl.' für 1838.

could not greatly assist zoological investigations. Several beautiful figures are also given in the same volume of the Berlin Academy Transactions for 1838, of some recent Foraminifera, highly magnified (plates 1, 2, 3; see further on); and several samples of washed dust from various limestones and other fossil deposits are also figured on plate 4, magnified about 300 times linear. Some interesting conclusions were arrived at, valuable and true in the main:—namely, that the same kinds of Foraminifera (omitting all the other minute organisms, with which we do not now occupy ourselves) occur in both the fossil and recent state; but that at the same time each set of strata has more or less decidedly its own special group of Microzoa, and that Chalk in particular, and probably most limestones and calcareous marls, are largely composed of the shells of Foraminifera (*Polythalamia*, Ehr.), in some instances these minute organisms, with Coccoliths (Morpholites, Ehr., in part), appearing to be the main constituents of White Chalk.

The following year Dr. Ehrenberg studied some living Foraminifera of the North Sea at Cuxhaven; and he figured two of them (*Polystomella striatopunctata* and *Nonionina umbilicata*) with great exactness, as well as some obscurer forms, which he had found in both the living and the fossil state. (See further on.)

Amplifying with his own increased knowledge the already published observations on this subject of the persistence of low orders of life, Dr. Ehrenberg wrote the interesting memoir which appears, with the plates just mentioned, in the Berlin Acad. Transact. for 1839, and in Taylor's 'Scientific Memoirs,' vol. iii. art. XIII. Full illustrations of the numerous Foraminifera referred to, and their comparison with previously published species, were still wanting; and, as we shall have occasion to remark, the geological status of some of their sources was wrongly determined.

In 1843 several highly magnified figures of minute recent Foraminifera from America were treated of and illustrated by Ehrenberg in the Berlin Acad. Transact. for 1841, pp. 438 &c. Unfortunately, however, being merely views of microscopic objects seen by *transmitted light*, and therefore appearing merely as *sections*, or bare skeletons as it were, of the minutest* forms, little can really be learnt from them. (See further on,

* It is not, however, wholly on account of their minuteness that they are nearly useless to the zoologist, but for want of structural detail. Many minute Foraminifera are as good representatives of species and marked varieties as large specimens; for with arrested growth characteristic features are still preserved.

for an attempt to correlate them with known species and varieties.)

In the 'Abhandl. Berlin. Akad.' for 1847, pp. 442 &c., many extremely minute Foraminifera, occurring in Wind-dust on different occasions in several parts of Europe, form part of the curious gatherings of invisible things that wind-storms make and disperse in their whirlings over the surface of the earth—sweeping the sea-shore, sand-bank, and dry river-bed, the volcano, the desert, and the ploughed field, for organic and inorganic particles, and winnowing its dusty harvest over distant and far different areas. These tiny Foraminiferal waifs are still less teaching than those of 1841 as to genera and species, though they are potent witnesses of the path and doings of the wind-storm.

In 1854, however, the crowning of his favourite labour was accomplished for the Foraminifera, in the publication of Ehrenberg's 'Mikrogeologie,' with the recognition and aid of the State. In this grand work, besides multitudes of fossil Diatomaceæ, Polycystina, Spongoliths, &c., the long-looked-for Foraminifera were depicted with the best artistic skill, with loving care, and right royal liberality.

The late Mr. Thomas Weaver, F.R.S. &c., in the 'Annals and Magazine of Natural History,' vol. vii. (June 1841), pp. 296 &c., and (July) pp. 374 &c., and in the 'Philosoph. Mag.' ser. 3. vol. xviii. pp. 375 & 443, contributed a full abstract of two of Dr. Chr. G. Ehrenberg's memoirs—(1) On the Composition of Chalk Rocks and Chalk Marl by invisible Organic Bodies*, and (2) on the numerous Living Species of Animals found in the Chalk Formation †—together with an Appendix touching the Researches of M. Alcide D'Orbigny on the Foraminifera of the White Chalk of the Paris Basin‡.

Dr. Ehrenberg's memoir "On the muddy deposits at the mouths and deltas of various rivers in Northern Europe, and the Animalcules found in these deposits" (from the 'Abhandl.

* "Ueber die Bildung der Kreidefelsen und des Kreidemergels durch unsichtbare Organismen," Abhandl. Berliner Akad. Wissensch. für 1838, pp. 59–149, 4to, 1839.

† "Ueber noch zahlreich jetzt-lebende Thierarten der Kreidebildung," Abhandl. Berl. Akad. Wiss. für 1840, 4to, 1841. This memoir is translated in full, and illustrated with the original plates, in 'Taylor's Scientific Memoirs,' vol. iii. art. XIII. pp. 319 &c. plates v.–viii.

‡ Mémoires de la Soc. Géol. de France, vol. iv. 1e partie, 1840. A notice of the Rev. W. Buckland's paper in the 'Edinb. New Phil. Journ.' April 1841, on the discovery of fossil Foraminifera in the Mountain-limestone of England, by MM. Tennant and Darker, in 1839, is also included in this Appendix by Mr. Weaver.

k. preuss. Akad. Wissensch. Berlin' for 1843) was noticed at large in the 'Quart. Journ. Geol. Soc.' vol. i. pp. 251 &c., as illustrative of the influence of microscopic life on recent and fossil stratified accumulations.

In these memoirs, and in shorter collateral notices in the 'Monatsberichte' of the Berlin Academy of Sciences*, Dr. Ehrenberg treated of numerous Diatomaceæ (Polygastrica), Polycystina, Foraminifera (Polythalamia), Spongoliths, and other microscopic organisms, which he had found, either recent, especially in the Red Sea, the Mediterranean, and the North Sea, or fossil in numerous deposits of various ages, such as the Mountain-limestone, Oolite, Chalk, Tertiary, and Posttertiary strata. Some few of the recent and fossil species were figured by him in the 'Abhandlungen' for 1838 and for 1839 (see pp. 218 & 221); but it was not until 1854 that Ehrenberg was enabled to fulfil his earnest and laudable desire to give to the world faithful and manifold portraits of the well-prepared and almost innumerable microscopic objects on which his published opinions had been founded. The second part † (middle third) of the magnificent folio volume entitled 'Mikrogeologie,' published under the patronage of Frederick-William the Fourth of Prussia, consists of 41 plates ‡, illustrating the Microliths, Microphytes, and Microzoa to which his memoirs refer. Explanations of the plates, with a full index, are given, but no descriptive text; most of the specimens, however, are alluded to in other portions of the book, and in the 'Monatsberichte.'

On the Diatoms, Polycystines, Spongoliths, Geoliths, and Phytoliths here illustrated we do not offer any remarks; but we have busied ourselves with the beautiful engravings of the Foraminifera in the 'Mikrogeologie,' that we might bring

* Namely, Monatsb. für 1838, p. 104, flint from Volhynia; pp. 192–200, Microzoa mainly constituting Chalk; für 1840, pp. 18–23, Foraminifera of the North Sea; für 1844, pp. 74–96, new genera and species of Foraminifera; pp. 206, 207, Microzoa from the South-polar Sea; pp. 245–248, *Spirobotrys ægea*; pp. 274, Microzoa from Kurdistan &c.; p. 414, Microzoa of the Chalk; für 1858, pp. 10–30, new genera and species from the Ægean and Mediterranean; pp. 118–128 and 295–311, siliceous casts of Foraminifera.

† The other parts of this grand work consist,—the first of catalogues, special and collective, of the microscopic objects, animate and inanimate, from 836 different freshwater deposits from all parts of the world, excepting North America; the third part contains notices of North-American microscopic life and microgeology, with special and collective catalogues of the objects found in upwards of 300 filterings, river-muds, and other deposits from the United States.

‡ Comprising four thousand figures, in great part coloured, and all (except in pl. 40) magnified at least 300 times linear.

them, with a corrected nomenclature, into correlation with the great mass of species and varieties, fossil and recent, now to be seen in numerous publications at home and abroad, and thus aid in working out the life-history of some, at least, of these remarkably persistent and widely diffused Protozoa.

It is difficult to follow Dr. Ehrenberg in his correlation of the several deposits from which he obtained the figured Foraminifera, because his identifications of Foraminiferal species and marked varieties are often incorrect, both among those of his own gathering and of these with such as had been figured or mentioned by D'Orbigny. And not merely are there difficulties as to *species*, but his generic groups are often discordant with the names they bear, and sometimes comprise two or more different genera (see Appendix). Nevertheless, taking a broad view of the results of his laborious, if not very discriminating, work among the recent and fossil Foraminifera, we may well congratulate him on having shown that several living species are also to be found fossil in Tertiary and Cretaceous deposits, though both his "species" and his geological conclusions are in many instances open to correction. Thus, throughout his interesting memoirs on the subject of the persistence of certain protozoan species, he uses the words "Chalk" and "Chalk-marl" for some *Tertiary* limestones and siliceo-calcareous earthy deposits; and, with respect to the zoological determinations of the Microzoa, we refer to the following observations on his figures and to the conclusions we arrive at concerning them, as showing the great discordance noticeable between his views and those of other rhizopodists. Yet throughout the work there truly appear numerous such persistent forms, belonging to the Cretaceous, Tertiary, and Recent periods, as his experienced eye really detected and in many instances his lists show, but which, for some occult reason, he failed generally to characterize by description and nomenclature, though often grouped naturally on his plates. As with his classification of the Foraminifera among his "Bryozoa" (1839)*, so with his 'Mikrogeologie' (1854), he failed to seize the clue to the right understanding and disentanglement of these many-featured Rhizopods. Ehrenberg's truthful plates, however, in the magnificent work last mentioned, supply the rhizopodist with a storehouse of beautifully prepared specimens, mostly seen by transmitted light, from various fossil deposits; and from these, for by far the most part, good and useful conclusions can be drawn, as from fresh specimens, except that, being viewed only in one manner (transparent),

* Abhandl. Berl. Akad. für 1838; Ann. & Mag. Nat. Hist. vol. vii. pp. 302, 303.

with but little perspective, and rarely with both faces of the shell, the student still finds himself too frequently at fault. The perfect engraving of shell-structure, tubes, pores, opacity, granulosity, &c., of septa, septal orifices in many cases, and other details, gives the majority of the figures great value; and, besides the evident truthfulness of form and structure, the picturing of accidental air-bubbles and contents of chambers (coloured sometimes) shows how exact and conscientious has been the artistic labour bestowed on the work.

In reading aright the generic and specific relations of Dr. Ehrenberg's Foraminifera, drawn so carefully in the splendid plates of the 'Mikrogeologie,' we have to remember that they are mounted in Canada balsam and seen by transmitted light; and, indeed, it requires an experienced acquaintance, almost if not quite as complete as that of Ehrenberg himself, with similarly mounted Foraminifera, from all parts of the world, to be enabled to detect and realize the zoological value of faint differences of apparent convexity and of opacity, punctation, porosity, and granulation, of relative thickness of shell-walls, which sometimes look like marginal keels,—of imperfect indications of the position, direction, and form of septal apertures, rarely shown except, as it were, in section,—and of other characteristic details which go to make the recognizable *facies* of a species or variety.

Few of the specimens figured are more than $\frac{1}{24}$ of a Paris line in diameter—that is, invisible to the naked eye. They are such as are readily washed away during the process of disintegrating soils, muds, and friable shales, marls, and chalk by means of water; whilst, on the contrary, such Foraminifera as have been figured by other authors are mostly those that remain after the muddy or chalky water has been poured off in the preparation, and can be readily picked out with the aid of a pocket-lens.

We cannot choose a better opportunity than the present to introduce the cordial and truthful expression of an accomplished American naturalist's well considered opinion of the great German microscopist's labours and expositions. Treating * of Ehrenberg's description of microscopic organisms from America, he says:—

"This important memoir by the illustrious Ehrenberg is characterized, like all the preceding works of this author, not

* Americ. Journ. Sc. Arts, vol. xlvi. April 1844: Notice of a memoir by C. G. Ehrenberg, "On the Extent and Influence of Microscopic Life in North and South America," pp. 297–313.

only by marks of the most accurate research and indefatigable industry, but by the still higher merit of far-reaching philosophical views and a just appreciation of the important bearings and applications of the facts which he has brought to light."

With this eulogium we fully coincide, and feel certain that the better Ehrenberg's work is understood, the more will his beautiful and lasting illustrations, and his painstaking synoptical registers, advance the progress of biology in its relation to both the present and the past. In removing some obscurity from the highly valuable groups of Foraminifera of which he has treated, we shall be of use to naturalists and geologists, enabling them to put several extensive faunæ and local groups into close critical relation with each other and with such as have been observed by others. Further, we are sure that Ehrenberg himself, thinking over the improved biological systems of later naturalists, and open to conviction on good arguments, would freshly recognize the force of his own words respecting the importance of rhizopodal studies and their slowly progressive nature *, and be pleased to find, also, his own researches not only serving as a broad basis for the study in general and as steps to higher knowledge, but still more freely trodden in the upward ascent when made somewhat clearer and firmer for the student.

In 1847 Prof. W. C. Williamson †, F.R.S., had already taken in hand a survey of Dr. Ehrenberg's microscopical work in relation to the origin of limestones and some other rocks. Not merely as a reading critic, but as an original observer Prof. Williamson handled this subject in his masterly and systematic memoir, in which, escaping from some of Ehrenberg's biological errors, but still hampered by others, he first makes a review of his own-collected materials—Desmids, Diatoms, Xanthids, Sponge-spicules, Foraminifera,

* *Op. cit.* p. 312. "From the rapid and great increase of the knowledge of *an independent deep-working life in the smallest space,* it follows that this field of research cannot be unworthy of the best efforts; and if it be not always equally and quickly productive, or if it may be more agreeable with easier speculation, and rather in poetic sport than seriously, to penetrate into the Remote, yet the only scientific and remunerating method is by slow and sure steps, and under the check of careful, and therefore laborious, research, to approach the goal which excites the minds of all thinking men of all generations, and will interest all generations yet to come."

† 'On some of the Microscopical Objects found in the Mud of the Levant, and other Deposits, with remarks on the Mode of Formation of Calcareous and Infusorial Siliceous Rocks.' 8vo, Manchester, 1847. (From vol. viii. of the Manchester Literary and Philos. Society's Memoirs.)

Polycystines (under the term "siliceous Infusoria"), shell-prisms, echinodermatal plates, &c. Secondly, he gives valuable notes on their distribution in the Levant, on the British coasts, in the West Indies, and elsewhere. Thirdly, their occurrence in the fossil strata of Barbadoes, Sicily, Paris, North and South America, and especially in the Chalk of Kent (Mr. Harris's collection), Yorkshire, Antrim, &c., the limestone of Lebanon, the Speeton Clay, Oolites, Lias, and the Mountain-limestone, with careful references to the labours of others, especially Ehrenberg and D'Orbigny. Fourthly, the origin of limestones, the manifold changes they have suffered, and silicification are his special objects of study; and, though doubtless Foraminifera are found to be the chief material of many limestones of very different ages, he warns his readers to be cautious in using these low and simple animalcules as exact criteria either for climates, depths, and regions, or for chronological succession. He critically applies the researches and statements of both Ehrenberg and D'Orbigny in support of this well-founded caution. Since 1847 few have laboured more than Williamson himself in clearing away the obscurities that beset the Foraminifera, enabling us to understand their genera, species, and varieties, to trace them through their species-life, and to compare them from remote strata and distant seas—and this with improved knowledge and far better results than fell to the lot of earlier observers.

We here refer the student to some careful drawings of Foraminifera from the Pacific, seen by *transmitted light*, and engraved in a former volume of the 'Ann. & Mag. Nat. Hist.' for comparison with those given by Ehrenberg. Among them are several of the species met with in the 'Mikrogeologie.' We have to correct the nomenclature used by the author.

J. D. Macdonald, "On Foraminifera from the Feejee Islands." (Ann. Nat. Hist. ser. 2. vol. xx. pp. 193 &c. 1857.)

Pl. 5. figs. 1, 2. Doubtful. Figs. 3–5. *Polycystina*. From 1020 fathoms.

fig. 6. Uvigerina pygmæa, *D'Orb.* Dimorphous variety. figs. 7–10. Lagena globosa *et* marginata (*Montagu*). Entosolenian.	From 440 fath.
figs. 11–14. Globigerina bulloides, *D'Orb.* fig. 15. Planulina? fig. 16. Cymbalopora Poeyi (*D'Orb.*). fig. 17. Discorbina globularis? (*D'Orb.*). Young. figs. 18, 19. Nonionina umbilicatula (*Montagu*). fig. 20. Discorbina globularis? (*D'Orb.*).	From 1020 fath.

Pl. 6. fig. 21. Uvigerina pygmæa, *D'Orb.* Aculeate variety.		
fig. 22. Verneuilina pygmæa (*Egger*).		
fig. 23. Virgulina Schreibersii, *Czizek.*		
fig. 24. V. Schreibersii (irregular and dwarf).		From 1020 fath.
fig. 25. Discorbina Berthelotiana (*D'Orb.*).		
fig. 26. Textilaria pygmæa, *D'Orb.*, *vel* Bolivina punctata, *D'Orb.*		
fig. 27. Bolivina punctata, *D'Orb.* With an aculeate base.		
fig. 28. Spiroloculina planulata (*Lam.*).		
fig. 29. Quinqueloculina seminulum (*Linn.*). Young.		From 440 fath.
fig. 30. Triloculina oblonga (*Montagu*).		
figs. 31, 33. Calcarina Spengleri (*Gmel.*), var.		Shallow water.
fig. 32. Described as a lenticular body, like a *Nummulina.*		

Whatever the peduncles in figs. 31 & 33 may be, the terminal processes, referred to by Mr. Macdonald as peduncles, in figs. 2, 4, 6, 21, 23, & 30, are the usual more or less produced, tubular, stoloniferous apertures.

Several good *sectional views* of typical forms are given by Dr. J. G. Egger, 'Neues Jahrbuch für Mineralog. Geog.' &c. 1857, among his figures of the Miocene Foraminifera of Ortenberg; and these also may be advantageously used in comparison with Ehrenberg's figures.

§ 2. In the first place we propose to offer such conclusions as we think we can safely arrive at with respect to the figures of Foraminifera given in the 'Abhandlungen' for 1838, 1839, 1841, and 1847.

I. Abhandl. Berl. Akad. Wiss. für 1838 (1839), pp. 54–149, with table and 4 plates. (Ueber die Bildung der Kreidefelsen und des Kreidemergels durch unsichtbare Organismen.)

Pl. 1. fig. 1, A, *a*, *** &c., B, *a*, *b*, *c*, *d*, *e*, &c. Rotalia Beccarii. From the Adriatic. =*R. Beccarii*, var. *ammoniformis* (Lin. et Lam.).

fig. 2. A, *α*, *a*, *b*, *c*, B. Marginulina raphanus [Linn. sp.]. From Rimini, Adriatic.

Pl. 2. fig. 1, *a*, *b*, *c*, *d*, *x*, *y*, &c. Peneroplis planatus. From the Red Sea. =*P. pertusus* (Forskål).

fig. 2, *a*, *b*, *α*, *x*, &c. Coscinospira* Hemprichii. From the Red Sea and Libyan portion of the Mediterranean. The elongate subtype of *Peneroplis.*

Pl. 3. fig. 1, *a*, *b*, *c*, *d*, &c. Orbiculina numismalis [Lamarck].

* This subgeneric name (=*Spirolina*, Lamarck) is misapplied to the elongate *Lituolæ* in some of Dr. Ehrenberg's memoirs.

From the Antilles. =*Orb. adunca*, and var. *orbiculus* (F. & M.).

fig. 2, *a*, *b*, *c*. *d*. Sorites orbiculus. From the Red Sea and Mediterranean. Young stage of *Orbitolites orbiculus* (Forskål).

fig. 3. Amphisorus Hemprichii. From the Red Sea? Old condition of the same.

Pl. 4. fig. 1. "Writing Chalk," from Puszkary, Poland; opposite Grodno, on the Memel.

fig. 2. The same, from Jutland, Denmark.

fig. 3. The same, from Rügen Island, Pomerania.

fig. 4. The same, from Gravesend, on the Thames.

fig. 5. The same, from Meudon, near Paris.

fig. 6. "Harder writing Chalk," from Cattolica, Sicily.

fig. 7. "Compact Chalk," from Cahira, Mokattam Hills, near Cairo.

fig. 8. The same, from the catacombs of Thebes, Upper Egypt.

fig. 9. "Compact grey limestone," from Hamam Faräun (Mountain), Sinai, Arabia.

fig. 10. "Chalk-marl," from Oran, Africa.

fig. 11. The same, from Caltanisetta, Sicily.

fig. 12. The same, from Greece.

These are samples of the limestones or marly earths*, finely levigated, showing the Microzoa &c. of which they are severally composed, highly magnified, and few exceeding $\frac{1}{24}$ of a (Paris) line in diameter.

The following list comprises the Foraminifera figured in plate 4, as named in the memoir:—

Globigerina bulloides (?), *D'Orb.*
—— helicina (?), *D'Orb.*
Planulina sicula.
—— turgida†.
Robulina cretacea.
Rosalina foveolata†.
—— globularis (?), *D'Orb.*
—— lævigata†.
—— pertusa.
Rotalia globulosa†.
—— ocellata.
—— ornata.
Rotalia perforata.
—— scabra.
—— stigma.
Textularia aciculata (?), *D'Orb.*
—— aspera†.
—— brevis.
—— dilatata†.
—— globulosa†.
—— perforata.
—— spinosa.
—— striata†.
Turbinulina italica (?), *D'Orb.*

Excepting those from Poland, all the above and many

* The first six and the eighth are "chalk" or "chalk-marl," or, rather, cretaceous limestones; 10 & 11 are white siliceo-calcareous earths, composed of Diatoms and Polycystines, with relatively few Foraminifera; and 12 is argillaceous.

† These are the most abundant.

others are better figured and determined in the 'Mikrogeologie,' 1854.

The species of Foraminifera known to Ehrenberg in 1839 are enumerated and characterized at pp. 130–135, Abhandl. für 1838.

II. Abhandl. Berl. Akad. für 1839 (1841), pp. 94 *et seq.*, with 4 plates. (Ueber noch zahlreich jetzt-lebende Thierarten der Kreidebildung.)

Pl. 1. fig. 1, *a–g*. Geoponus stella-borealis *. = *Polystomella striatopunctata* (F. & M.).

Pl. 2. fig. 1, *a–g*. Nonionina germanica*. = *Nonionina umbilicatula* (Montagu).

fig. 2, *a*, *b*, *c*. Rotalia perforata. = *Planorbulina.*

fig. 3, *a*, *b*. —— globosa. = *Planorbulina?*

fig. 4, *a*, *b*. —— turgida. = *Cristellaria rotulata* (Lamarck).

fig. 5, *a*, *b*. Textilaria aciculata. = *Bolivina dilatata* (?), Rss.

III. Abhandl. Berl. Akad. Wiss. für 1841 (1843). (Verbreitung und Einfluss des mikroskopischen Lebens in Süd- und Nord-Amerika.)

P. 438, pl. 1. fig. 31. Rotalia peruviana. = *Pulvinulina?*

P. 441 (from Cuba), pl. 2. fig. 39. Triloculina antillarum. = *Miliola* (*Quinqueloculina?*).

fig. 40. Triloculina turgida. = *Uniloculina?*

fig. 41. Rotalia perforata. = *Planorbulina?* vel ?*Discorbina globularis?* (D'Orb.).

fig. 42. Rotalia cochlea. } = *Pulvinulina cultrata?*
fig. 43. Rotalia egena. } (D'Orb.).

fig. 44. Textilaria semipunctata. = *Bolivina?*

P. 443 (from Vera Cruz), pl. 3. fig. 41. ?Spirillina vivipara. This is stated to be *siliceous*; but it is extremely like some of the simply tubular, non-segmented *Pulvinulinæ*, and has been taken as a subtype. In the 'Mikrogeologie,' at p. 3 and elsewhere, in the lists of Microzoa, a *calcareous Spirillina vulgaris*, Ehr., is mentioned; but whether this is a relation of *Pulvinulina*, or a *Cornuspira*, or a *Trochammina*†, we have no means of judging.

* These two species are described in the Monatsber. for 1840, p. 23.

† The group of unchambered shells for which *Sp. vivipara* was taken as a type by one of us in 1850 (in King's "Monograph of Permian Fossils," Palæontogr. Soc. pp. 18–20) has been divided into the three divisions above indicated. The Permian discoidal fossil is really a *Trochammina*; but, from its supposed relationship to the Bordeaux fossil (a real

fig. 42. Spiroloculina lagena. =*Miliola.*
fig. 43. ? Planularia pelagi. = *Pulvinulina auricula?* (F. & M.)
fig. 44. Textilaria ocellata. =*Bolivina dilatata*, Rss.
fig. 45. Grammostomum tenue. = *Virgulina Schreibersii*, Czjz.
fig. 46. Text. stichopora. =*Textilaria sagittula?*, Defr.
fig. 47. ?Cristellaria vitrea. =*Rotalia orbicularis*, D'Orb. (Vitreous variety of *R. Beccarii.*)
fig. 48. Planulina tenuis. =*Planorbulina?*
fig. 49. Allotheca megathyra. =*Planorbulina farcta*; young, with coarse pores.
fig. 50. Nonionina millepora. =*Nonionina.*
fig. 51. Ptygostomum oligoporum. =*Planorbulina?*

IV. Abhandl. Berl. Akad. für 1847 (1849). (Passatstaub und Blutregen.)

P. 443. (Wind-dust, Italy.)
Pl. 1. fig. 95. Spiroloculina? Young *Miliola?*
fig. 96. Fragment.
fig. 97. Rotalia globulosa? Fragment. ?
fig. 98. R. senaria? Fragment. ?
P. 445. (Wind-dust, Calabria.)
Pl. 1. fig. 109. Miliola? (Oolina?) ?(Not *Miliola.*)
fig. 110. Fragment.
P. 446. (Wind-dust, Malta.)
Pl. 2. fig. 77. Textilaria striata. *Textilaria gibbosa* (?), D'Orb.
figs. 78, 79. T. globulosa. Fig. 78, *T. globulosa*, Ehr., and fig. 79, *T. carinata*, D'Orb.
fig. 80. Grammostomum. *T. agglutinans*, D'Orb.
fig. 81. Gr. carinatum? *Bolivina costata* (?), D'Orb.
fig. 82. Spirillina. Young *Cornuspira?* or *Miliola.*
fig. 83. Rotalia? ?
fig. 84. R. globulosa. ?
fig. 85. R. senaria. ?
P. 456. (Wind-dust, Lyons.)
Pl. 5. fig. 108. Nodosaria? ?
fig. 111. Textilaria globulosa. *T. globulosa*, Ehr.
figs. 112, 113. Rotalia globulosa? ?
fig. 114. Rotalia. ?

Spirillina of the *Pulvinulina* family) mentioned at p. 19, much confusion arose, which was not cleared quite away until the three kinds of discoidal unchambered Foraminifera were recognized. See Ann. Nat. Hist. ser. 4. vol. iv. pp. 386 &c.

P. 457. (Wind-dust, Paster-Thal.)
  Pl. 6 I. figs. 82, 83. Spiroloculina. Young *Cornuspira?* or *Miliola?*

P. 460. (Wind-dust, Silesia and Austria.)
  Pl. 6 III. fig. 59. Textilaria globulosa? *T. gibbosa*, D'Orb.
  fig. 80. Textilaria globulosa? *T. globulosa*, Ehr.

§ 3. We now proceed to study the 'Mikrogeologie' (1854), beginning with the first plate that contains figures of Foraminifera.

I. *Marl* [?], *or clay from Ægina, Greece.* ("Plastischer Thon" in the explanation of the plate; "Mergel-Fels. als plastischer Thon. *aus Ægina*" on the plate.) (Abhandlungen der Berliner Akademie der Wissenschaften, 1838; Griechenland no. 5. Monatsberichte Berl. Ak. Wiss. 1838, p. 176; 1842; 1844, pp. 62, 73, &c.; 1847, p. 43.)

This certainly appears to be a Tertiary* clay containing Diatoms, spicules, and Polycystines in abundance, and with so little calcareous matter (*Foraminifera*) that it can be used for terra cotta. Its position is thus described by Herr Fiedler in Dr. Ehrenberg's memoir:—"Ueber einen plastischen Kreidemergel von Ægina aus mikroskopischen Organismen und über die möglichkeit, durch mikroskopische Untersuchung des Materials den Ursprung gewisser alter ächtgriechischer Kunstdenkmäler aus gebrannter Erde (Terracotten) mit bisher unbekannter Sicherheit zu bestimmen." (Monatsber. 1842, pp. 263–268.)

"In Ægina there is much chalk-marl [?], particularly in the valley north of the town. A little peaked hill in the middle of the valley, on which stands a small chapel to St. Demetrios, is overlain by pale-red trachyte two fathoms thick; under this, down to the base, the hill consists of yellowish-white and greyish chalk-marl [?]. The upper, yellowish marl contains *Venus* shells; the lower, pale-pellow marl, with greenish streaks, has *Pecten* shells and rusty specks, and there only is soft to the nail. This lower portion in particular forms (*bildet*) a plastic clay which is worked" (p. 263).

Clays rich in Diatoms have been used for brick-making and ceramic purposes in England, Europe, Asia, and North America.

Plate xix. figs. 1–80 comprehend Diatomaceæ, Polycystina, Spongoliths, &c. Fig. 81, *Nodosaria monile* (1844, p. 93), is *N. filiformis*, D'Orb. Fig. 82, *Grammostomum depressum*

* It is referred to as of Tertiary age by Ehrenberg, 'Abhandlungen,' 1856, p. 127.

(1844, p. 93), is a short stout *Textilaria gibbosa*, showing a tendency towards *T. subangulata*, D'O. Fig. 83, *Gr. laterale* (1844, p. 92), is a neat, small, and rather broad *Bolivina punctata.* Fig. 84, *Gr. polystigma* (1844, p. 92), is a very fine large typical *Bolivina punctata.* Fig. 85, *Polymorphina* (?) *aculeata* (1844, p. 94), is *Bulimina aculeata*, D'Orb. Fig. 86, *Strophoconus græcus* ("1844, p. 96; *Textilaria aciculata*?, 1838"), seems to be either *Virgulina Schreibersii*, or, from its shell-structure, perhaps *Virgulina Hemprichii* (Ehr.), see 'Geol. Mag.' no. 89, p. 509. Fig. 87, *Rotalia Pandoræ* (1844, p. 95), is probably a small *Planorbulina.* Fig. 88, *R. umbilicus* (1844, p. 95), is also doubtful; it looks like some variety of *Planorbulina.* Fig. 89, *R. globulosa*, α (1838), is a young *Globigerina.* Fig. 90, *R. senaria* (1842), also is probably a young *Globigerina.* Fig. 91, *R. lepida* (1844, p. 95), seems to be a small *Planulina ariminensis* (?). Fig. 92, *Globigerina depressa* (1844, p. 92), is a good *G. bulloides.* Fig. 93, *Planulina elegans* (1844, p. 93), is a neat, delicate, sublobate *Planorbulina* of the *Haidingerii* subtype. Fig. 94, *Planulina globularis* (1844, p. 94), and 95, *Pl. porosa* (1844, p. 94), are two small, but neatly grown, specimens of a variety of *Planorbulina farcta*, near var. *Haidingerii*, but limbate on the margins and septa. It is the larger stage of *Pl. globulosa* (Ehr.). Fig. 96, *Planulina vitrea* (1844, p. 94), a young delicate individual of *Planorbulina Haidingerii.* Fig. 97. *Spiroloculina elongata* (1844, p. 96), a rather narrow form of *Sp. planulata*, Lamk.

The *facies* is that of a fauna from between 50 and 90 fathoms depth. Too many forms are present for an abyssal fauna.

Species and noticeable Varieties from Ægina (No. 1), *figured by Ehrenberg.*

1. Nodosaria filiformis, *D'Orb.*
2. Bulimina aculeata, *D'Orb.*
3. Bolivina punctata, *D'Orb.*
4. Virgulina Schreibersii (?), *Czjzek.*
5. Textilaria gibbosa, *D'Orb.*
6. Globigerina bulloides, *D'Orb.*
7. Planorbulina Haidingerii (*D'Orb.*).
8. —— globulosa* (*Ehr.*).
9. Planulina ariminensis (?), *D'Orb.*
10. Spiroloculina planulata (*Lamarck*).

* This must not be regarded as a species of real worth; for the young of *Planorbulina Haidingerii, Pl. vulgaris, Pl. lobatula*, and *Pl. ariminensis* are almost indeterminable one from another and from young *Nonioninæ*, especially when seen by transmitted light. Further, Ehrenberg's "*Rotalia globulosa*" not only comprises the above, but small *Globigerinæ* also.

II. *Laminated Marl* [?], *or marl-like Diatom-earth* ("Platten-Mergel, Placca di Furni, Plocafurno") *from Zante, Greece.* Composed largely of Diatoms and Polycystines. (Monatsber. Berl. Akad. Wiss. 1837, p. 61 : 1839. Abhandlung. Berl. Akad. 1838, Tabelle.)

Plate XX. I. figs. 1–53. Diatomaceæ, Polycystina, Spongolithi, &c.

Figs. 54, *Rotalia globulosa*, β? (1838), and 55, *R. senaria*, are probably young *Planorbulinæ* (*Pl. globulosa*?). Fig. 56, *Planulina annulosa*, looks like a small *Pl. ariminensis*, but it may be a *Nonionina* (?).

Species and noticeable Varieties from Zante figured by Ehrenberg.

1. Planorbulina farcta (*F. & M.*), var. *globulosa* (Ehr.).
2. Planulina *vel* Nonionina?

III. *Non-plastic marl from Ægina, Greece.* (Monatsb. Berl. Akad. 1838, p. 176. Abhandl. Akad. 1838, Tabelle, Griechenland no. 4.)

The specimen yielding the Microzoa here figured was a slightly plastic calcareous clay (marl) of Tertiary age, from the bed lying immediately on the plastic clay in the same hill in Ægina. In it Foraminifera predominate, and Diatoms and spicules are relatively few; and it differs so much in its organic contents that Ehrenberg thought it must be Tertiary, whilst he assigned the lower bed to the Cretaceous series, like those siliceo-calcareous deposits from Sicily and Oran * described by him (erroneously) as "Chalkmarls."

Pl. XX. II. fig. 1, *Nodosaria monile*, = *N. filiformis*, D'Orb. Figs. 2, *Strophoconus auricula*, 3, *St. ovum*, and 4, *St. gibbus*, are small specimens of *Virgulina Schreibersii*; and 5, *St. gemma*, is another, but varietal, approaching *Bulimina elegantissima* in its mode of growth. Fig. 6, *Spiroloculina tenera*; a small *Adelosina*, or first stage of nearly any *Miliola*. Fig. 7, *Grammostomum elegans*, is a delicate, rather broad, and partially punctate *Bolivina punctata*. Fig. 8, *Proroporus argus*, is a fine, strong, thick-shelled, short-chambered, and coarsely perforate variety of *B. punctata*. Fig. 9, *Gr. sulcatum*, is *B. costata*, or rather a delicate subvariety, neatly marked with slight furrows. Fig. 10, *Gr. aciculatum* ("*Textilaria aci-*

* The Microzoa of the lower plastic clay bed are compared with those of Caltanisetta and Oran, in a synoptical table, under revised names, in the 'Monatsbericht,' 1844, the Foraminifera at p. 44.

culata, 1838"), is a small *Bolivina dilatata*, Reuss (Denkschr. k. Akad. Wiss. Wien, 1850, pl. 48. f. 15); for a larger specimen see Mikrogeol. pl. 29. f. 23 (from Moen). Fig. 11, *Rotalia Pandoræ* (?), a small *Planorbulina* (?). Figs. 12, *a*, *b*, and 14 *a*, *R. globulosa*, 14 *b*, *R. senaria*, are probably minute *Planorbulinæ* (*Pl. globulosa*). Fig. 13, *a*, *b*, *R. umbilicus*, are larger, but still small, *Planorbulinæ*. Fig. 15, *Globigerina* (?), is a well-grown *Gl. bulloides*. Fig. 16, *Planulina proroteras*, =young *Gl. bulloides*. Fig. 17, *Pl. fumigata*, is the same as fig. 93 in pl. xix., but shows the opposite face,—a delicate *Pl. Haidingerii*, with subglobose inflated chambers. Fig. 18, *Pl. denticulata*, and fig. 19, *Pl. porosa*, is an interesting variety of *Planorbulina farcta*, such as is not rare in some seas, having a rough or aculeate shell, with thickened or limbate margin. These are variable characters in this very common species. Figs. 20, *Pl. adspersa*, 21 *a*, *Pl. turgida*, and 21 *b*, *Pl. annulosa*, are various small *Planorbulinæ* (fig. 21 *a* may be *Planulina ariminensis*). Fig. 22, *Pl. sparsipora*, is *Rotalia orbicularis*, seen with its flat face upwards: it has a clear colourless shell, with very fine pores. The few holes shown in the figure are perhaps borings. Fig. 23, *Pl. stellaris*, is a young, close-built *Planorbulina Haidingerii*, with some more limbation than usual. Fig. 24, *Robulina cristellina*, looks like a delicate *Cristellaria rotulata*. Fig. 25, *Cristellaria incrassata*, is a strongly limbate *C. cultrata*.

Belonging to a fauna inhabiting from about 50 to 90 fathoms depth.

Species and noticeable Varieties from Ægina (No. 2) *figured by Ehrenberg.*

1. Nodosaria filiformis, *D'Orb.*
2. Cristellaria rotulata (*Lamk.*).
3. —— cultrata (*Mtft.*).
4. Bolivina punctata, *D'Orb.*
5. —— argus (*Ehr.*).
6. —— sulcata (*Ehr.*).
7. —— dilatata, *Rss.*
8. Virgulina Schreibersii, *Czjzek.*
9. —— gemma (*Ehr.*).
10. Globigerina bulloides, *D'Orb.*
11. Planorbulina Haidingerii (*D'Orb.*).
12. —— denticulata (*Ehr.*).
13. —— globulosa (*Ehr.*).
14. Planulina ariminensis (?), *D'Orb.*
15. Rotalia orbicularis, *D'Orb.*
16. Miliola (young).

IV. The deposit that yielded the Diatomaceæ ("Polygastrica," Ehr.) and Foraminifera figured in plate xxi. was a white finely laminated calcareous and diatomaceous deposit containing numerous well-preserved impressions of fishes. This so-called "marl," also termed "Infusoria-conglomerate," "Tripoli-marl," and "Tripoli" by Ehrenberg, was found by M. Rozet, as two layers, with some calcareous and sandy beds, containing *Ostreæ* and *Gryphææ*, between them; and all of them occur among white chalk-like limestones and yellowish marls, with *Ostreæ* &c., in the plain east of Oran and extending to the Atlas. M. Rozet regarded these deposits as of Tertiary age; but Dr. Ehrenberg referred them to the Cretaceous series, on account of his determination of the same kinds of "Polygastrica" and "Polythalamia" in them as in other beds regarded by him as Cretaceous. He considers this Oran Tripoli to be equivalent to a similar white diatomaceous and calcareous earthy bed, with fish-remains, that is found in Sicily (see further on). This latter deposit is characterized by *Clupea tenuissima*, and, like that of Oran, has been classified among the Tertiary formations; nor does there appear any valid reason, based on its Microzoa, to group it otherwise.

Shaly Tripoli-bed, from Oran, Africa. Abounding with Diatoms and Polycystines. (Abhandl. Berl. Akad. Wiss. 1838, table no. 4, and fig. x. Monatsber. 1840; 1844, pp. 62, 73, &c. Ann. Nat. Hist. vol. vii. p. 312.)

Plate xxi. figs. 1–81 comprise Diatomaceæ, Polycystina, Spongoliths, &c.

Fig. 82, *Grammostomum cribrum* (1844, pp. 67, 93), = *Bolivina dilatata*. Fig. 83, *Proroporus lingua* (1844, pp. 67, 95), = *Bol. punctata*, with slight indications of ribbing, and therein approaching to *costata*. Fig. 84, *Gr. plica* (1844, pp. 67, 93), and fig. 85, *Gr. aciculatum* (1844), are *Bol. punctata*. Fig. 86, *Gr. divergens* (1844, pp. 67, 93), = *B. dilatata*. Fig. 87, *Textilaria globulosa* (1844), is a small *T. gibbosa*. Fig. 88, *Strophoconus africanus* (1844, pp. 68, 96), is a young *Virgulina Hemprichii*. Fig. 89, *Planulina perforata* (1844), fig. 90 *a*, *b*, *Rotalia globulosa* (1838, 1844), and fig. 91, *Pl. ocellata* (1844, p. 67), are young individuals of *Globigerina bulloides*. Fig. 92, *Prorospira princeps* ("1844, pp. 67, 95, = *Planulina turgida*, 1844, young"), = *Planorbulina ammonoides*. Fig. 93, *Pr. comes* (1844, pp. 67, 95), is a variety near *Pl. ammonoides*. Fig. 94, *Planulina squamula* (1844, pp. 67, 94), is a small limbate *Planorbulina*. Fig. 95, *Pl. spatiosa*, is a large, broadtopped, gently sculptured, glassy, flat *Pulvinulina*, so much coated with clear secondary shell-deposit as to have the fine pores masked. It is near var. *pulchella* of *Pulv. repanda*. Ehrenberg has figured it also from the Chalk of Moën (pl. 29. fig. 15), and a very close ally from that of Rügen (pl. 30. fig. 28). Fig. 96, *Globigerina foveolata* (1844, p. 67), is *Gl. bulloides*. Fig. 97, *a*, *b*. *Nodosaria*? These are single and double rough-coated hollow globules, possibly chambers of *Globigerina* (?), but not of *Nodosaria*.

Inhabiting a depth of from 40 to 50 fathoms.

Species and noticeable Varieties from Oran, figured by Ehrenberg.

1. Bolivina punctata, *D'Orb.*
2. —— dilatata, *Rss.*
3. Virgulina Hemprichii (*Ehr.*).
4. Textilaria gibbosa, *D'Orb.*
5. Globigerina bulloides, *D'Orb.*
6. Planorbulina ammonoides (*Rss.*).
7. Pulvinulina spatiosa (*Ehr.*).

V. The deposit yielding the Microzoa figured in pl. xxii. is described as a white, chalk-like, thinly laminated "marl," analogous to tripoli, from Caltanisetta, in Sicily. It was obtained by the late Mr. Hoffmann; and in his MSS. it was termed "white chalkmarl," and referred to the Cretaceous rocks dipping at a high angle below unconformable Tertiary deposits. Ehrenberg, however, identifies these laminated marly beds, containing numerous fishes, found between Caltanisetta and Castrogiovanni, near the middle of Sicily, with the diatomaceous earth from near Oran, above treated of. Between the two Sicilian localities mentioned above, Cretaceous rocks certainly are exposed; but others of Tertiary age also abound, including, we believe, the diatomaceous calcareous earth, with *Clupea tenuissima*, already referred to; and if this white earthy siliceo-calcareous deposit (which is not a "marl" in the correct sense), abounding with *Coscinodisci* and *Globigerinæ**, be the same as that to which Ehrenberg alludes, there is no doubt of its *Tertiary* age.

White Chalky Marl [?] *of Caltanisetta, Sicily.* (Abhand. Berl. Akad. Wiss. 1838, pl. 4. fig. xi. Monatsb. 1840, 1844. Ann. Nat. Hist. vii. p. 313.)

Pl. xxii. figs. 1–73. Diatomaceæ, Polycystina, Spongoliths, &c.

* We have some of this rock, from Sicily, in our own collection.

Fig. 74, *Globigerina foveolata* (1844, p. 67), a large and characteristic *Gl. bulloides.* Fig. 75, *Planulina pertusa* (1844, p. 67), fig. 77, *Pl. stigma* (1844, p. 67), and fig. 78, *Rotalia globulosa* (1838; 1844, p. 67), are young *Globigerinæ.* Fig. 76, *Colpopleura ocellata* ("1844, pp. 67, 92; *Rotalia ocellata*, 1838") is a variety of *Planorbulina farcta*, very near to *Haidingerii*, with very large irregular holes. Fig. 79, *Rotalia scabra* (1844, p. 67), a very coarse-shelled variety of *Pl. farcta*, of the *ammonoides* group. Fig. 80, *Textilaria perforata* (1844, p. 68), obscure; possibly an unusually perforate young *Textilaria* with globose chambers, but probably an irregularly grown *Globigerina.* Fig. 81, *Strophoconus ovum* (1844, p. 96), is a young *Virgulina Schreibersii.*

These represent a fauna that lived at not less than 100 fathoms.

Species and noticeable Varieties from Caltanisetta, figured by Ehrenberg.

1. Virgulina Schreibersii, *Czjzek.*
2. Textilaria?
3. Globigerina bulloides, *D'Orb.*
4. Planorbulina Haidingerii (*D'Orb.*).
5. —— ammonoides? (*Rss.*).

VI. The Nummulitic Limestone of Egypt has been regarded as of Tertiary age by geologists since the determination of its Eocene characteristics by the late lamented Sir Roderick Murchison, in his memoir on the Alps and Carpathians, &c. Quart. Journ. Geol. Soc. 1849, vol. v. p. 303. It had previously been looked on as of Cretaceous age; and Ehrenberg, in the 'Mikrogeologie,' speaks of it as belonging to that period, on the ground of his finding Cretaceous Foraminifera in it. His figures do not bear evidence of this in a special manner; indeed the *Nummulinæ* are preeminently "Tertiary," none being known in the Chalk of Europe, and only a few specimens of *Operculina**, their nearest ally. A doubtful *Nummulina, N. cretacea*, Fraas†, has been recorded as belonging to the Hippurite (Cretaceous) Limestone of Palestine, near Jerusalem; and with this feeble link (strengthened by other considerations) it may be said that there may be some Nummulite-bearing rocks transitional from the Chalk series to the Eocene. Those of Egypt, however, are markedly Eocene.

* *Operculina Fleuriausi* (Rss.); *Op. cretacea*, Rss.; *Op. clypeolus* (Rss.); *Op.? angularis*, Cornuel; *Op. turgida* (Ehr.).

† 'Aus dem Orient,' 1867, pl. 1. fig. 8.

The specimens of limestone analyzed by Dr. Ehrenberg were brought from Gyzeh, on the left bank of the Nile, and from Mokattam, near Cairo, on the right bank. It was compact, the small Foraminifera serving as cementing-matter among the Nummulites of which the rock is mainly composed.

The figured Foraminifera of plate xxiii. bear evidence, in the truthful engraving of their somewhat rough, partly obscured, and occasionally broken condition, to their having been closely cemented and much mineralized by carbonate of lime in their fossil matrix.

[To be continued.]

XXIV.—*On some Recent Researches in Vegetable Physiology.* By M. Marc Micheli.

[Continued from p. 155, and concluded.]

II.

The study of the phenomena of which the interior of cells is exclusively the theatre, of the transformations which are manifested there, and of the substances which they contain has also produced some works which deserve notice, and in the first place the researches of M. Schrœder * upon the "spring period of the maple." The author has paid attention to all the successive phases presented by the development of the vegetation, from the ascent of the sap to the moment when the expanded leaves begin to decompose carbonic acid. This is one of those complete and conscientious works which, even when they do not contain any very novel results, are nevertheless very useful to read and consult; but it is difficult to give a clear notion of them in a few words.

A glance at the course followed by M. Schrœder will show the great number of facts which group themselves within a framework such as he has adopted.

The first part is entirely devoted to the study of the sap, its ascent, and its composition. The maple, under the latitude of Breslau, "*weeps*" for about a month; the sap rises gradually to a certain level, whence it descends again by degrees, in proportion as the development advances. Holes pierced in the trunk at different heights enabled this sap to be collected daily; and very numerous analyses keep us informed of the smallest variations in its composition. It always contains sugar, a transitory product of the transformation of the starch accumulated in the tissues during the pre-

* "Frühjahrsperiode des Ahorns," Pringsheim's Jahrb. vii. p. 261.

ceding summer, and destined to become retransformed when it reaches the buds. The proportion, faithfully represented by a great number of curves, is but slight at the first awakening of vegetation; it increases gradually up to a certain maximum, in proportion as the vital phenomena acquire more intensity; and, finally, it diminishes when the young organs, approaching the term of their development, are on the verge of sufficing for themselves. These facts are therefore perfectly in accordance with such a theory of growth as has been established by the researches of modern observers.

The albumen and the mineral salts are successively studied from the same point of view; and their dissemination in the sap at different heights at the same moment, and at different periods, is exactly governed by the different phases of development.

The second part is devoted to the microscopic examination of the bud. The different substances which are called upon to assist in the development of the young leaf are traced by means of reagents from cell to cell. Two, especially, give origin to detailed observations, namely starch and tannin.

The dissemination of the former in the different tissues, its transportation through the starchy layers of the fibro-vascular bundles, its disappearance towards the point of vegetation, at the surface of which it speedily reappears as cellulose—all these different phases are taken up step by step; and here, again, we find a confirmation of all that theory led us to foresee.

As to tannin, it is developed in all the cells of the bud; and when once it has made its appearance, it persists there without appreciable change. Its function has greatly embarrassed M. Schrœder, as he was unable to recognize in it any of the characters of an excrementitial product, properly so called. The fact that it is constantly to be found in the youngest tissues (in which life is most intense) seems to indicate that it is a sort of final product, charged with a still unknown office in the life of the cell. If the true chemical nature of this substance were better known, the solution of the problem would perhaps become easier.

Certain authors have thought that the course of vegetation in the Agarics induced a marked exhalation of gaseous ammonia at their surface. M. Sachs mentions the fact in his 'Treatise on Physiology,' but without absolutely affirming it. M. Borscow * has undertaken a series of experiments, upon which he

* Mélanges Biologiques tirés du Bull. de l'Acad. Imp. des Sci. de St.-Pétersb. tome vii. p. 121.

relies to affirm positively the existence of this phenomenon. According to him, the production of gaseous ammonia is a general fact in the family of the Agarics; the quantity of gas exhaled is in proportion to the vital activity of the plant, but has nothing to do with its weight. It is equally without any relation to the production of carbonic acid as a result of respiration.

But quite recently MM. Wolff and Zimmermann* have objected to these conclusions. In all their experiments they were only once able to recognize some traces of ammonia, and the Agaric was not under conditions so normal as the others. These two authors, therefore, believe that in the Agarics, as in other plants, ammonia is a product of the decomposition of the tissues, but a product which begins to make its appearance immediately the vital functions of the organism are slackened.

Inuline, a substance of the starch-group, which is met with in a considerable number of plants, has been made by M. Prantl † the subject of a memoir crowned by the University of Munich.

The results obtained by the author of this memoir are in all essential features in accordance with what MM. Nägeli and Sachs have said of inuline. M. Prantl describes this substance as a hydrate of carbon, which differs from starch, cellulose, and lichenine in never taking on an organic form. Its fixity sufficiently differentiates it from dextrine. It seems to approach most nearly to cane-sugar.

Inuline is constantly found in plants in the form of a solution of 1 part of inuline to 7 of water. As in artificial solutions 0·01 gramme of inuline saturates 100 cub. centims. of water, we may suppose that when dissolving in the plant it undergoes transformation. It never appears except in subterranean organs.

This substance is pretty frequently produced in plants of different families, but especially in the Compositæ. The dahlia and certain *Helianthi* contain considerable quantities of it.

From a physiological point of view, inuline plays exactly the part of one of those nutritive principles which are put in reserve, such as starch, sugar, oils, &c. As we have just said, it exists exclusively in subterranean organs, tubers or rhizomes. At the moment of growth it is transformed into cane-sugar towards the collar of the root, then mounts into the

* Bot. Zeitung, 1871, Nos. 18 and 19.

† Das Inulin, Munich, 1870; and Bot. Zeitung, 1870, No. 39.

stem in the form of starch, and thus passes towards the buds. Subsequently the starch produced in the leaves descends along the stem in the form of starch itself or of sugar; and it is only on its arrival in the root that it takes on the form of inuline.

III.

We cannot conclude this revision of the principal recent physiological publications without casting a glance upon a group of very interesting works, although these do not yet allow us to rise to general conclusions. We would speak of fecundation in phanerogamous plants, and the part which insects perform in it. The idea itself is not new; and even a century ago Sprengel* cited numerous cases of flowers fecundated by the mediation of insects. But it is only in our time that it has been attempted to generalize these facts; and Mr. Darwin was the first to put forward the notion that the fecundation of a flower by itself is contrary to the laws of nature, and that the reproduction of a species is not well assured except by crossings between different individuals.

A theory like this cannot of course be proved except by direct investigation of facts; and the facts, when we have to do with fecundation, are most minute, and demand peculiarly ingenious and patient observations. Several naturalists have advanced to the breach; and we possess a fine collection of special memoirs, the conclusions from which already form a solid basis for theoretical ideas. However, if the observers have had to manifest great patience, the recompense waited for them at the end. Nothing is more curious than the details of organization by which spontaneous fecundation, apparently so easy, is rendered useless or even impossible. The researches of Mr. Darwin himself upon the fecundation of the Orchids, upon the dimorphism of the primrose, and upon the trimorphism of *Lythrum salicaria* are well known. He has found imitators in MM. Hildebrandt and Delpino. Both these authors have published numerous memoirs, sometimes studying thoroughly all the details of fecundation in a certain plant or family, sometimes tracing throughout the vegetable kingdom a certain type of fecundation, and pointing it out wherever it is manifested. M. Hildebrandt †, moreover, some time since, brought together all the data we possess upon the subject, and endeavoured to group them methodically. The perfectly uniform conclusion of all these works is, that in the great majority (if not in the totality) of plants direct and spontaneous fecundation is im-

* Das entdeckte Geheimniss der Natur im Bau und Befruchtung der Blumen. Berlin, 1793.

† Die Geschlechter-Vertheilung bei den Pflanzen. Leipzig, 1867.

possible, and that the intervention of insects is always necessary.

In a multitude of cases the expansion of the stigma does not take place at the same time as the opening of the stamens; the flowers are what are called "dichogamous," and may be protandric or protogynic.

The former are most frequent. Entire and most important families enter this category, such as the Labiatæ, the Scrophulariaceæ, the Compositæ, and the Campanulaceæ. Here the office of insects is very evidently necessary; and it is facilitated by the most varied details of organization. For example, in the whole of the immense group Compositæ* the five stamens have the anthers soldered into a cylinder, which envelopes the pistil; they open and allow the pollen to escape before the style has become elongated. The style bears, below the stigma, a certain number of rigid hairs, which retain the pollen-grains, and carry them forward with them in their ascending movement at the moment of the elongation of the style. The pollen thus carried up out of the cylinder of the anthers is collected by insects and transported to flowers the stigma of which is already expanded.

In the Campanulaceæ†, Lobeliaceæ, &c. the system is the same, only the appendages destined to retain the pollen on the style present a very variable form.

In the whole of the group of Scrophulariaceous Labiatæ‡ the axis of the flower is horizontal, and the stamens are approximated beneath the upper lip of the corolla. The insects, in passing, separate and jostle them, cause the pollen to fall from them, and then transport it to a more advanced flower. In certain genera the stamens alone stand in the way of the insect, which always seeks the bottom of the flower, where the nectaries are. Later on they curve outwards, the style in its turn becomes elongated, and advances to take their place, and its recurved extremity caresses the body of the insect loaded with pollen.

In certain plants in which the expansion of the reproductive organs is simultaneous, the part performed by insects is no less maintained. In their absence spontaneous fecundation, which nevertheless appears to be inevitable, does not take place, or produces very little effect. Such, for example, are numerous Leguminosæ§, in which the stamens and the pistil are enclosed in the keel, in very close proximity. Insects, going to collect

* "Ueber die Geschlechtsverhältnisse bei den Compositen," Acta Leop. Carol. vol. xxv. 1869, and Bot. Zeitung, 1870, No. 30.

† "Ulteriori osservazioni sulla dicogamia nel regno vegetale," Atti della Soc. Ital. di Sci. Nat. vols. xi. & xii.; and Bot. Zeitung, 1870, Nos. 37–42. ‡ *Ibid.* § *Ibid.*

the nectar, touch the back of the keel; the latter throws itself briskly backward; the insect receives a few grains of pollen, and transports them to the neighbouring flower. Without this intervention, often not a single seed is produced.

The family Fumariaceæ, lately studied by M. Hildebrandt*, presents us with a perfectly analogous example. The stamens and the pistil are narrowly enclosed between the two petals, and appear to be removed from all exterior action. But the base of the petals, which is produced into a spur, offers an abundant provision of nectar. To reach it the insect must pass between the two petals, the upper part of which, borne upon a sort of hinge, separates easily. It thus loads itself with pollen.

Lastly, some flowers are polymorphic. By this name we designate the species in which the stigma and the stamens, which are placed at different heights in the corolla, do not always occupy the same relative positions. In some individuals the stigma, borne upon a long pistil, passes the corolla more or less, whilst the stamens remain very short; in others the stamens advance and the pistil remains short.

Mr. Darwin † was the first to study this peculiarity in *Primula* and *Lythrum*. M. Hildebrandt has since observed a great number of polymorphic flowers. Better than any others they show the necessity of crossings. In fact a pistil is fertilized only by the stamens which are developed at the same height with itself relatively to the corolla, and consequently of necessity in another flower. Numbers in connexion with this subject are more eloquent than any thing else. In experimenting upon a trimorphic *Oxalis*, M. Hildebrandt ‡ obtained the following results:—

28 flowers with long styles, fecundated with pollen from flowers with long stamens, produced 28 capsules, each containing on an average 11·9 fertile seeds.

23 flowers with long styles, fecundated with pollen from median stamens, produced 2 capsules, which, together, only furnished a single seed.

14 flowers with long styles, fecundated with pollen from short stamens, produced no capsule at all.

38 flowers with median styles, fecundated with pollen from median stamens, produced 38 capsules, containing on an average 11·3 seeds.

* "Bestäubungsvorrichtungen bei den Fumariaceen," Pringsheim's Jahrb. vii. p. 423.

† "Dimorphism in *Primula*," Linn. Soc. Journ. vi. 1862. "Hétéromorphisme et ses conséquences," Ann. Sci. Nat. 1863, tome xix.

‡ Bot. Zeitung, 1871, Nos. 26 and 27.

The other numbers correspond exactly with the preceding; but these suffice to enable us to appreciate what takes place.

It is likewise useless to prolong further the extracts from these works. What we have said is sufficient to show their general character, and the importance of the results already obtained.

We here terminate this rapid and necessarily imperfect revision. But the quantity of materials is considerable, the subjects treated are very varied, and it is very difficult to bring the whole within the limits of a single essay. We hope on another occasion to be able to complete what is deficient here.

XXV.—*On the Development of* Syngamus trachealis. By Prof. Ehlers*.

I am indebted to the kindness of Baron von Freyburg, of Regensburg, for the opportunity of tracing experimentally the course of development of this worm, which is parasitic in the tracheæ of birds, and, when it occurs in quantity in aviaries, pheasantries, and poultry-yards, produces considerable losses by the destruction especially of young and weakly animals. The parasite was introduced with some exotic birds into the aviary of the Baron von Freyberg during the illness of its owner, and has since occurred there more or less abundantly. The birds attacked by the worm betray this generally at first by a peculiar cough, during which they frequently throw the head to and fro, and not unfrequently at the same time expel small masses, which they generally pick up and swallow immediately. Large birds bear the parasitism of the worm, if it does not occur in too large numbers, for a long time; small birds, on the contrary, often die suddenly—it would appear, especially by the pair of worms (which, as has long been known, reside in the trachea usually *in copulâ*) placing themselves in such a position that the passage of the air-tubes is stopped, and the birds are suffocated.

In a *Cardinalis virginianus* which M. von Freyberg gave me for examination, and which, according to him, had long been infested by *Syngamus*, I could see the animals in the entrance to the upper larynx, and take them out with a fine forceps. In freshly infected tits, the mucous membrane of the throat was more strongly reddened than usual, and exhibited some very fully charged superficial veins. But the most

* From the 'Sitzungsberichte der phys.-med. Societät zu Erlangen,' Dec. 5, 1871. Translated by W. S. Dallas, F.L.S., from a separate copy communicated by the Author.

certain character to prove the presence of *Syngamus* in a coughing bird (as the phenomena of coughing may be produced by very different maladies) is the examination of the dung of the bird, because as soon as the disease has continued a little longer, so that the parasites have become sexually mature in the trachea, the ova may be easily found in the dung. I made this observation on the above-mentioned cardinal grosbeak, and found it confirmed when I saw at M. von Freyberg's, in Regensburg, a *Euplectes melanogaster* (Sw.) which coughed a little in the evening and morning, and in whose dung the readily recognizable ova of *Syngamus* immediately occurred.

I made use of the material at my disposal, in the first place, to trace the development and migration of *Syngamus*. *A priori* it was not probable that a bird would acquire the parasite when it ate the ova of a *Syngamus*, since the ova occurred in the dung of birds, and evidently pass through the intestines uninjured when the bird swallows the mucous masses or fragments of the worm containing ova which have been expelled from the trachea. An experiment made in this direction remained so far without result that a canary which I allowed to swallow a female *Syngamus* filled with mature ova did not acquire the parasite.

It seemed more probable that the ova, when expelled from the trachea or evacuated with the fæces, would be developed at first outside the bird. Leuckart's statement * that the species of the genus *Strongylus* which are parasitic in the lungs have an intermediate form, which lives in an intermediate host, belonging generally to the Insecta, together with the statement of M. von Freyberg, that he had observed the disease among his birds especially after they had been fed with insects, induced me to give cockroaches and mealworms the opportunity of eating the ova of *Syngamus*, and allowing the latter to become developed in them. With insects thus infected I thought to introduce the worm into the birds, but without result. I was, however, soon put upon the track of a simpler mode of development.

The ova of *Syngamus* are developed, with sufficient moisture and warmth, in the open. The mature ovum of *Syngamus* is evacuated by the female in various degrees of segmentation; it occurs under these conditions in the mucus of the air-passages in diseased birds, and somewhat further developed, but always so that the vitellus consists of a number of globules of segmentation, in their fæces. It has a cylindrical or slightly ellipsoidal form, with a length of 0·11 millim. and a breadth

* Die menschlichen Parasiten, Bd. ii. 1868, p. 402.

of 0·036 millim. A distinctly double-contoured shell forms the external envelope: it exhibits at each pole a circular gap; but even here the entrance to the interior of the ovum is closed by a very fine membrane, which adheres closely to the inner surface of the shell throughout. In the centre of the ovum the dark, segmented vitellus lies in a clear, apparently fluid, substance; in this stage it is 0·084 millim. in length. Such ova I put into earth which was kept moist, or into dung, or into water with or without an intermixture of mucus from the trachea of the birds, or other portions of animal tissue. Here the ova were developed, whether the materials did or did not fall into a state of strong decomposition. The only variation was in the duration of the development, evidently chiefly in dependance on the temperature; for ova which I had set aside for development in an unwarmed room on the 20th September, presented no change for a long time at first, and it was only on the 27th October, when the room was permanently heated, that young worms, rolled into several convolutions, were developed in them. In another case, when the room was kept at a uniform temperature, the ova were developed in the same way in eight days. From a number of ova, although always comparatively few, the young worms escaped at one of the poles of the ovum, where the circular gap existed in the firm egg-shell. The free young worms were filiform, with a blunt head and a pointed tail; the anterior third of the body was translucent; but further on there was a finely granular mass. They were always enveloped by a sheath-like, clear, and extremely fine membrane, which could also be recognized on the young still remaining in the ovum. During this hatching many of the animals died, from not being able completely to quit the egg-shell. Those which acquired their freedom usually moved but sluggishly; and I have been unable as yet to trace their further development. This is evidently only an exceptional case, but still worthy of notice. The majority of the ova remain in a condition in which the young worms developed in them, which now occupy the whole space within the egg-shell, lie quietly or make but few movements. This is not the place to enter upon the details of the development; and it will suffice to state that the development in general takes place as in other parasitic Nematodes.

I made feeding-experiments with ova developed in the above manner. A cole tit (*Parus major*), which I had long observed in a cage in order to convince myself of its good health, received, on the morning of the 3rd November, in a drop of water, a great number of the ova in which the embryos were developed. On the evening of the 20th November

I first heard this tit coughing; but it had struck me a few days previously that the bird was quieter than usual, although in other respects it showed no symptoms to indicate disease. On the next morning I examined the freshly evacuated fæces of the bird, and found in them ova of *Syngamus* in the usual state of development. I killed the tit, and found in its trachea two pairs of *Syngami in copulâ*—a large pair, of which the female was swelled with mature ova, and a smaller pair, the female of which bore only a few mature ova. From the administration of the embryoniferous ova to the time when the disease manifested itself and the *Syngami* were sexually mature, 17 days had elapsed.

A canary to which I had administered embryoniferous ova in the same way, coughed within seven days, and presented remarkable difficulty of breathing; but its fæces contained no developed ova. On the twelfth day after feeding I killed it, and found in the trachea twelve pairs of small *Syngami in copulâ*, but without matured ova. Here the worms produced the diseased phenomena in the trachea of the bird before they had attained full sexual maturity; and this explains the absence of the ova in the fæces.

My investigations are not yet completed. I have still to ascertain the mode of immigration into the trachea, as I am by no means certain whether during the pouring in of the ova they remain adherent at the entrance of the larynx and the whole development takes place in the trachea or the lungs and airsacs, or whether the ova are swallowed (which in my experiments was certainly the case with the majority of them) and the young then quit the egg-shell in the intestine of the bird, bore through the wall of the stomach or intestine, and, entering into the airsacs, thus obtain access to the trachea. From what I have as yet observed in connexion with this, the former would appear to be the way in which the immigration takes place.

Upon this, and upon the structure of the full-grown and of the developing animal, I shall report elsewhere in detail, with reference to the existing literature of the subject. My object in this communication was to state that the ova of *Syngamus* in the open and under various conditions, when deposited in moist localities either with the fæces or the ejections from the trachea of the bird, become so far developed that the parasites escape from them as soon as they are taken up by a bird. By this means a course is to a certain extent indicated in which, by preventive measures, we may protect poultry-yards or aviaries from the immoderate and destructive diffusion of these parasites. Careful observation of coughing birds, in which the examination of the fæces for ova will give the most certain information as to the presence of these parasites, and measures to make sure that in districts frequently affected by this worm-disease no *Syngami* are introduced at the purchase of new birds, are of the greatest prophylactic value. If the disease make its appearance in great extent, various ways must be adopted, according to the localities, in order to prevent the food-vessels from being contaminated by the fæces or other ejecta, and the soil in damp spots from forming breeding-places from which fresh infections of the birds may continually take place. The custom of many bird-fanciers, of throwing the carcasses of birds among their meal-worms, " in order to make the worms fat," is very well fitted, in the case of the carcasses containing *Syngamus*, to disseminate the ova, which would be readily developed in the moist and warm mass with the meal-worms, and to transfer them, with the latter, into birds.

BIBLIOGRAPHICAL NOTICES.

Figures of Characteristic British Fossils, with Descriptive Remarks. By W. H. Baily, F.L.S., F.G.S., &c. Part III. Plates 21–30. *Upper Silurian and Devonian.* 8vo. London: Van Voorst, 1871.

The three parts of this work that have now been published contain 30 lithographic plates, illustrating 504 fossils and their parts, together with explanations and descriptive remarks, which are further illustrated by several woodcuts. With the author's guidance we have learned the meaning of the ancient relics of primæval creatures, which he has arranged for us out of quarry and cabinet, and can value them truly as medals of creation and trustworthy indications of past times and conditions, as the numismatist uses his coins and tokens. Mr. Baily explains the nature of the different types of the great groups of the animal and vegetable kingdoms as they come successively, in relative abundance, in the several formations, and supplies plentiful references to the describers of fossil species, and takes trouble to indicate the distribution of the several typical fossils that his correct judgment leads him to lay before his reader.

We are promised that "Part IV. will complete the Palæozoic division of strata, and conclude vol. i.;" and another such set for "the Secondary" and another for the "Tertiary" strata and fossils will make up the useful and trustworthy work, of which we have had so good a beginning. Though the lithographs are rather woolly, there is no doubt of their accuracy; for the accomplished author cares for them himself. A few *errata* of greater or less importance will have to be noticed:—*Gothlandicus* for *Gotlandicus*, *Cælenterata* for *Cœlenterata*, *Cymbœformis* for *Cymbæformis*, *Loxonoma* for *Loxonema*, *Astrea* for *Astræa*; and at p. xlvi, line 23, has *for* have.

In this Part 3rd of Mr. Baily's book of fossils we have:—Mollusks and Crustaceans from the Wenlock rocks; a Coral, Echinoderms, Mollusks, Crustaceans, and Fish-remains from the Ludlow strata; Plants, Corals, Crinoids, and Brachiopods from the Devonian formations. We recognize the results of much research among modern works; but occasionally the author has omitted a point, such as Ray Lankester's correction of the generic alliance of *Scaphaspis* (olim *Pteraspis*) *truncatus*, and Harley's determination of the figured *Plectrodus*-remains not being jaw and teeth, but prickly processes of cephalic shields. Doubtless such corrections, reminding us of the very extensive field a palæontologist has to work over, will be noticed for the student in the sequel of the palæozoic chapters.

Both to student and advanced geologist, and to every one wishing to know what fossils are, to what they belong, and what they teach, we cordially recommend this lucid and well-arranged work. It is written and illustrated by a painstaking and practical geologist, highly esteemed as an authority among palæontologists; and he is entitled to great credit for its fulness of information and for the conscientious and judicious treatment of the manifold matters which he has to bring within its limit.

A Manual of Zoology for the use of Students, with a General Introduction on the Principles of Zoology. By Henry Alleyne Nicholson, M.D. &c. Second Edition, revised and considerably enlarged. Small 8vo. Blackwood: Edinburgh and London, 1871.

It is little more than a year since we called attention to the completion of Dr. Nicholson's 'Manual of Zoology;' and we are glad to find that the favourable opinion which we then expressed of it is confirmed by the circumstance that already a second edition has been called for. Having noticed the work so recently, we need add little to what we have already said about it; it is still essentially the same book; but some slight errors have been corrected, and considerable additions have been made to some parts of it, especially in the account of the Vertebrata. It is gratifying to our feelings, as critics, that several of the errors and omissions pointed out in our former notice have been corrected or supplied; we can only hope that Dr. Nicholson may speedily have an opportunity of considering whether he will not, in a new edition, adopt one or two more of our suggestions.

MISCELLANEOUS.

Osteology of the Solitaire.

To the Editors of the Annals and Magazine of Natural History.

Gentlemen,—Prof. Newton writes that he and his brother "made personal and explicit inquiry" of me "respecting the fate" of certain bones of the Solitaire.

Had this been so, I could not have forgotten the circumstance.

The Messrs. Newton called on me at the British Museum, in 1868, for the purpose of examining the bones of the Dodo; and the time at my command was spent in showing them those remains in one of the basement storerooms.

If this has escaped Prof. Newton's recollection, any incidental mention of the Solitaire's bones on that occasion, the only one in which I was favoured by their visit, may well have escaped mine.

The impression that no such inquiry had been made by the Messrs. Newton was fixed by their making no mention of such inquiry in their paper in the Philos. Trans. of 1868, from which I first learnt their interest in the subject, and satisfied it to the best of my knowledge; in giving which information (Zool. Trans. 1871, p. 519) no imputation of carelessness was made or intended.

RICHARD OWEN.

Argas reflexus s. Rhynchoprion columbæ.

Though I know not that this Arachnid has yet appeared in the British fauna, it occurs rather plentifully at Canterbury, where some of the vergers consider the creature "an insect peculiar to Canterbury Cathedral." Professor Westwood, having seen a specimen that my son took lately to Oxford, determined it as above; and perhaps that eminent entomologist may favour us with a complete account of this species from specimens that I hope to send him for this purpose. Meanwhile a notice of it will be sent by my son for the information of the East-Kent Natural-History Society, at Canterbury, where these curious creatures are locally interesting. Two of them that we kept in a tin box for upwards of five months, quite without any sort of food, were lively all the time, and would, when touched, "play 'possum," shamming death, like veritable spiders.—GEORGE GULLIVER.

Habits of Tropic Birds. By the EARL OF PEMBROKE.

"For our own part, not believing in our queen Moé as implicitly as we ought to have done, we began shooting the tropic birds as they flew over us; but we soon gave it up, for two reasons:—first, that we found that if we got a rocketer, the chances were ten to one that we cut the scarlet feathers out of his tail; and, secondly, because we discovered that, by diligent peering under the bushes, we might pick up as many live uninjured specimens as we liked. I never saw birds tamer or stupider, which tameness or stupidity may be accounted for by the extreme smallness of their brain, which is really not larger than that of a sparrow. They sat and croaked, and pecked, and bit, but never attempted to fly away. All you had to do was to take them up, pull the long red feather out of their sterns, and set them adrift again. Queen Moé was right. On Tubai you may pick up tropic birds as easily as a child picks up storm-worn shells on the sea-shore.

"It was really no small comfort to be able to get specimens of this beautiful bird without betraying their confidence by shooting them from the schooner. Small-brained as they are, they are gifted with an extraordinary amount of inquisitiveness, particularly in the early morning. As we bowl along before the flashing trade-wind, we hear a few harsh screams, and up come a pair of 'bosens' with their bright scarlet tail-feathers glowing in the morning sun. They make two or three sweeps around us, evidently comparing notes, and then away into the deep blue, on their own private affairs. They fish generally like the tern, to whom I suspect they are cousins german; but they have a way sometimes of hovering perpendicularly, with the bill pressed against the breast, that I have never observed but in one other bird, the black-and-white kingfisher of the Nile. When the 'bosen' has sighted his prey in this position, he turns over in the deftest manner, and goes down straight as a gannet, up to his neck, no further, and remounts for a fresh hover. I have never had the good fortune to see the white-tailed phaeton fishing, often as I have looked for him; indeed I have rarely met him out at sea at all. The finest I have seen were hanging about the high cliffs of the Society Islands; and I do not exaggerate when I state that I have seen more than one with a glorious waving white tail-feather, two good feet long, though the bird itself was not much larger than a black-headed gull. What they do with their tails when they feed passed my comprehension.

"Not only did we find full-grown tropic birds, but we found their eggs and young,—the former about the size of a hen's egg, prettily splashed with reddish brown, laid on the bare sand, under a bush; the latter really handsome creatures, about the size of a herring-gull, beautifully marked with black and white (like a falcon). The bill at this stage of their existence is black, not red. When you find your young friend under a bush, he is ensconced in a small basin of coral-dust, without any nest at all, and his surroundings show him to be a cleanly thing. When you come upon him suddenly, he squalls and croaks and wabbles about, and is as disconcerted as a warm city man when you try to drive a new idea into him unconnected with money. But he sticks stoutly to his dusty cradle, and never attempts to escape, saying plainly enough, 'My mother told me to stop here till she brought me my supper; and here I am going to stay.'"—*South-Sea Bubbles*, p. 143.

Fish-nest in the Seaweed of the Sargasso-Sea. Extracts from a letter from Prof. Agassiz to Prof. Peirce, Superintendent, United States Coast Survey, dated 'Hassler' Expedition, St. Thomas, December 15, 1871.

* * * * The most interesting discovery of the voyage thus far, is the finding of a nest built by a fish, floating on the broad ocean with its live freight. On the 13th of the month, Mr. Mansfield, one of the officers of the 'Hassler,' brought me a ball of gulf-weed which he had just picked up, and which excited my curiosity to the utmost.

It was a round mass of sargassum, about the size of two fists, rolled up together. The whole consisted, to all appearance, of nothing but gulf-weed, the branches and leaves of which were, however, evidently knit together, and not merely balled into a roundish mass; for though some of the leaves and branches hung loose from the rest, it became at once visible that the bulk of the ball was held together by threads trending in every direction among the seaweed, as if a couple of handfuls of branches of sargassum had been rolled up together with elastic threads trending in every direction. Put back into a large bowl of water, it became apparent that this mass of seaweed was a nest, the central part of which was more closely bound up together in the form of a ball, with several loose branches extending in various directions, by which the whole was kept floating.

A more careful examination very soon revealed the fact that the elastic threads which held the gulf-weed together were beaded at intervals, sometimes two or three beads being close together, or a bunch of them hanging from the same cluster of threads, or they were, more rarely, scattered at a greater distance one from the other. Nowhere was there much regularity observable in the distribution of the beads; and they were found scattered throughout the whole ball of seaweeds pretty uniformly. The beads themselves were about the size of an ordinary pin's head. We had, no doubt, a nest before us of the most curious kind—full of eggs too—the eggs scattered throughout the mass of the nest, and not placed together in a cavity of the whole structure. What animal could have built this singular nest? was the next question. It did not take much time to ascertain the class of the animal kingdom to which it belongs. A common pocket-lens at once revealed two large eyes upon the side of the head, and a tail bent over the back of the body, as the embryo uniformly appears in ordinary fishes shortly before the period of hatching. The many empty egg-cases observed in the nest gave promise of an early opportunity of seeing some embryos freeing themselves from their envelope. Meanwhile a number of these eggs with live embryos were cut out of the nest and placed in separate glass jars to multiply the chances of preserving them, while the nest as a whole was secured in alcohol, as a memorial of our unexpected discovery. The next day I found two embryos in one of my glass jars; they occasionally moved in jerks, and then rested for a long while motionless upon the bottom of the jar. On the third day I had over a dozen of these young fishes in my rack, the oldest of which began to be more active, and promised to afford further opportunities for study.

* * * * But what kind of fish was this? About the time of hatching, the fins of this class of animals differ too much from those of the adult, and the general form exhibits too few peculiarities, to afford any clue to this problem. I could only suppose that it would probably prove to be one of the pelagic species of the Atlantic, and of these the most common are *Exocœtus*, *Naucrates*, *Scopelus*, *Chironectes*, *Syngnathus*, *Monacanthus*, *Tetraodon*, and *Diodon*. Was there a way to come nearer to a correct solution of my doubts?

As I had in former years made a somewhat extensive study of the pigment-cells of the skin in a variety of young fishes, I now resorted to this method to identify my embryos. Happily we had on board several pelagic fishes alive, which could afford means of comparison; but unfortunately the steamer was shaking too much and rolling too heavily for microscopic observation of even moderately high powers. Nothing, however, should be left untried; and the very first comparison I made secured the desired result. The pigment-cells of a young *Chironectes pictus* proved identical with those of our little embryos.

It thus stands as a well authenticated fact that the common pelagic *Chironectes* of the Atlantic (named *Chironectes pictus* by Cuvier) builds a nest for its eggs, in which the progeny is wrapped up with the materials of which the nest itself is composed; and as these materials are living gulf-weed, the fish-cradle, rocking upon the deep ocean, is carried along as an undying arbour, affording at the same time protection and afterward food for its living freight.

This marvellous story acquires additional interest if we now take into consideration what are the characteristic peculiarities of the *Chironectes*. As its name indicates, it has fins like hands; that is to say, the pectoral fins are supported by a kind of prolonged wrist-like appendages, and the rays of the ventrals are not unlike rude fingers. With these limbs these fishes have long been known to attach themselves to seaweed, and rather to walk than to swim in their natural element. But now that we have become acquainted with their mode of reproduction, it may fairly be asked if the most important use to which their peculiarly constructed fins are put is not probably in building their nest.—*Silliman's American Journal*, Feb. 1872.

Morphology of Carpellary Scales in Larix. By Thomas Meehan.

The facts which I have from time to time contributed, verbally or in papers, to the Academy, in regard to longitudinal series of axillary buds and adnate and free leaves in Coniferous plants, will, I believe, explain something of the structure of the flowers of Coniferæ, which, if not quite distinct from any view before taken, will at least have reached the conclusion by an original line of argument.

I have shown that in the cases where there are longitudinal series of buds, one of the buds, and generally the upper supraaxillary one, is the largest. So far as this longitudinal series of buds is concerned, I find by extensive observation that there are very few of our American trees or shrubs which do not produce them under some circumstances, although they are more generally apparent in some than in others. In many cases they do not break quite through the cortical layer, but continue to grow from year to year, just as the wood grows, always remaining just under the outer bark. It is from these concealed but living buds that the flowers of the *Cercis*, or the spines of *Gleditschia*, will often appear from trunks many years old. In *Magnolia* and *Liriodendron* these concealed buds are easily detected by a thin shave of the outer bark with a sharp knife. In very vigorous shoots of the latter, a series of two (one supraaxillary) is not rarely found prominently above the bark. In many cases one of these buds, usually the lower and really axillary one, never pushes into growth. In *Gymnocladus* neither upper nor lower would probably ever push, only for the fact that it matures no terminal bud, and thus the laterals have to renew the next season's growth. But for this, *Gymnocladus* would go up like a palm, or, more familiarly, as *Aralia spinosa* does, without a single branch. Failing in the terminal, but two laterals push, giving the branches their dichotomous character. The two which push are always the upper ones in the series of 2, 3, or 4 which appear in this species.

The purpose of this duplication of axillary buds will interest all who study this part of botany. I find that they are not for the duplication of parts, but are separately organized from one another. Thus in *Cratægus* and *Gleditschia* the upper bud produces a spine, the lower is organized to grow as an axillary shoot the next season. But the best illustration of the distinctive organization is in those cases where both upper and lower buds sometimes push the same season, as in *Itea, Lonicera, Caprifolium,* or *Halesia.* Here we find that one is organized for floral organs, and the other for axillary prolongation. The upper bud always has the same function, and the lower its own, in the same species.

A flower being a modified branch, in which the bract is the leaf and the peduncle the axillary bud, it follows that the laws of axillary stem-production will be more or less reproduced in the inflorescence.

Referring, now, to my paper on adnation in Coniferæ, we found that the true leaves of many genera in this order were adnate to the stem, forming what some botanists have termed *pulvini*, or cushions, under the fascicles of some species of *Pinus*, and that what are commonly called leaves, the "needles," are really phylloidal shoots. An examination of *Abies excelsa* will show that the upper portion of the needle has a different origin from the lower adnate portion, or pulvinus, and that in all probability it is a modification of the phenomenon referred to in *Gymnocladus* and other plants, of a longitudinal string of buds, in which the upper is of a different organization from the lower one. In *Larix* it was shown that in the verticils, or perhaps more properly spurs or clusters, the true leaves were free, while in the elongated axis they became for most of their length adnate with the stem, forming the spathulate scales we find peel off the two-year-old wood.

At the flowering-time of the larch, the male and female flowers proceed from the termination of the spurs—not merely "of the preceding year," according to Gray's 'Manual,' but in some cases of many preceding years, "the sterile from leafless buds, the fertile mostly with leaves below" (Gray's 'Manual,' 5th ed. p. 472). Why have the female flowers leaves under them, and the male none? Comparing the male and female catkins, we see why. The scales of the male are formed out of the leaves which become fully formed in the female one. The pair of anther-cells are thus simply on the back of a transformed leaf, just as we find the spore-cases of ferns borne in the same way. The weaker organization which I have shown in my paper and communications on sex, permits no further development here. But in the case of the female flower the leaf maintains a separate organization all through the catkin or cone; and, as shown in my paper on the stipules of *Magnolia*, the midrib of the leaf shortens, and, assuming a stipular character, increases in width, until we have the purple bracteæ so well known in *Larix*. As soon as these bracteæ have been arrested in their development, the carpellary scales, which answer to the phylloidal fascicles of *Pinus*, commence their growth in most species of larch, finally equalling the bracts in length.

Whether or not the ovules which appear in the axis of the carpellary scales again result from a third longitudinal bud, I have no evidence; what I have proposed to myself in this paper is simply to show that *the scales in the male catkin of* Larix *are modified true leaves; while in the female they arise from buds of another organization, being the metamorphosed secondary leaves, or phylloidal shoots, as I term them, of other Coniferous genera.—Proc. Acad. Nat. Sciences of Philadelphia*, 1871, pp. 106–108.

Supplementary Note on the Genus Lichenocrinus. By F. B. Meek.

Since writing the remarks published in the October number of the American Journal*, I have received from Mr. Dyer a very complete suite of specimens belonging to the two known species of this curious type. One of these specimens seems almost to demonstrate that the long, slender, column-like appendage mentioned in the descriptions cannot correspond to the ventral tube or so-called proboscis of crinoids. This specimen is a small individual of *L. Dyeri*, only measuring 0·22 inch in diameter across the disk; yet its column-like appendage measures near 2·80 inches in length, and tapers very gradually and regularly from a diameter of 0·03 inch near the disk, to that of scarcely 0·01 inch near the free end, where it actually appears to taper to a mucronate point. Of course the canal, within so attenuated an appendage, must be extremely minute, and could scarcely have performed the same functions as that of the ventral tube of a crinoid, even if open at the free end, which is at least exceedingly improbable.

The extreme tenuity of the free end of this appendage (which I had already mentioned as an objection to viewing it as a ventral tube) appears to be almost, if not quite, as strong an objection to the suggestion that possibly the disk might have been a root, with the real body attached at the other extremity of the long appendage; since it is scarcely possible that a body could have been supported at the free end of such an extremely slender, hair-like organ as that of the specimen under consideration.

This and some of the other specimens also show that, at least in the species *Dyeri*, this long appendage, although apparently equally divided longitudinally by five sutures along its entire length, does not always have the pieces of which it is composed distinctly alternating and interlocking along these sutures, excepting near the disk.

* See the 'Annals' for November, 1871, p. 341.

On the contrary, these pieces sometimes become gradually less and less alternately arranged, until they appear to the eye, as examined by the aid of a glass, to abut against each other, so as to form regular joints, like those of a minute column composed of little rings or disks. In the specimen under consideration there appears, at a first glance, to be two of these long appendages issuing from one disk or body; but a closer inspection shows that there are two of the disks growing or crushed one against or partly upon the other.

The inquiry has been suggested whether these may not have been free crinoids, with the power of attaching and detaching themselves at will, by the flat side opposite the long appendage? Among the objections, however, that present themselves to this view, may be mentioned the fact, that the most careful examinations under the very best magnifiers, of both the inner and outer surfaces of this flat side, by which the disk is usually found attached, fail to detect even the most minute openings; and as there are no traces of arms or pinnulæ, it is difficult to understand by what means the animal could thus have attached and detached itself, or have sought, and adjusted itself to, a suitable station, when once detached. In addition to this, they are sometimes found growing upon uneven surfaces, and closely conforming to the inequalities of the same, even to lines and furrows on the surface of a shell; while the rigid radiating laminæ of the interior would seem to preclude the possibility of such an adjustment by flexibility*.

It is perhaps scarcely necessary to add that the irregular arrangement of the plates composing the disk of this type, without any tendency to arrange themselves into radial and interradial series, together with its general habit of growth, show that it belongs to the *Cystoidea*, and not to the typical group of *Crinoidea*. Its want of arms and pinnulæ also approximates it to the *Cystoidea*, in which the arms are generally in a more or less rudimentary condition, or the former, in some cases, even entirely wanting. In its apparent entire absence of both arms and pinnulæ, and especially in its want of visible openings and the possession of a system of internal radiating laminæ, it is entirely peculiar, and unlike any other known type, either of the typical *Crinoidea* or *Cystoidea*. How the respiratory, reproductive, and nutritive functions of such a being as it appears to be could have been performed, remains a mystery; and hence it is evident that something yet remains to be learned in regard to its structure.

Of course, such a form cannot be properly ranged in any of the recognized families of the typical *Crinoidea* or of the *Cystoidea*, but should be regarded as the type of a new family of the latter, under the name *Lichenocrinidæ*.—*Silliman's American Journal*, Jan. 1872.

* One specimen, now before me, from Mr. Dyer's collection, is seen lying in the matrix in such a manner as to expose the detached under side of the disk, while one of its edges is curved and folded upon itself. As none of the plates, however, are broken or displaced, nor any of the sutures between them gaping along the folded edge, I cannot believe this folding due to flexibility, but that some peculiarity of its station caused this individual to *grow* in this way.

THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[FOURTH SERIES.]

No. 52. APRIL 1872.

XXVI.—*Descriptive Notes on a nearly entire Specimen of* Pleurodus Rankinii, *on two new Species of* Platysomus *and a new* Amphicentrum, *with Remarks on a few other Fish-remains found in the Coal-measures at Newsham.* By ALBANY HANCOCK, F.L.S., and THOMAS ATTHEY.

[Plates XVII. & XVIII.]

Pleurodus Rankinii, sp. ined., Agassiz.

Several years have elapsed since we first obtained specimens of the peculiar little tooth named by Agassiz *Pleurodus Rankinii*: a few only occurred; they were found at Cramlington. Since then several specimens of it have been procured at Newsham and Kenton, but never in any great abundance.

The tooth is, we believe, all that has been known, up to the present time, of this reputed Selachian. In the spring of last year (1870), however, we had the good fortune to meet with the remains of an almost entire specimen of this fish at Newsham, exhibiting a crushed head containing the teeth, most of the body, with thoracic expansions, a dorsal spine, and the shagreen covering or skin (Pl. XVII. fig. 1). In addition to this interesting specimen, a detached head with the teeth, and a separate spine, have also occurred in the same locality.

These discoveries are highly important, inasmuch as they seem to demonstrate not only that this species is a Selachian, but that it is a Cestraciont, not far removed from the curious Permian form *Wodnika*, Münster. This relationship is not only seen in the general characters of the teeth, but also in the similarity of the shagreen and in the form and grooving of the dorsal spine.

The specimen lies apparently on its belly, and measures a little more than three inches from the front of the head to the posterior tapering extremity of the body, which has lost the tail, and is a little less than two inches wide across the thoracic expansions, which are just behind the head. The contour is much obscured by the scattering of the tubercles composing the shagreen; and the slab has been broken away so as to remove a part of the left side of the specimen. A portion of the counter slab, however, has been saved; and on this the left thoracic expansion is sufficiently revealed. The head (Pl. XVII. fig. 1, *a*) lies immediately in front of and in connexion with the body, but it is so much distorted that the form cannot be determined: it is about five eighths of an inch long. No bones are distinguishable; but the substance is here a little thickened, indicative of the cartilaginous remains of the cranium; nor is there anywhere in the body the least appearance of bones, the skeleton undoubtedly having been cartilaginous throughout. The teeth (*b*) lie within the area of the head, in a disturbed condition, some with the crown uppermost, others with it downwards. They do not seem to have been numerous, but are so obscured that the exact number cannot be ascertained. In the detached head, however, ten or a dozen can be counted; but there is no certainty that the number may not have been greater; indeed it is probable that some have been removed with the counter slab.

The body suddenly widens immediately behind the head, the width being considerably increased by the thoracic expansions (*c*, *c*), which extend about halfway down and appear to have had their margins pointed; thence it tapers backwards, and soon dies out, there being no definite indication of the form of this portion; and, as has been already stated, there is no trace of the tail. The spine (*d*) is situated a little behind the thoracic expansions; consequently it is nearer the posterior than the anterior extremity. It projects from the dorsal margin, and is inclined backwards, apparently in its natural position, marking the situation of the dorsal fin; but no traces of this remain. About two thirds of the spine is in a good state of preservation, the other third being well and sharply defined in cast; it is straight and stout in proportion to its length, and tapers somewhat abruptly to a sharp point; it is compressed laterally, with the anterior margin thicker than the posterior; the surface is coarsely and irregularly grooved and ridged longitudinally; it measures five eighths of an inch in length, and is at the thickest part one eighth of an inch wide.

Shagreen covers the whole of the specimen, defining its extent and form, though, as already noticed, with no great precision, as the margins are much blurred by the displacement of the shagreen-tubercles; but, notwithstanding this disturbance, towards the margins in many places considerable patches of them lie in their natural order, particularly on the right thoracic expansion, on a large portion of which the shagreen is entire. The tubercles are very minute, requiring a powerful lens to exhibit them, and the lower powers of the microscope to display their characters. They are many-sided, irregularly formed bodies, closely fitting together like mosaic work; the surface is a little raised and beset with irregular rugæ. This is the appearance presented where the shagreen is undisturbed; but it is doubtful whether it may not be the under surface that is presented to view. In places where the tubercles are scattered numerous shining bodies are observed; these are about the same size as the tubercles, and, like them, are irregular in form, but are more gibbose, and have a ridge or two on the surface, which are produced into points at one of the sides. From analogy we might suppose that these bodies exhibit the upper surface of the shagreen-tubercles; but further observations are required to determine this point.

The teeth are boss-like in form, somewhat elongated and ridged or carinated along the longer axis; the sides are considerably expanded in the centre, the expansions dying out towards the ends of the tooth; usually the expansion is more produced on one side than on the other, and the ridge inclined to the opposite side. The expansions are frequently transversely ridged or plaited, and sometimes tuberculated. The central ridge or carina of the crown is arched in the long axis of the tooth, following the curvature of the surface, and is frequently reduced, as if by wear. The whole surface of the tooth, as well as the lateral expansions, is covered with a thick brownish-white enamel, and is coarsely punctate, the punctations being most conspicuous when the enamel is worn off. The tooth measures two tenths of an inch in length: a variety, however, four or five of which have occurred at Kenton, is twice that size; but it is more oblique than the small form, has no coronal carina, and is broad and rounded on the upper surface; in all other respects it agrees with the small and usual form. It is quite possible that these large teeth may belong to another species.

From the above description it will be perceived that *Pleurodus* is a not very distant ally, as we have already stated, of *Wodnika*, of the Magnesian Limestone, the relationship being seen in the characters of the spine and shagreen, and particularly in the form of the teeth: in both genera they have the same boss-like, carinated crown, with expanded lateral margins, more or less ridged or crenate; in both, too, they are coarsely punctate, and covered with a stout, highly polished enamel.

We are thus assured that *Pleurodus* is a Cestraciont; and such being the case, its small size is very remarkable. But it must be mentioned that if the large teeth are mere varieties of the small and usual form, then our specimen may not by any means be fully grown; however, after making every allowance for increase in size on this account, still the species would be a very small Cestraciont, most of which are of considerable dimensions. *Wodnika*, which is a small species, judging from Münster's figure*, cannot have been less than a foot long. It is nevertheless quite possible that our specimen is, notwithstanding, a fully developed individual. This is rendered probable by the fact that the teeth in connexion with it are of the usual size of those found detached at Newsham; and of such we possess thirty or forty: some of these are smaller than those connected with the specimen; scarcely any are larger; or if so, there is a mere shade of difference in this respect. In the separate head before alluded to, the teeth are likewise of the usual size; and the second or detached spine already mentioned is not quite so large as that in connexion with the fish.

Platysomus rotundus, n. sp.

A very distinct and beautiful species of *Platysomus* has occurred at Newsham; three almost perfect specimens of it have been met with, and four or five considerable portions, all of which exactly agree in character, though they vary a little in size. The largest and most perfect specimen is three inches long, measured from the clavicle to the end of the tail-fin, and is two inches and three quarters deep at the widest part. It is in a fine state of preservation; the contour is perfect, with the exception of that of the head, which is moderately developed in proportion to the body; the cranial bones, however, are dislocated and thrust a little forward; but apparently the head would not project much were they restored to their natural positions. The dorsal margin, from the occipital crest to the root of the tail, is regularly and deeply convex; so is the ventral margin in its whole extent from the clavicle downwards; the body of the fish, including the head, is therefore almost circular. The pectoral fins appear to have been well developed, but they are badly displayed; the ventrals are also very indistinct, though sufficient of one of them is seen for verification†: the dorsal and anal are well preserved; they

* Beiträge, Heft vi. p. 48, Taf. 1. fig. 1 *a* to *d*.

† As the existence of ventrals in *Platysomus* has been doubted, we take

are placed opposite to each other, terminating in front of the caudal peduncle, and anteriorly near the centre of the body; the anterior portion of each is considerably prolonged, and the articulations of the rays are much longer than wide. The caudal fin is well developed, with the lobes, which are nearly of equal length, only slightly recurved at the extremities.

The scales (Pl. XVII. fig. 2) are rhomboidal, long, narrow, and exceedingly delicate, the thickening of the anterior margin being very inconspicuous at the surface, so that the usual ribbed appearance is scarcely observed: the upper surface is finely and regularly striated longitudinally, the striæ being raised a little, undulated, and almost parallel to the margins of the scale; they occasionally bifurcate, and, though minute, are relatively strong and few in number, there being not more than eight or ten on each scale. The length of the scale, including the peg, is five sixteenths of an inch; the peg is long and pointed. The occipital crest, all the bones of the head, gill-covers, clavicle, and mandibles are striated in the same manner as the scales. The mandibular teeth are minute, conical, and pointed; those of the maxillaries are of the same character, but more minute; on the premaxillaries they seem a little larger.

This is a very distinct species, and is at once distinguished from *P. striatus* by its small size and the much greater delicacy of its parts: the scales of *striatus* are wide, thick, and coarse in comparison with those of *P. rotundus*, in which they are thinner and much narrower than in any other species with which we are acquainted; and, moreover, the striæ in *P. striatus* are much more numerous and more oblique. The same features equally distinguish our new species from *P. gibbosus*, which is apparently a close ally of *P. striatus*. On account of its small size, it might possibly be confounded with *P. parvulus*: but the scales of the latter are twice the width of those of the former, and the striæ are much more numerous; the head-bones, too, are tuberculated, while in *P. rotundus* they are, as we have already pointed out, striated; the teeth of *P. parvulus* are likewise considerably larger.

Of the inedited species *P. declivis*, Agassiz, we know very little, but understand that the scale is similar to that of *P. striatus*; the name, too, so far as it is descriptive, is certainly not specially applicable to *P. rotundus*.

---

this opportunity of stating that a specimen of *P. parvulus* in our possession displays distinctly the pectoral, ventral, and anal fins, the form of one of the ventrals being well defined: it is small and narrow.

Platysomus Forsteri, n. sp.

We have in our possession considerable portions of three specimens of another species of *Platysomus* that appears to be undescribed; they were all obtained at Newsham. Unfortunately, the general contour cannot be traced in any of them; the fins are not present; and though many of the cranial bones are well preserved, they are all scattered. We shall therefore have to rely mainly on the scales for specific characters. The scales (Pl. XVII. fig. 3) however, are, sufficiently marked to distinguish the species from all its congeners, and are in good condition. They are large, measuring nine tenths of an inch in length, including the peg, and two tenths of an inch wide; they are consequently long and comparatively narrow; the form is rhomboidal; the peg is long, and tapers gradually to a fine point; the smooth anterior margin of the scale is rather wide, the rest of the surface being covered with close-set, raised, longitudinal striæ, which are somewhat undulated and slightly diagonal, passing upwards a little inclined towards the front or smooth border, and becoming finer as they approach it: they very rarely bifurcate; and new striæ are abruptly introduced, and do not originate in other striæ.

The head-bones, occipital crest, gill-covers, clavicle, and mandibles are all striated like the scales. The mandibular teeth are large, conical, stout, and obtusely pointed; those of the maxillæ are small, conical, and tubercle-like, with wide bases and recurved pointed apices, and are disposed without order along the alveolar border.

This fine species cannot measure less than *P. striatus*, and at first sight, so far as the scales are concerned, might be confounded with it; but on attentive examination, they are seen to be very different. They are much longer and narrower; and while these are rhomboidal, those of *P. striatus* can scarcely be so designated, being more nearly oblong. The striæ are coarser and much less oblique in *P. Forsteri*; the peg is longer, more slender, and with a sharper point. Indeed, from the form and character of the scales, it would seem that this species is more nearly allied to *P. rotundus* than to *P. striatus*. *P. gibbosus* is distinguished by having some of the cranial bones granulated, which is not the case with our new species; and, besides, the scales of the former resemble those of *P. striatus*, according to the figures in Agassiz's 'Poissons Fossiles,' vol. ii. tab. 15. *P. declivis* would appear also to have the scales of similar proportions.

This species is named after G. B. Forster, Esq., of Backworth, who has kindly granted every facility for the examination of the shale at Newsham, without which valuable privilege much of our knowledge of the palæontology of the Low Main could not have been attained.

Amphicentrum striatum, n. sp.

A new species of this rare and interesting genus has been found at Newsham; seven or eight specimens have been obtained. It differs by well-marked characters from the *A. granulatum*, Huxley, the only other known member of the genus, and it is much smaller. The contour of the new species is rhombic, the trunk being a little wider than long, measured from angle to angle; the dorsal and ventral angles are not much produced. The head is small and conical, with the muzzle forming the anterior angle; the upper and lower margins are continuous with the dorsal and ventral lines of the trunk. The cranial bones are too much disturbed to admit of particular description; they are, however, covered with a lustrous enamel, and are ornamented with strong striæ and tubercles, which irregularly run into each other. The fins are almost entirely wanting in our specimens; only one of them shows a little of the dorsal, which appears to be very delicate; and another a portion of the caudal.

The scales are well preserved in three or four specimens. They are oblong, perhaps somewhat rhomboidal, and are much longer than wide; the peg is long; they become smaller towards the dorsal and ventral margins of the trunk, where they are strongly tuberculated: the large central scales, of which there are three series in depth, have their extremities also a little tuberculated; but their middle and greater portions are covered with strong, somewhat irregular, raised, longitudinal striæ; so that the trunk of the fish has tuberculated dorsal and ventral belts, with the central portion striated.

The V-like arrangement of the dental tubercles, so far as we have been able to examine it, is the same as in *A. granulatum*; and the mandibular dental plates, which are frequently found detached, do not seem to differ in any important respect from those of that species, size being the chief distinguishing feature. The length of the body, including the head, is two inches, and its depth from the dorsal to the ventral angle an inch and three quarters.

This is a very beautiful species, and is at once distinguished from its congener by its small size and, particularly, by the striæ on the middle portion of the body, which ornamentation contrasts well with the strong marginal tubercles, the whole being coated with brilliant enamel.

Cœlacanthus lepturus, Agassiz.

We have long had in our possession certain mandibuliform bones from the Newsham shale, evidently piscine, though we could not make out to what species or even to what genus they belonged; and it was not till some short time ago, when we fortunately obtained a crushed head of *Cœlacanthus*, that the enigma was solved. This specimen exhibits our supposed mandible in connexion with the rather strangely formed bone figured and described in the 'Memoirs of the Geological Survey,' Decade 12, by Professor Huxley, as the mandible, and so placed in relationship to it that it became at once evident that the mandible of Huxley is merely the articular piece, and our supposed mandible the dentary bone.

The articular piece is well represented in the memoir referred to. We have three or four isolated specimens of it in a good state of preservation; also one or two others in connexion with the bones of the head and united to the dentary bone. The articular piece (Pl. XVII. fig. 4, *a*) is long and narrow, with a large arched lobe rising from the upper margin and situated a little nearer to the proximal than the distal extremity; the proximal extremity is obtusely pointed, and the upper border is occupied by a narrow longitudinal channel (the glenoid surface, *b*), which widens a little backwards and is twisted or inclined to the external surface; the borders of the distal extremity are nearly parallel, and in front it thins out and is diagonally truncated forwards and upwards. Our largest specimen is about two and a half inches long, and at the widest part measures five eighths of an inch across.

The dentary bone (fig. 4 *c*) is as peculiar in form as the articular piece: it is narrow and semicylindrical in front, the outer surface being convex, the inner channelled or concave; the posterior portion, more than half the entire length, widens backwards, and has the upper and lower borders somewhat thickened; the proximal extremity thins out, is truncated diagonally downwards and backwards, and has the lower border, which is the longer, produced into a point. The whole bone is strongly arched, the lower margin being regularly convex; the symphysial surface is not distinguishable, and was probably formed chiefly by the cartilage that undoubtedly occupied the groove or channel of the inner surface.

The teeth (*d*) are placed on the upper border of the expanded portion, and extend in a close series of from six to eight from the posterior extremity almost to the junction of the border with the anterior semicylindrical portion of the bone: the dentary area is thus very limited. The teeth are small, short, stout, conical, and obtusely pointed, and seem to be firmly anchylosed to the bone.

The dentary bone has apparently been united to the articular piece by a squamose suture; but, howsoever this may have been, it is evident that the attachment was only slight, as the two bones are frequently found detached.

The maxillary teeth are well developed; they are larger than those of the mandible, are stoutish at the base, decidedly recurved and sharply pointed; but we are unable to determine their number and arrangement, on account of the disturbed condition of our specimens. There are teeth on both the maxillæ and præmaxillæ. In addition to these dental organs, the vomer is armed with close-set, minute, rounded tubercles or teeth. This is undoubtedly the same spatulate dentigerous bone figured and described in the 12th Decade of the Geological Survey by Professor Huxley as the parasphenoid or vomer in *Macropoma*: in form and position it is very similar.

Ctenodus, Agassiz.

The body-scales of *Ctenodus* are entirely unknown, with the exception of those of *C. elegans* and *C. obliquus*, which we described some time ago*—the former in a good state of preservation, the latter in a less perfect condition. We have, however, obtained from time to time numerous fragments of large scales, so frequently associated with the remains of the larger *Ctenodontes* that we can have little doubt they belong to them†. Among these fragments are four or five which exhibit the greater portion of the contour of the scale, and one which has it almost entire. These are all parallelogramic in form,

* Ann. Nat. Hist. ser. 4. vol. i. p. 77.

† As this paper was passing through the press, we obtained complete proof of the truth of this opinion in a fine specimen of the greater portion of a cranium and part of the trunk of a large *Ctenodus* with the opercular plates attached: a considerable number of the ribs are exhibited in connexion with the head, disposed in natural order; and numerous neurapophyses and apparently interneural spines are scattered along the dorsal ridge. Everywhere mixed up with this interesting specimen these peculiar scales are found, much broken, indeed, but occupying both sides of the body portion of the fish, in such a manner as to leave no doubt on the subject. The scales are very similar to those described in the text, differing only specifically, the margin being wider; the smooth central area has the same peculiar minute surface-structure, and the upper surface is minutely granulated in the same manner. Moreover this specimen shows the hatchet-shaped bones, or clavicles, described by us on a former occasion, in connexion with the cranium, almost in their natural positions; so that here we have not only proof respecting these scales, but the true nature of the hatchet-shaped bones is also established.

are thin and delicate, and apparently represent three species, though the distinguishing characters are slight.

The first (Pl. XVIII. fig. 1), the largest and most perfect specimen, measures two and a half inches long, and upwards of two inches wide. The sides are parallel; the anterior extremity (*a*) is a little arched outwards, and the posterior or exposed extremity (*b*) is rounded; the angles are rounded off; the central area (*e*), under an ordinary hand-lens, appears quite smooth, and is bordered by a rather narrow margin (*c*), having several concentric undulations or lines of growth, and marked with minute radiating striæ; no growth-lines are visible within the marginal border. On examination with the inch object-glass, the central area is found to be finely reticulated with slightly elevated bony fibres, the meshes being sunk, so that the surface is minutely and regularly punctate. This is undoubtedly the underside of the scale; the upper surface is revealed on fragments, and, at a rupture (*d*) near the centre of the rounded exposed extremity, is minutely granular. Of course, in the latter case, it is only the cast of the upper surface that is seen; and at this point it is evident that the granules are enlarged and become arranged so as to form imperfect and very irregular vermicular grooves.

The second species (fig. 2) is less perfect than that just described; the greater portion, however, of the scale is preserved; but the border of one side is gone, as well as the posterior margin and part of the anterior. The sides are slightly convex, and so is the anterior extremity, the angles being rounded; the border (*c*) is wide, and distinguished by several concentric lines of growth and fine minute radiating striæ, as in the first species. The central area (*d*) is likewise similar; but the minute surface-structure is finer, and the bony network has the meshes drawn out in the long axis of the scale; the punctures, too, are not so large and distinct. This fragment (for fragment it is) measures two inches long, and one inch and one eighth wide.

The third species, which has lost the greater portion of the rounded posterior extremity, and is in other respects imperfect, is upwards of an inch and three fourths long; it seems to have been more nearly square than either of the other two forms, and is characterized by a very narrow border, which shows only one or two concentric lines of growth and minute radiating striæ. The bony network of the central area is fine and indistinct, with a longitudinal arrangement of the meshes, as in the second species; the punctures are numerous, rather large, and longitudinally oval.

The last description is apparently of a mere cast of the under surface; but a small portion of the scale, exhibiting the upper surface, is adherent, and proves that it is minutely striated in an irregular broken manner, the striæ for the most part having a longitudinal disposition.

The peculiar rectangular form distinguishes these from all the cycloid scales with which we are acquainted; and they are much thinner than any other of the *large* scales of the Coal-measure fishes. The only scale that can be compared to them in this respect is that usually attributed to *Rhizodus*—the scale which we described some time ago as belonging to *Archichthys**. But this scale is pretty regularly rounded, is more coarsely granulated on the surface, and usually exhibits concentric lines of growth over the whole surface; it is also generally found split open, exposing to view the internal structure, when the concentric lines of growth and minute radiating striæ are sharply defined over the entire surface. The scale of *Ctenodus* is never seen with the internal structure thus exposed; at least we have never seen the concentric lines of growth and radiating striæ pass beyond the border, the under surface being usually exposed to view. This is well shown in our second species, the specimen being preserved on one slab in relief, the cast of the underside in intaglio on the other. This specimen, too, enables us to judge of the thickness of the scale, as it is evident the entire substance of it is present, and that it is not torn open by the splitting of the shale.

The rectangular outline of these scales we have just pointed out as peculiar; and in this respect these large scales agree with those we previously described of *C. elegans* and *C. obliquus*, the former being the smallest known species of the genus. And here we must not overlook the similarity both in form and size of these large *Ctenodus*-scales to those of the so-called *Ceratodus Forsteri*, as figured and described by Dr. A. Günther in his valuable memoir on this remarkable Australian fish, recently published in the 'Philosophical Transactions.' This resemblance is very striking in our second species, in which the sides are nearly parallel, being a little arched outwards, much in the same way as they are in the recent species. In both forms the scales are of an extraordinary size: those of *Ceratodus Forsteri* are two inches and three eighths long, and one inch and six eighths broad; the largest *Ctenodus*-scale measures two inches and a half in length, and an inch and a half in breadth; and that of *C. elegans*, which is quite a small species, is remarkably large for the size of the fish.

* Ann. Nat. Hist. ser. 4. vol. v. p. 266.

We have shown on a previous occasion that the dental plates of *Ctenodus imbricatus* are so similar to those of the Australian fish that without other aid they could not be generically separated; and we now see that in the peculiar form and great size of the scales the similarity is equally striking.

Gyracanthus tuberculatus, Agassiz, and *Cladodus mirabilis*, Agassiz.

We believe we were the first to point out that certain minute bodies found associated with the remains of these two species are dermal tubercles *. When we wrote our remarks on the subject we described two forms of these peculiar bodies—one considerably larger than the other, and having from four to seven cusps with carinæ on their convex surfaces, the smaller form having only two or three smooth points. And we thought both varieties belonged to *Gyracanthus*, having found the large scattered amidst the small form (which latter was by far the more numerous), and both associated with the spines of that fish and with the teeth of *Cladodus*. We have long been satisfied, however, that this was a mistake, and that, while the small form is the dermal tubercle of *Gyracanthus*, the large variety is that of *Cladodus*. This is satisfactorily proved by numerous specimens in our possession, in which the small variety unmixed with the other is associated in large patches with the spines and other remains of *Gyracanthus*; while the large form has occurred on several occasions, unaccompanied by the small variety, on the same slab with the teeth of *Cladodus* and the spines of *Ctenacanthus hybodoides*. This has so frequently happened now, that it is impossible any longer to question the fact that the two forms belong respectively to these two large Selachians. And we are also satisfied that the so-called tooth *Mitrodus quadricornis* of Owen is the larger form of these dermal tubercles, as we originally asserted, and consequently belongs to *Cladodus* or *Ctenacanthus*, and not to *Gyracanthus*, as we at first thought.

We have much pleasure in observing that the dermal nature of these minute spinous bodies has recently been confirmed by the researches of Mr. James Thomson, of Glasgow, who has found the large form associated with the teeth of *Cladodus mirabilis* and the spines of *Ctenacanthus hybodoides*†.

* See paper entitled "Notes on the Remains of some Reptiles and Fishes from the Shales of the Northumberland Coal-field," Ann. Nat. Hist. ser. 4. vol. i. p. 370.

† See paper entitled "On a Specimen of *Acanthodes Wardii* from the

This gentleman, however, seems to confound *Diplodus* with these dermal tubercles, and to consider the remains of the semicartilaginous skeleton to be shagreen. It is to Professor Williamson that we owe the discovery of the true nature of this peculiar substance, who clearly proves it to be the remains of what he terms the chondriform bone or semicartilaginous skeleton*.

In a former communication† we described a large triangular bone associated with the spines of *Gyracanthus* as one of the carpals. We have now to notice a second carpal, several of which have occurred on the same slabs with the spines and triangular bones. In one instance the two spines are associated with one triangular bone and two of our second carpal. This second form is probably the inner carpal: it is a broad, flat bone, irregularly bilobed, or somewhat reniform, with one of the lobes produced and the external margin straightened; the convex border is a little flattened, angulated, and thickened; thence the bony fibres radiate to the opposite or lobed margin, which gradually thins out. It measures in the transverse or longest diameter eight inches and a quarter, and in length, from the thickened to the thin margin, two inches and a half. The former we take to be the proximal margin; consequently the thin opposite edge will give support to the fin. The texture of this bone is quite similar to that of the large triangular carpal; namely, it is of a semicartilaginous appearance, with coarse radiating fibres extending from margin to margin.

Helodus simplex, Agassiz.

We take this opportunity to announce the occurrence of this strange form of tooth at Prestwick, Northumberland. Only a single specimen has been found; and we believe this to be the first that has been obtained in the district.

EXPLANATION OF THE PLATES.

Plate XVII.

Fig. 1. View of *Pleurodus Rankinii*, natural size: *a*, head; *b*, teeth; *c c*, thoracic expansions; *d*, dorsal spine; *e*, counter slab, on which the left thoracic expansion is preserved, and which is represented as if seen through.

Lanarkshire Coal-field, and on *Ctenacanthus hybodoides*," Trans. Geol. Soc. Glasgow, vol. iv. pt. 1. pp. 57–59.

* "Investigations into the Structure and Development of the Scales and Bones of Fishes," by W. C. Williamson, Philosophical Transactions, 1851, pt. 1, pp. 669–679.

† Ann. Nat. Hist. ser. 4. vol. i. p. 369.

Fig. 2. Outline of a scale of *Platysomus rotundus*, considerably enlarged.
Fig. 3. Outline of a scale of *Platysomus Forsteri*, enlarged.
Fig. 4. Outline of a mandibular ramus of *Cœlacanthus lepturus*, slightly enlarged: *a*, articular piece; *b*, glenoid surface; *c*, dentary bone; *d*, teeth. The articular piece and dentary bone are laid together in their natural positions, but not united; so that the form and extent of each can be distinctly traced.

PLATE XVIII.

Fig. 1. Scale, natural size, of *Ctenodus* (first species): *a*, anterior margin; *b*, posterior or exposed ditto; *c*, marginal border; *d*, rupture exposing cast of upper surface; *e*, central area.
Fig. 2. Scale, natural size, of *Ctenodus* (second species): *a*, anterior margin; *b*, posterior extremity; *c*, marginal border; *d*, central area: the dotted line indicates the form and extent of the scale.

XXVII.—*The Mollusca of St. Helena.* By J. GWYN JEFFREYS, F.R.S.

WITH the assistance of my friend Mr. M'Andrew, I have examined a collection of shells made by Mr. J. C. Melliss at St. Helena; and I subjoin a list of them. Most of the marine shells were picked up on the beach, and are consequently in bad condition. The only specimen procured from deepish water (about fifty fathoms) is *Ostrea crista-galli*; and this is covered with two kinds of stony coral, which Prof. Duncan refers to *Sclerohelia hirtella* and a species of *Balanophyllia*. The land-shells of St. Helena have been already noticed by the late Mr. G. B. Sowerby in the Appendix to Mr. Darwin's work on Volcanic Islands, as well as by Mr. Blofeld and the late Prof. E. Forbes in the Quarterly Journal of the Geological Society of London for August 1852. In the opinion of the last-named author, "a closer geographical relationship between the African and American continents than now maintains is dimly indicated" by the marine mollusks of St. Helena; and "the information we have obtained respecting the extinct and existing terrestrial mollusks of this isolated fragment of land would seem to point in the same direction, and assuredly to indicate a closer geographical alliance between St. Helena and the west [?east] coasts of South America than now holds." And in the Report of the British Association for 1851 will be found an abstract of a paper by the same distinguished naturalist, entitled, "On some Indications of the Molluscous Fauna of the Azores and St. Helena." It is here stated that "the marine mollusks [of St. Helena] would seem to point to the submergence of a tract of land probably linking Africa and

South America before the elevation of St. Helena. Along the sea-coast of such a tract of land the creatures common to the West Indies and Senegal might have been diffused." I am not quite satisfied with this hypothesis, and I believe that more information is needed to support it. Some of the land-shells of St. Helena are European, and may have been introduced by the agency of man; others are peculiar to the island. A few of the marine shells are Mediterranean, while the greater number are well-known inhabitants of the Indian Ocean and the West Indies: all these may have originated anywhere. But it must be borne in mind that St. Helena is separated from Africa and South America in every direction by very deep water, which is nowhere less than 2000 fathoms or 12000 feet. It therefore seems scarcely probable that such an abyssal and extensive tract of the sea-bed could have been dry land or "sea-coast," in a geologically recent period, so as thus to account for the diffusion of littoral species such as *Mytilus edulis*, *M. crenatus*, and *Littorina striata*. I should be rather inclined to attribute the present distribution of the marine fauna of St. Helena (not to a supposed continuity of land between Africa and South America in that or any other direction, but) to the action and influence of the great Agulhas Current, which issues from the Indian Ocean and flows round the Cape of Good Hope northwards towards St. Helena, and thence past Ascension to the West Indies. The partial correspondence between the Mollusca of the Indian Ocean and of the Mediterranean may have been owing to the Guinea Current, as well as to a passage which formerly existed across Africa in the line of the Sahara—a very wide tract, which certainly was submerged during the quaternary period. I must admit, however, that our information as to the marine Mollusca of the South-Atlantic region, including St. Helena, is very scanty and unsatisfactory. The only dredging that has ever, to my knowledge, been attempted off St. Helena was made by Dr. Wallich in 1857, on his return home from India; and this was at a depth of from 20 to 30 fathoms. It produced a few small shells, which Dr. Wallich kindly gave me. Many of these appear to be undescribed species. The promised circumnavigation expedition, under the auspices of the Royal Society, will doubtless enable us to learn something of the South-Atlantic fauna.

Mr. Edgar Smith will describe such of the species in the subjoined list and of those dredged by Dr. Wallich as are new to science. Mr. Melliss has presented to the British Museum all the specimens, with the exception of a few duplicates, which are in the excellent and accessible collection of Mr. M'Andrew.

Class *CONCHIFERA.*

Order LAMELLIBRANCHIATA.

Family Ostreidæ.

Ostrea crista-galli, *Linné.*

Family Aviculidæ.

Pinna pernula, *Chemnitz.*
Avicula hirundo, *L.*

Family Mytilidæ.

Mytilus edulis, *L.*
—— crenatus, *Lamarck.*
Lithodomus lithophagus, *L.*

Family Arcidæ.

Arca domingensis, *Lam.*

Family Lucinidæ.

Lucina, *n. sp.*

Family Chamidæ.

Chama gryphoïdes, *L.*

Class *GASTROPODA.*

Order PECTINIBRANCHIATA.

Family Patellidæ.

Patella plumbea, *Lam.*
Tectura virginea, *Müller.*
Hipponyx mitrula, *Lam.*
—— radiatus, *Quoy & Gaimard.*

Family Fissurellidæ.

Fissurella arcuata, *G. B. Sowerby.*

Family Littorinidæ.

Littorina striata, *King.*

Family Scalariidæ.

Scalaria modesta, *C. B. Adams.*

Family Pyramidellidæ.

Odostomia circinata, *H. Adams.*

Family Ianthinidæ.

Ianthina fragilis, *Bruguière.*

Family Eulimidæ.

Eulima, *n. sp.*

Family Naticidæ.

Natica nitida, *Donovan.*

Order SIPHONOBRANCHIATA.

Family Buccinidæ.

Purpura Rudolphi, *Lam.*

Family Muricidæ.

Triton variegatus, *Lam.*
—— olearium, *L.*
Ranella cælata, *Broderip.*
Murex, *n. sp.*

Family Nassidæ.

Cassidea testiculus, *L.*
Nassa incrassata, *Ström*, var.
Columbella cribraria, *Lam.* (*H. & A. Adams*).
Cominella lugubris, *C. B. Adams.*

Family Cypræidæ.

Marginella, *n. sp.*
Cypræa lurida, *L.*
—— spurca, *Lam.*
—— turdus, *L.*
—— moneta, *L.*

Family Conidæ.

Conus testudinarius, *Martini.*
—— irregularis, *G. B. Sow.*

Order PULMONOBRANCHIATA.

Family Limacidæ.

Limax gagates, *Draparnaud.*
——, *n. sp.*
——, *n. sp.*

Family Helicidæ.

Succinea picta, *Pfeiffer.*
—— solidula, *Pf.*
—— Helenæ, *Forbes.*
—— Bensoniana, *Forb.*
Zonites cellarius, *Müll.*
—— alliarius, *Miller.*
Helix aspersa, *Müll.*
—— polyodon, *G. B. Sow.*, =H. Alexandri, *Forb.*
Bulimus auris-vulpina, *Chemn.* (semifossil).
—— fossilis, *G. B. Sow.* (semifossil).
Pupa umbilicata, *Drap.*
Achatina subplicata, *G. B. Sow.* (semifossil).

XXVIII.—*The Origin of the Vertebrate Skeleton**.

By Harry G. Seeley, St. John's College, Cambridge.

§ 1. *The Problem of Osteology.*

The facts of comparative osteology are the growth of similar constituent bones of skeletons to different extent and in different directions in the several groups of vertebrate animals. Hence to the palæontologist the discovery of new types of life in the strata usually means a new and limited growth of a few elements of the skeleton in definite directions. These peculiarities of growth give the skeletons which they characterize a plan of structure which differs from that of other animals; and therefore that plan becomes comparable with the plans of growth which distinguish the several known groups. The multitudinous array of species is so reduced to a few factors; and these limiting facts enable the student to investigate and discover the relation of one animal to the remainder, and of all animals to each other, in a manner not dissimilar and with similar success to the way by which meridians of longitude and parallels of latitude localize geographical districts. The biological problem admits of infinite complication, from the skeleton being composed of many different bones, each of which has its definite form, which may vary a little in every species of the group. And though a few general plans may accurately be spoken of as limiting and comprising this vast difference of detail, yet there is no plan except that which is manifested in each and all of the individuals forming the species which the group includes. And if it be necessary, as it is, to see how closely one plan of structure approximates to other plans, or how it differs from them, such a result can only be attained by comparing and contrasting individuals which manifest the kind of growth which is named the plan of the group.

Here comparative osteology offers for investigation the subject of growth of bone. And if a sufficient elucidation of that question can be given, less difficulty will be experienced in understanding the nature of the special growths in specified directions which give a common plan to each of the several zoological groups of Vertebrata named orders.

The skeleton, however, is but a degraded portion of the organism; and, in the kinds of animals which inhabit the world now, the *functions* of the several bones are often known, as well as the nature and modifications of the soft structures, nerves, vessels, viscera, muscles, which are correlated with

* Being an introductory chapter from the Author's MS. 'Osteology of the Reptilia.'

the different types of skeletons. This has in old times made the comparative anatomy of these living animals more a study of the soft vital tissues than of the hard osseous structures, with which alone the fossil types of life can be compared. It has also had a tendency to make the skeleton seem important chiefly as an index to the nervous or respiratory or other organization of the animal to which it pertains. The skeleton, however, has a distinct morphological importance of its own in classification, probably as significant of near affinity as any part of the organism. And in the endeavour to determine the relations of affinity to each other of the fossil groups, and their zoological position, it will be necessary to adhere to this simple morphological test, as well as to apply it to the living ordinal groups, which will hereafter be examined.

The skeleton nevertheless often, in some of its elements, manifests convincing evidence of the condition of some of the soft parts, being subservient to them; and this gives an empirical evidence of affinity which the traditional practice of anatomists would warrant us in valuing highly. Still that estimate of the soft parts of an animal which makes the salient features of all animal classifications will admit of question, and may even seem artificial, when animals are considered in all their affinities. At present, classifications, so far as they are consistent and logical, only express what may be named the lateral affinities of groups of animals—that is, their resemblance to others which are upon the same horizon of organization. But some animal orders also have affinities with other animal orders which are both above and below them in complexity of structures. And if any form of creation by physical and chemical law is admitted into the domain of science, then the affinities which are indicative of evolution must obviously afford a more philosophical ground for classification than those affinities which merely show the parallelism, in their successive stages, of groups of organisms which are parted from each other by inevitable gaps, chasms comparable to those which (as a small illustration) divide from each other the phalanges of the successive digits.

So that we may regard the final problem of comparative osteology as the production, under laws, of a calculus of affinities of animals, in which their relations to each other will be manifest in a classification which transcribes nature herself.

In the following pages a sketch is made of the way in which such a philosophy may be led up to by a consideration of the bones and the fundamental conditions which determine their relations to each other.

§ 2. *The Mechanism of Growth.*

Sir James Paget happily interprets the coexistence of growth of different tissues in the same organism by adopting a doctrine advanced by C. F. Wolff and Treviranus, that each single part of the body, such as fat, muscle, bone, &c., in respect of its nutrition, stands to the whole body in the relation of an excreted substance. Modern chemistry may be considered to have demonstrated that this organized excrement which constitutes the animal, continually excretes itself in other structures, which are capable ot passing naturally out of the body. Even while remaining as constituent in the body, the tissues change from a more live to a less live kind; so that muscle is degraded into urea and fat before the fat is got rid of in carbonic acid and water; and cartilage must first be degraded into bone, the most feebly organic of structures, before it is removed from the body by the natural processes of secretion.

Here, then, the question arises, By the operation of what law are the assimilated parts of our food converted into the tissues which manifest this complemental interrelation of organs? for it would seem probable that there is but one general law governing them all, since, when a bone elongates, almost invariably the muscles, nerves, and vessels which are related to it undergo a corresponding growth.

And the reply to this question will recognize that growth consists of two seemingly different processes:—first, simple increase of substance; and, secondly, differentiation of substance. The increase of bulk is well studied in the individual, while the differentiation of parts can only be observed in the aggregate of individuals which constitute a tribe or order. The tribe-growth has two totally different aspects—in embryology on the one hand, and in morphology on the other; while the chief means for experimental investigation are offered by the mechanical and pathological aspects of growth.

With the comparative anatomist, nerves, muscles, bones, and the other tissues are ultimate facts, as much so as are the different mineral species to the mineralogist; and their essential difference from each other is in chemical composition. They are only to be spoken of, as to origin, as organic colloids separated from each other by continuous organic dialysis. What is named nutrition is no more than dialysis of the nutriment which has been elaborated into blood—a process which is made possible by the disintegrating function of the capillaries of the veins and the repairing function of the arteries. And it comes about by the covering membrane of nerves dialyzing nerve-substance, by the covering of muscular fibres dialyzing muscle-substance, and by the covering of the bones dialyzing osseous substance. Therefore fundamentally the constitution of the body into its anatomical machinery is a matter of chemistry. And on the condition of the blood which supplies the material to be dialyzed, and upon the condition of the dialyzing membranes, depend changes which take place in the chemical composition of organic substances. Thus, under certain conditions, the dialyzing function gets disordered; and then, instead of the body being maintained in healthy equilibrium, pseudomorphs of muscles and bones are produced in other substances, commonly in fat.

Under some circumstances the removal of substances from the body is less rapid than their accumulation; and this produces normal healthy increased growth, which, whether it affect a special muscle or bone or the entire organism, is spoken of as hypertrophy. Under other circumstances the supply of material is less rapid than its removal, and results in a diminution of growth, which is spoken of as atrophy. Now, as the organic degeneration becomes faster or slower, both relatively and actually, than the reconstruction, and *vice versa*, so must all the parts of the body undergo changes in their forms and sizes, which will constitute animals with an infinite variety of shape and stature. But the result of a defective quantity of nutriment is in some cases a smaller tissue, while in other cases the tissue elaborated is of defective quality; and there is as yet no known reason why one of these conditions should prevail rather than the other. If the tissue accumulated is of defective quality, it is probably fat, and in some cases may be bone. On the other hand, the result of superabundant nutriment is in some cases increase and improvement in the quality of the several fibres or particles, and in other cases a multiplication of them; that is, in hypertrophy some parts simply grow large, while in other cases new parts are differentiated. And if hypertrophy and atrophy operate together in the same individual, the result may be that in one organ a new part will be produced, while in another organ an old part will be removed. Thus these natural processes vary not only the shape and aspect of animals, but their structures also.

Hence it follows that the law of nutrition which produces in different individuals of a human family visible difference of form and function, is the same in kind, and only differs in degree from the differentiation which constitutes separate species and genera. In other words, if the hypertrophies and atrophies of individuals could determinate towards special parts, they would inevitably accumulate in the pliable young body when passed onward in successive generations; and there is no inevitable limit to this accumulation or loss of structure, except the maintenance of harmony in the organic functions.

Here, then, the question presents itself, What are the conditions which produce these modifications of the dialyzing action which are manifested in hypertrophy and atrophy? This I now will endeavour to answer. The question may be taken in the abstract. Assuming the amount of nutrient material to remain constant, the change of growth must obviously be due to some change of the conditions which affect the part. Now the only conditions which, while affecting the whole body, may be variable in the different parts, are the forces manifested by the organs in the discharge of their several functions. These act either from within or without; and therefore, as will be generally admitted, every mechanical force acting on the elements of the body is in its effect either of the nature of an impact or of an explosion; and these, with all other forces acting upon and within the animal, can only produce alternations of pressure and tension and rest*. These, therefore, are the stimulants to growth. But growth, being a condition in which the particles expand and increase externally, can only take place when the pressure is removed. And since increase of size can only be resisted by continuous pressure, that, therefore, is the mechanical condition of atrophy. In other words, these mechanical changes are the phenomena which we speak of collectively as exercise. Now the reason why these mechanical actions should produce growth is not far to seek. They alter the conditions of nutrition. Pressure upon a muscle squeezes the blood which was in the veins out of that muscle more rapidly than it usually circulates; and the removal of pressure causes the blood to rush into the part with more force than usual. That is, the establishment in a part of the body of alternate pressure or tension and rest, sets up there a local pump-action which, in effect upon the circulation, is like an additional heart added to that part. It brings more blood to the part, and circulates more food through it; the dialyzing action is carried on faster; and the fibres or cells become plump with abundant food, and new matter is thus fixed in the tissue, and the part has grown.

Therefore since growth, so far as it characterizes the individual and is kinetic, is produced by these mechanical actions, we have to look upon nature and see in what ways the parts of an organism act mechanically upon each other. And should the evidence be conclusive that such actions ac-

* Annals of Nat. Hist. Nov. 1866, No. 107, vol. xviii. p. 347.

tually take place as we have theoretically found should take place, and if they produce the results which theory assigns to them, then the conviction which such phenomena will enforce we may fortify by examples of abnormal growths, due to mechanical causation, afforded by pathology, and test its truth by application to morphology.

In the first place, every organism on the earth's surface has upon it the pressure of the earth's atmosphere—a pressure which, in the case of a man's body, is usually computed at about 70 to 100 tons; and therefore growth can only take place when a force is manifested which is sufficient to lift the atmosphere and hold it up. The skin experiences this pressure, and in consequence, probably, has its superficial epithelial cells flattened to scales. The life is crushed out of them by a pressure which is never appreciably relaxed, and they die under it, and are removed. Such is an example of atrophy. But when the skin is exposed to special extra intermittent pressure, it grows. This relation of growth to pressure was known to John Hunter, and is clearly expounded by him. Generalizing from a consideration of corns, he remarks, in a passage quoted by Sir James Paget:—"The cuticle admits of being thickened from pressure in all parts of the body: hence we find that on the soles of the feet of those who walk much the cuticle becomes very thick; also on the hands of labouring men. We find this wherever there is pressure, as on the elbow, upper part of the little toe, ball of the great toe, &c."

With regard to the internal organs, it would lead me too far away from the object of this writing upon bones to discuss the interrelations of them all. I therefore omit whatever can be dispensed with, and limit myself to what is taught by a few great sets of organs, such as the bones, muscles, nerves, lungs, blood, which show tension and pressure in their functions.

The bones, by supporting each other, act on each other mechanically; for the motion of the body is a succession of falls, which permit alternations of pressure and rest upon the limb-bones. Thus, if we take the humerus, for instance, it will be found most extended in the direction between the radius and the scapula, in which it has, when in mechanical use, to support and lift the weight of the carcass. If the ends are examined, where rotation or movement is permitted, it will be seen that pressure is experienced over a wider area than is possible in the section of the shaft, which only serves as a prop. Hence, and partly from the attachment and pressure of other organs, the articular ends of bones are enlarged; but it is probable that something of the enlarged size of the ends of bones is also due to the vertical pressure causing lateral overgrowth at the joints to be growth in the direction of least resistance, as pointed out by Prof. Humphry.

The bones normally present are dialyzed by the degeneration of the surrounding connective tissue called periosteum, or from the terminal articular or interosseous cartilage. To this periosteum, or to the bone, muscles are for the most part attached, and usually so attached that there is at least one joint between the bones along which they extend. Now the property of a muscle is, that the fibres which constitute it contract and extend. Therefore the very circumstance of their attachment on the bones where there is a condition of yielding implies that when they contract the muscles experience tension; and if the bone does not yield, it experiences pressure or tension from the pull of the muscles. Consequently the attached muscles can undergo no movement without bringing their modifying mechanical influence to bear upon the bones, which is done partly by enabling them to act upon each other, and partly by the intermittent pressure which the periosteum thus is caused to exercise. The same action causes the bones or skin to press against the muscles, and one muscle to press against another. Thus in their exercise the muscles themselves experience this same mechanical condition, which, resulting in a pump-like action, sustains growth.

Of the nerves, only the cerebro-spinal system is sufficiently largely developed to exhibit any visible results of pressure. And here the growth of the brain extends the bones of the brain-case to cover the nervous substance; and when the brain contracts as in old age, the tension of the dura mater upon the bones causes them to thicken, and adapt their inner surface to its reduced size. Similarly the growth of the spinal cord forms the perforation between the neural arch of the vertebra and its centrum; and the perforation enlarges by growth of the vertebral elements with the increase in size of the spinal cord.

The lungs, too, by inspiration and expiration, exert a continuous intermittent pressure upon the ribs; and it may be observed that the ribs are stretched and lifted up at each inspiration. For a considerable period of life this is done with increasing vigour; and during that time the articular cartilages grow. But just as hair, when it has passed through its cycle of growth, grows no more, and dies, and as the particles of the muscles and nerves and other organs which have by exercise undergone the molecular change which has rendered them effete die, and go through new conditions, so a time comes in the life of cartilage when, in normal health, it can no longer form new cartilage-cells; and then there is no further growth of the bone, and the articular cartilage itself gradually becomes thinner. The action of the lungs moves the muscles which are attached to the ribs, and in some cases in this way greatly modifies the form of the bones.

Another example of a mechanical influence is seen in the blood. The weight of blood in the body is not great; but it is the amount of nutriment sufficient to maintain healthy dialysis in all the tissues. The whole of the blood makes its way into the lungs, where it apparently loses bulk and gains temperature. Under the heated condition it is driven through the body in the arterial vessels by the left ventricle, and therefore exercises an intermittent (pulsating) pressure not only upon the arteries themselves, but, in a quieter way, upon the tissues adjacent to them. That this muscular power has a mechanical effect upon growth is shown in the heart itself, by growth being continuous throughout life. The return of the blood to the heart is facilitated by its decreased temperature lessening its bulk, by the material left in the tissues, as well as by the pump-action which passes it into the lungs and enables the lymphatics to pour in new material. Evidence of its mechanical power in producing growth is well seen in the thickening of arterial walls in the condition named aneurism.

These are some of the chief mechanical engines of the body which are capable of influencing the skeleton. That they actually produce by their mechanical action the phenomena of growth which theoretically they are sufficient to produce is not capable of elaborate proof in the healthy individual, because, from the deep-seated position of the changes, they cannot usually be observed. Yet, in the case of athletes and gymnasts, it is observed that, with exercise, the whole body becomes heavier, and the circumference of the chest permanently greater; and often special muscles are seen in a short time to augment visibly. This may be observed in the legs of women who dance and the thighs of men who ride. But to see the effect upon the bones, it is necessary to contrast the skeleton of the wild animal, where the muscles are used with great power, with the skeleton of the tame animal, where the muscles have more limited action; and then it will be seen that powerful crests and processes on the bones are developed in direct proportion to muscular activity. Moreover Professor Humphry finds that bones are densest in those parts which are subject to the greatest mechanical stress, and hardest in those persons who are strongest and most active—and that the bones are most curved in those persons whose muscular strength is greatest, while weak persons, on the contrary, have comparatively straight bones. But, important as this kind of evidence is, it gives but a poor idea of the potency of this power to produce growth when circumstances are specially favourable.

In the case of muscles, the most wonderful example is afforded by the increase of the uterus in the exercise of its function, and its rapid degeneration when that function is completed.

In the case of bones, an example no less wonderful as an increase, but not so obviously due to a local function as to an hereditary condition of the body, is afforded by the antlers of the male deer; and no more striking example could be afforded of the dependence of growth upon nutrition, which under other circumstances these mechanical actions increase, than is seen in Hunter's experiment, the transplantation of the spur of the cock to its comb, where the spur grows vigorously, and in one case has attained, in a spiral form, a length of 6 inches.

These and such like considerations have not escaped the attention of some of the greatest physiologists and best observers of the body in health and disease, and have led them to advance, on inductive evidence, views of growth identical with those which are here urged deductively. Thus Sir James Paget finds that growth is due to intermittent pressure, which approximates the state of the tissue towards that of inflammation, but does not actually in healthy growth reach the inflammatory state.

In the last instances adduced, examples have been given of the result of altered nutrition upon growth, where that alteration was not due to mechanical action. Now we may notice some individual cases in which the dialyzing action called nutrition becomes altered abnormally, and parts change their characters so as to present in the individuals of a species processes similar to those which are normal in comparative anatomy. In some of its aspects pathology might be called an inverted palæontology.

Thus Sir J. Paget concludes that "when any of the long bones of a person who has not yet attained full stature is the seat of disease attended with unnatural flow of blood in or near it, it may become longer than the other or more healthy bone." And in one case where one segment of a leg was defective in growth, another segment lengthened to supply the deficiency. But the examples of hypertrophy of bones from disease are not numerous; and in rickets only an inflammatory thickening of the bones takes place. Still the cases are many in which increased osseous growth takes place in consequence of the inflammatory condition induced by fractures.

Mr. Hawkins refers to some curious cases in which muscle becomes changed into bone by a simple inflammatory action. Thus a surgeon in the Prussian army found that in 18 out of 600 recruits there was a swelling of the deltoid and pectoral muscles in front of the shoulder, due to the pressure and irritation induced by first carrying the musket, and that in these cases pieces of bone were deposited, from 2½ to 7 inches long, which were removed by operation. He mentions the case of a boy in whom the least blow would cause an exostosis or ossification of a muscle or ligament; and, finally, details a case where his patient, after getting wet, became liable to painful swellings which eventually became the seats of ossification. One such bone, between the rhomboid and trapezius, and extending from the scapula to about the sixth vertebra, was removed: it had the microscopic and chemical characteristics of true bone, consisted to a small extent of cartilage, had the usual dense outer shell, which was covered with periosteum, into which the muscular fibres were inserted, as in natural bone. And Sir J. Paget refers to a specimen in the College of Surgeons in which nearly all the muscles of the back were ossified. He supposes that the osseous deposit originally took place in the connective tissue, and by its growth through pressure produced atrophy and destruction of the proper muscular substance. Ossification of the ligaments is very common among all animals; and Mr. Hawkins refers to numerous ossific deposits in the cellular tissue behind the pleura, and to a case in which the lungs have great masses of bone in them, occupying at least a third of their bulk. And a case was recorded by Dr. Allbut in which the lung was full of well-developed bones.

The other normal tissue which is commonly produced in the body by disease is fat. This, to a considerable extent, may replace all the muscles and all the bones. In one case, all that remained of the upper part of a femur, after boiling, is described as scarce any thing besides a great quantity of white crystalline fatty matter. Occasionally the bones lose their osseous matter without any fatty substitution.

These pathological illustrations of variety in growth have their chief interest in the proved hereditary character of disease (often symmetrical). In the case of fatty degeneration, from that condition supervening as a consequence of inactivity, it is suggestive, as showing the way in which structures which are no longer or less used may be got out of the body, perhaps not in one but in successive generations. Even the heart reduces its size in accord with the amount of blood which it has to circulate. The bones in the individual, according to Prof. Humphry, most effectively reduce their length by such disease as obliterates the epiphysial lines, while their thickness decreases by cessation of muscular action.

Growth also has a local morphological aspect. Thus Edentates, Cetaceans, Chelonians have the bones of the skeleton solid; most mammals and most living reptiles have medullary cavities in their long bones, while in most birds these cavities become chambers into which prolongations of the membrane covering the lung extend. It is necessary to remark that Edentates and Chelonians are comparatively inactive animals, and that Cetaceans move in a comparatively unresisting medium, so that, however active, their muscular labour is light; and that birds, as a rule, are far more active than mammals. Now in mechanics there is a law (clearly stated as a mechanical law by Mr. Herbert Spencer), the law of the neutral axis, by which, if a substance is exposed alternately to pressure in opposite directions, there will be at the outsides alternate pressure and tension, and in an internal part (of varying extent according to the substance strained) the neutral axis which experiences compressions only.

Now we have seen that the alternation of pressure and tension is the condition of growth, and compression the condition of atrophy. Hence it may be inferred that the solidity of bones will be in the inverse proportion to the activity of the muscles which are attached to them; or, speaking generally, the hollowness of bones is in direct proportion to the activity of the animal, the compressions at the neutral axis necessarily resulting in atrophy of the bone there. Among flexible trees, the law of the neutral axis is seen in the formation of pith.

Another special condition of bones, is that in some animals they become composite—that is, develope special and terminal parts or plates called epiphyses, which sometimes subsist throughout life, and are sometimes obliterated as the energy of growth declines. Thus, in the internal skeleton of *living* Chelonians and Crocodiles I have not noticed any appearance of separate terminal ends; while if certain bones of crocodiles are compared with others of some marsupial mammals, there will be seen, with a close resemblance of form, separate bone-elements in the mammal, which make the articular ends. Such separate elements may be seen in amphibians, lizards, many mammals, and, rarely, perhaps, in some birds. Why this difference? Of course we naturally infer that the kind of pressure and tension which ossified the bone originally sets up in the articular cartilage (or elsewhere) the same kind of action within its substance by the mechanical power of locomotion. Dr. Humphry states that epiphyses appear at the sternal ends of the clavicles; but they are not there in childhood while growth is going on in a normal way, but are only developed when the chest is undergoing its greatest lateral expansion, in the years from 17 to 20, when they become anchylosed to the shaft of the bone. And in many heavy-bodied active animals, like the buffalo, rhinoceros, &c., the rib terminates at its head in an epiphysis, which articulates with another epiphysis on the neural arch; while in light-bodied animals no such epiphyses are met with. And wherever epiphyses are found, whether as terminal of bones or as places for the attachment of powerful muscles, it is only where pressure and tension are manifested under conditions of great activity of the part. This new bony growth takes place towards the articular termination of the cartilage, where the subinflammatory condition is induced by local activity—and so, while giving a means for the articular ends of bones to become better adapted to each other, protects the epiphysial cartilage and furnishes it with an additional surface on which bony growth may take place. From which considerations it would appear that one ossification may develope another upon itself whenever the forces manifested at its ends (or elsewhere) are more than sufficient to continue simple growth by increase on the normal surface. Small ossifications are often met with about the joints in many parts of the body, which have originated in this way. The fact of epiphyses being only characteristic of certain species of animals in each class shows us that they have no necessary connexion with the animal grade of organization; the fact of their appearing under conditions of unusual activity shows that their origin is the same as that of all other bones, but that they are of subordinate importance in the skeleton, since they become united to the normal skeletal elements, and do not necessarily modify the form of their terminal ends.

I now notice the general morphology of bones and its relation to mechanical causation.

Mr. Charles Darwin finds that the domestic races of pigeons, fowls, and ducks, which fly little, have the chief bones to which are attached the muscles which are exercised in that function smaller and lighter than in the parent races. Similarly it is observed that, in the improved races of pigs, shortened legs and snout, and altered form of the occipital condyle, may be attributed to the parts not having been fully exercised; for the highly cultivated races do not travel in search of food nor root up the ground with their ringed muzzles. Also domestic rabbits have the body and whole skeleton larger and heavier than the wild animal, and the leg-bones are heavier in proportion; but neither the leg-bones nor scapulæ have increased in length proportionally with the increased dimensions of the remainder of the skeleton. All of which is in accord with the law of pressure and tension, the increase of bulk of the tame animal depending merely on luxuriant diet. The leg-bones, less exercised, experience less central compression, and are consequently relatively heavier; and similarly, from less exercise of the parts usually most exercised, they become relatively shorter. And with respect to cattle, Prof. Tanner finds that in improved breeds the lungs and liver are considerably reduced in size when compared with those organs in animals having perfect liberty—thus changing the form of their bones by respiration and nutriment.

But the kind of evidence which more particularly concerns the subject now is the converse of this. Thus ungulate animals which are light of body (deer, horses, &c.) have the limbs longer than have most unguiculate animals; and as a rule, those hoofed animals are more active, and strike the ground with greater force, so that the bones can act on each other more powerfully. And in man, where the position of the body is erect, and the habit not active, so that the weights of the upper parts of the body act on each other with no violent pressure, and that alternating with rest in sleep, the vertebræ will be seen to steadily enlarge, from the neck down to the sacrum. But in quadruped animals with a large head carried erect in running and pendent in seeking food, like the deer, the cervical vertebræ will be seen to be longer and larger than the dorsal vertebræ; and here it is to be remarked that the neck-bones have to support the weight of the head, and that their processes experience the pressure and tension caused by its movements, while the back-bones only have to share between them the general weight and tension of the carcass. In animals which walk erect, and chiefly use the hind limbs, the hind limbs are longer than the fore limbs, as in man and the ostrich, and in jumping animals, such as kangaroos, jerboas, frogs, &c. On the other hand, animals which use their fore limbs more than the hind limbs, have them longer than the hind limbs: familiar examples of this condition are seen in the tribe of bats and in most birds, such as the albatross or the swan. Here the pressure and tension experienced by the bones in flight is very great in comparison with the influences which could stimulate growth in the hind limbs; and the growth is greater.

Special modification of structures in relation to modified function may be seen in the humerus of the burrowing mole: this bone experiences enormous lateral tension, and accordingly attains enormous width from side to side. The animal's method of burrowing causes a great use of the pectoral muscles; and the use of these muscles coincides with the condition of their attachment for the development of a sternum similar in form to that of a bird; and true coracoid bones are attached to it, as in birds. In quadruped animals which carry the head and neck erect, like the giraffe, where the vertebræ experience the weight of the head and part of the neck above each in pressure, made intermittent by activity, the vertebræ are found to attain enormous length; but the upper bones are the longer ones: whence it may be inferred that a moderate intermittent pressure is more favourable to growth than a considerable pressure, the greater pressure producing what is relatively atrophy; and in the elephant, where the pressure of the head upon the vertebræ is great, and not greatly varied, the force of growth is unable to overcome the weight, and the vertebræ are short from back to front, though they grow at their circumference. The same shortening of the neck-vertebræ, connected with the continuous pressure of a large head, is admirably seen in the Cetacea, where in progression the neck-vertebræ have to support the non-intermittent pressure of the immense head. Whatever and wherever the pressure and tension are manifested, it is always with this result in increase or decrease of growth, which vary as the pressure is intermittent or constant. Examples of it could only cease when the enumeration of organisms was terminated.

But the inference from these facts is not merely that the same law holds true for growth in the different parts of the skeleton and in the whole skeleton as governs the growth of a single bone and of its parts, but that the whole distinctive plan of the part which is inherited from individual to individual is as completely in harmony with this law of growth as though it had been produced not by inheritance at all, but wholly by mechanical causation, in the individual animal in which it is visible; that is, growth in the individual and growth in the plan of the individual are commonly in the same directions, and such as would have been produced by the continuous action of the same cause, namely intermittent pressure and tension. But it is seen that only an infinitesimal element of the plan of the animal *is* produced by the individual; hence, since the plan-growth exists in all the individuals of a group, it is justly inferred that the plan has accumulated in the sum of the individuals by being passed on from generation to generation; for in that way, and in that way only, could the mechanical law act which has been seen to have acted in the daily life of animals, so as to produce the forms of special parts in accord with the conditions of mechanical causation which we found to characterize regions of the body.

Finally, it will conduce to clearness to show the kind of way in which structures are inherited, so as to get the results of persistent modifying causation accumulated. The individuals of that common bond called a species, though nearly resembling each other, as is well known, have differences so marked that it is rare for the eye to be unable to distinguish them; so that the variation of a species is enormous: and if this variation, instead of being in a multitude of different directions, be in any manner caused to be chiefly of the same kind, obviously the mere summing of the variation will produce most extensive differences. Here it is necessary to remark that in every family there may be seen two kinds of variation among the children,—first, that which depends upon the individual peculiarities of nutrition, and which gives a different aspect to brothers and sisters, and then that kind of inheritance by which the child reproduces the mental and physical form and distinctive peculiarities of the parents. And when the variation in nutrition coincides with the distinctive peculiarities in inheritance, these latter will be specially intensified. And it is found by experiment that the accumulation of characters by inheritance has an influence in fœtal development by which parts may be multiplied. It is probable that the epiphyses of bones thus take their origin; and it is certain that increase in the number of vertebræ is thus instituted. Upon this point Mr. Charles Darwin's observations upon pigeons are specially instructive. Pigeon-fanciers have gone on selecting *pouters* for the length of their bodies; and it is found that their vertebræ are generally increased in number, and their ribs in breadth. The *tumblers* have been selected for their small bodies; and their ribs are generally lessened in number. *Fantails* have been selected for their large, widely expanded tails with numerous tail-feathers; and the caudal vertebræ are increased in size and number. From which it seems to me evident that the special exercise of a function in life sometimes produces an increase of structure in reproduction, beyond that which was possible to the parent from the plan of its structures.

The variation from nutrition in reproduction sometimes goes so far that a tissue is dialyzed with its characters so far intensified as to be both unlike the parent and all others of its species. Two cases quoted by Mr. Darwin illustrate this. First, there is Lambert, the porcupine-man, whose skin was covered with warty projections which periodically moulted, and whose six children and two grandchildren were similarly affected; and there is the Burmese family observed by successive ambassadors at the court of Ava, where father, daughter, and grandson had the body, with the exception of the feet and hands, covered with long, straight, silky hair. And from these and many similar cases it would seem a natural inference that, just as the bones and dermal covering vary with altered nutrition, so also do all other parts of the organism, which are less easily observed.

In conclusion, it has been seen that growth depends upon a kind of organic dialysis, called nutrition, which is sustained throughout the body by the mechanical actions of the parts of the organism which produce pressure and tension, while the direction in which this action is manifest is due to the common plan on which the individual is built. And the amount of the change is due to the change of structure produced in the individual by changed function inherited in the offspring, and partly by the realization in the offspring of such structures as the parent's functions tended to produce, but which its common plan rendered impossible for itself to develope. And with this condition of variation, the general inference from the phenomena of growth is, that the form of the whole skeleton, as of every bone, is due to the mechanical strains to which it is subjected, since these govern its nutrition.

[To be continued.]

XXIX.—*On the Nomenclature of the Foraminifera.* By W. K. Parker, F.R.S., and Prof. T. Rupert Jones, F.G.S.

[Continued from p. 230.]

*Nummulitic Limestone of Gyzeh and Mokattam**. (Abhandl. Berl. Akad. Wiss. 1838, p. 93, tables XIV. XVI. pl. 4. fig. vii.)

Pl. xxiii. fig. 1, *Miliola sphæroidea* ("compare *Cenchridium oliva*, 1843"), and fig. 2, *M. ovum*, are both *Lagena globosa*; but the second specimen is longer in proportion (oval-oblong). Fig. 3, *Textilaria globulosa* (1838), *α*, fig. 4, *β. obtusa*, fig. 5, *γ. amplior*, fig. 6, *δ. dilatata*, are *Text. globulosa*, Ehr. Fig. 7, *T. linearis* ("*T. striata*, 1838, is known only in fragments"), fig. 8, *Grammostomum polytheca* (?), figs. 9 & 10, *Gr. ægyptiacum*, figs. 11 & 12, *Gr. angulatum*, fig. 13, *Gr. falx*, fig. 14, *Gr. siculum* (?), fig. 15, *Gr. increscens*, fig. 16, *a*, *b*, *Gr. poly-*

* See Mr. Bauerman's section of the Mokattam Cliff, Quart. Journ. Geol. Soc. London, vol. xxv. p. 40, where references are made to the works of Figari Bey and Oscar Fraas. See also Russegger's 'Reisen in Europa, Asien, und Afrika,' &c. 5 vols. and Atlas, 1841–42.

stigma, and fig. 17, *Gr. rhomboidale*, are various *Textilariæ*; figs. 8–14 and 17 are of the *gibbosa*-group, with tendencies towards the *agglutinans* type; figs. 15 & 16 belong to the *sagittula* type. Fig. 18, *Gr. phyllodes*, seems to be *Bolivina punctata* (?). Fig. 19, *Gr. thebaicum* (?), with its delicate misty shell, is probably *Virgulina Hemprichii*, which will be further noticed in describing the next plate. Fig. 20, *Gr. attenuatum* (?) may be a small *Textilaria*; indeed it corresponds with the first few chambers of fig. 17. Figs. 21, *Gr. phyllodes* (?), 22 & 23, *Gr. attenuatum* ("*Text. aciculata*, 1838, proves to be fragments of several small species of *Grammostomum*"), and 24, *Strophoconus*? (*Gram.*?) *teretiusculus*, are rather broad individuals of *Bolivina punctata*, or may be grouped as *B. dilatata*. Fig. 25, *Proroporus*? (*Gram.*?) *pachyderma*, passes well as a coarse-shelled *Text. agglutinans*. Figs. 26 & 27 (?), *Polymorphina gyzensis* ("compare *Grammobotrys* and *Sphæroidina*"), evidently a puzzling form to the author, is especially so as a figure. It has relatively large swollen segments, like a full-plaited "chignon," and has the aspect of a *Polymorphina* in some respects; but it shows no aperture, and is probably a *Textilaria*.

Figs. 28, *Rotalia aspera*, and 29, *Planulina globigerina* (?), are *Planorbulina tuberosa*, varr., near *Pl. Haidingerii*. The next three are probably *Globigerinæ*—namely, figs. 30, *Rotalia increscens*, 31, *Planulina Isidis*, and 32, *Allotheca rotalia* ("*Rotalia globulosa*, 1838"). Figs. 33 & 34, *Globigerina cretæ* ("*Rosalina foveolata*, 1838"), is the typical *Glob. bulloides*, D'Orb. Fig. 35, *Planulina Pharaonum*, is a variety of *Pulvinulina Menardii*, near *pulchella*. Fig. 36, *Plan. incurva*, answers to *Plan. ariminensis*. Fig. 37, *Nonionina Hemprichii*, is very near *N. scapha*. Fig. 38, *Planulina pyramidum* ("1838; small specimen"), is without doubt an *Operculina complanata*. Fig. 39, *Plan.? eurytheca* is a young *Planorbulina*, probably of the *ammonoides* group. Fig. 40, *Rotalia incrassata* ("*Planulina turgida*, 1838") may be catalogued as a small *Cristellaria cultrata*. Fig. 41, *Planulina heptas*, is a young *Planorbulina farcta*, sublimbate perhaps, but scarcely to be referred, for want of specialization, to any particular variety, though probably tending towards *Pl. ammonoides*. Figs. 42 & 43, *Planulina lenticulina*? ("compare *Rotalia lenticulina*"). Here we have gradations of form from the loosely set, lobate, round-chambered (42) *Pl. globulosa* (Ehr.), through a more compactly grown shell (43), to figs. 41 & 39, above noticed.

Figs. 44, *Planulina? eurytheca*, and 45, *Pl. hexas*, belong to *Cristellaria cultrata*; the latter figure shows a very slight keel. Fig. 46, *Nonionina Hemprichii* (?), is a true *Rotalia*, very near *R. Beccarii*, var. *ammoniformis*. Fig. 47, *Planulina? umbilicata*, appears to be *Crist. cultrata*; also figs. 48, *Pl.? ampla*, 49, *Pl.? involuta*, and 50, *Pl.? ampliata*. Fig. 51, *Rotalia auricula*, is also a *Cristellaria*, somewhat produced, as is common in connexion with the rapid increase of the segments in size. Fig. 52, *Quinqueloculina? caudata*, is indeterminable.

A. The weathered surface of a piece of Egyptian Nummulitic Limestone. B. Weathered piece of limestone largely composed of "*Planulina pyramidum*" (see fig. 38). C. The dust of the Nummulitic Limestone, magnified 300 diameters, part seen by transmitted, part by reflected light: "no Chalk Morpholites" (Coccoliths). D. Similar dust, but without the finest particles. E. The *Nummulites*, of natural size: 1, *a*, *b*, *N. placentula*; 2, *a*, *b*, *c*, *N. gyzensis*; 3, *a*, *b*, *c*, *N. seminulum*, which, together with *N. cellulosus* and "*Planulina pyramidum*," are easily seen by the naked eye.

1. *Nummulina placentula*, Ehr., is the *Nautilus major* of Forskål (see Ann. Nat. Hist. ser. 3. vol. viii. p. 235), which name was evidently meant for the largest of the common Nummulites of Gyzeh (sometimes 1½ inch across). Some of these are sufficiently large and thin for the typical *N. complanata*, Lamarck (*op. cit.* pp. 232 & 234); but Ehrenberg's figure (1, *a*, *b*) does not exceed in size some illustrating *N. gyzehensis* in D'Archiac & Haime's 'Foss. Ind.' p. 94, pl. 2. figs. 6–8. *N. placentula* (*N. major*) and *N. gyzehensis*, therefore, are the same, differing only in size.

2. *N. gyzehensis* (Forskål). These smaller specimens, indicated by Forskål and figured by Ehrenberg, are probably such as have a large primordial chamber* and relatively great thickness, referred to *op. cit.* p. 233. *N. curvispira*, Meneghini, as figured by D'Archiac & Haime, 'Foss. Ind.' pl. 6. fig. 15, is not only one of these subvarieties, but possibly the one alluded to by Forskål and Ehrenberg.

3. *N. seminulum*, Ehr., had not been figured by Ehrenberg when D'Archiac & Haime published their important and exhaustive work on Nummulites. There can be little doubt that it is the same as their well figured and described *N. Guettardi* ('Foss. Ind.' 1853, p. 130, pl. 7. figs. 18, 19).

4. "*N. cellulosus*" may possibly be another name for the small forms of *N. gyzehensis*.

The Foraminifera shown on plate XXIII. (as those also on

* This kind of growth characterizes Ehrenberg's proposed genus *Monetulites*, Abhandl. 1856, p. 145, note.

plates XXIV., XXV., XXVI.) indicate a sea-depth of from 30 to 40 fathoms. In broad terms, they may be said to be not of shallow water nor of very great depths, neither littoral nor abyssal, but decidedly within 20 and 90 fathoms.

Species and notable Varieties of Foraminifera from the Nummulitic Limestone of Gyzeh and Mokattam, Egypt, figured by Ehrenberg.

1. Lagena globosa (*Montagu*).
2. Cristellaria cultrata (*Montf.*).
3. Bolivina punctata, *D'Orb.*
4. —— dilatata, *Reuss.*
5. Virgulina Hemprichii (*Ehr.*).
6. Textilaria agglutinans, *D'Orb.*
7. —— sagittula, *Defrance.*
8. —— gibbosa, *D'Orb.*
9. —— globulosa, *Ehr.*
10. Globigerina bulloides, *D'Orb.*
11. Planorbulina farcta (*F. & M.*), varr.
12. —— globulosa (*Ehr.*).
13. —— ammonoides (*Rss.*).
14. —— ariminensis (*D'Orb.*).
15. Pulvinulina Pharaonum (*Ehr.*).
16. Rotalia ammoniformis (*Lam.*).
17. Nonionina scapha (*F. & M.*).
18. Operculina complanata (*Defrance*).
19. Nummulina gyzehensis (*Forskål*).
20. —— curvispira, *Meneg.*
21. —— Guettardi, *D'Arch. & Haime.*

VII. *Limestone from the Tombs at Thebes, Egypt.* (Abhandl. 1838, p. 94, table XIV., pl. 4. no. viii.; Annals Nat. Hist. vol. vii. July 1841, p. 374 &c.)

This very interesting Foraminiferal Limestone, "halibiolith" (Ehrenberg), or marine organic rock, is, both by relative position* and contents, older than the Nummulitic Limestone. The presence of *Globigerina cretacea*, D'Orb., goes far to prove this halibiolithic formation to be of Secondary age.

The limestones of Benisoucf, Siout, and Thebes, on the western banks of the Nile, are represented in this analysis.

Plate XXIV. figs. 1, 2, *Cenchridium dactylus* ("compare Monatsber. 1845, p. 358"). This is a long-ovate and sub-

* See Newbold's description and section, Quart. Journ. Geol. Soc. vol. iv. p. 328; also Russegger's 'Reisen' and Atlas, 1841–42.

cylindrical Entosolenian *Lagena*, probably *L. emaciata*, Reuss. Figs. 3 & 4, *C. oliva*, the Entosolenian *Lagena globosa* (Montagu). Fig. 5, *Miliola striata*, is the *Lagena costata* of Williamson. Fig. 6, *Nodosaria monile*, = *N. pyrula*, D'Orb. Fig. 7, *N. tumescens*, = *N. ovicula*, D'Orb. Fig. 8, *Vaginulina cretæ*, = *V. lævigata*, Rœmer (three early chambers). Fig. 9, *V. bullosa*, = *V. leguminiformis* (Batsch), three early chambers. Really, however, figs. 8 & 9 are the young of one *species*, with slightly different proportions. Fig. 10, *V. subulata*, = *V. lævigata*, Rœmer; four early chambers of a larger and stronger shell than fig. 8.

Figs. 11, *Textilaria subtilis*, 12, *T. globulosa*, γ. *amplior*, 13, 14, *T. globulosa* (1838), 15, *T. inflata*, are small individuals, perhaps subvarietal, of *T. gibbosa*, D'Orb. Figs. 16 & 17, *T. linearis*, = *Bolivina punctata*. Fig. 18, *Grammostomum polystigma*, = *Text. sagittula*. Fig. 19, *Gram. cribrosum*, = *Boliv. punctata*. Figs. 20 & 21, *Gram. thebaicum*, = *Boliv. dilatata*. Figs. 22 & 23, *Gram. connivens*, are the young of the same.

Figs. 24 & 25, *Gram. lingua*, are *Virgulina squamosa*; 24 is typical, 25 is subvarietal. Fig. 26, *Strophoconus?* (*Grammostomum?*) *teretiusculus*, and 27, *Str.?* (*Gram.?*) *polytrema*, are *Virgulina Schreibersii*, the latter quite typical.

Figs. 28, *Stroph.?* (*Gram.?*) *leptoderma*, 29, *Stroph. ovum*, 30, *Stroph.?* (*Gram.?*) *leptoderma*, 31, *Stroph. spicula*, 32, *Stroph.? Hemprichii*, and 33, *Textilaria?* (*Grammobotrys?*) *thebaica*, are all of one species, *Virgulina Hemprichii* (Ehr.), of variable shape, but with persistently subarenaceous shell. See 'Geol. Mag.' vol. viii. pp. 508 & 509. This species is well illustrated by many figures in other plates, which we shall have to notice in treating of the 'Mikrogeologie;' and we are well acquainted with it in the recent state from the Indian seas. Fig. 32 exhibits a typical complanate individual of advanced growth.

Fig. 34, *Polymorphina prisca*, = *P. compressa*, D'Orb. This is the only *Polymorphina* on this plate, although we at first accepted some other figures as such (in the "Monograph on *Polymorphina*," Trans. Linn. Soc. vol. xxvii.). Figs. 35 to 41 are young *Globigerinæ*. We know of but one real species of *Globigerina* (*Gl. bulloides*) in both recent and fossil state, though about twenty-five reputed species have been described and figured, and others recorded. Of the varieties, *Gl. cretacea*, D'Orb., is one of the best marked, and it occurs on this plate (fig. 49). Some of the young forms here mentioned decidedly belong to it; but figs. 35 & 36 in particular may be true *Gl. bulloides*. The names given are:—figs. 35, 36, *Ro-*

talia rudis ("*R. laxa*, juv.?"); 37, 38, *R. globulosa* (1838); 39, *R. leptospira*; 40, *R. senaria*; 41, *R.? pertusa* ("*Rosalina pertusa*, 1838, in part").

Fig. 42, *Rotalia pachyphysa*, is a young lobulate *Planorbulina farcta*, near *Pl.* (*Truncatulina*) *lobatula*. Figs. 43, *Rot. quaterna*, *β. floscularis* ("compare *Planulina flos*"), & 44, *a*, *b*, *Planulina porosa* ("*Rosalina lævigata*, 1838, in part"), are small *Planorbulinæ Haidingerii* (D'Orb.). Figs. 45, *Plan. centoculus*, and 46, *Pl. megapora*, are characteristically the young of *Planorbulina vulgaris*. Fig. 47, *Planulina flos* ("compare *Rotalia quaterna*, *β. floscularis*"), is a young delicate *Planorbulina Haidingerii*. Fig. 48, *Planulina depressa*, is a young *Planorbulina*, with granular or rough surface, near *Haidingerii*, possibly *Pl. Ungeriana*. Fig. 49, *Globigerina foveolata* ("*Rosalina foveolata*, 1838"), is the typical *G. cretacea*, D'Orb. (see above). Fig. 50, *Planulina prorotetras*, is a roundish *Planorbulina tuberosa* (F. & M.), or may be said to be the spiral centre of a *Planorbulina* of the *vulgaris* subtype, which would afterwards grow less regularly and become outspread with somewhat concentric chambers. The notch of the aperture on the right-hand side of the figure is characteristic. Figs. 51, *Planulina millepora*, and 52, *Pl. pardalis*, are *Planorbulina* (*Anomalina*) *ammonoides* (Reuss). Fig. 53, *Prorospira princeps*, is *Planulina ariminensis*, D'Orb. Figs. 54, *Planulina ampliata*, and 55, *Pl. ammonis*, are *Planorbulina ammonoides*. Figs. 56 & 57, *Pl. integra* (56, with entire margin; 57, sublobate), are small *Planorbulinæ*. Figs. 58, *a*, *b*, *Pl. heteropora*, are *Planorb. ammonoides*. Figs. 59, *Pl.? umbilicata* ("*Pl. millepora*, juv.?"), probably the young of fig. 62, 60, *Pl. ampliata* (?), 61, *Pl. integra*, 62, *Rotalia Hemprichii* (rough shell, with rapid increase of the whorls), are all *Planorbulinæ*, near *Pl. ammonoides*; or these, with the foregoing, may be described as spiral beginnings of such Planorbuline varieties as grow in outspread forms in the shallow water, and, when *attached*, become mostly thick-walled.

Fig. 63, *Planularia thebaica*, is probably a small *Cristellaria* (*Saracenaria*) *italica*. Fig. 64, *Spiroloculina dilatata*. From the aspect of the shell, it seems to have become smoothly and finely arenaceous—an interesting feature. Fig. 65, *Quinqueloculina? nodulus*. A *Quinqueloculina*, probably *Q. seminulum*; but it seems to be the central portion only.

Figs. 66 & 67 are stellate spicules (?).

A. Fine dust, mainly composed of Coccoliths (*cyatholiths*) &c.
B. Group of the Foraminifera without the finer particles.

These belong to a depth of about 30 or 40 fathoms.

Species and notable Varieties from the Limestone of the Catacombs at Thebes, Upper Egypt, figured by Ehrenberg.

1. Lagena emaciata, *Reuss.*
2. —— globosa (*Montagu*).
3. —— costata (*Williamson*).
4. Nodosaria pyrula, *D'Orb.*
5. —— ovicula, *D'Orb.*
6. Vaginulina lævigata, *Rœmer.*
7. —— leguminiformis (*Batsch*).
8. Cristellaria italica (*Defrance*).
9. Polymorphina compressa, *D'Orb.*
10. Bolivina punctata, *D'Orb.*
11. —— dilatata, *Reuss.*
12. Virgulina squamosa, *D'Orb.*
13. —— Schreibersii, *Czjzek.*
14. —— Hemprichii (*Ehrenb.*).
15. Textilaria sagittula, *Defrance.*
16. —— gibbosa, *D'Orb.*
17. —— globulosa, *Ehr.*
18. Globigerina bulloides, *D'Orb.*
19. —— cretacea, *D'Orb.*
20. Planorbulina farcta (*F. & M.*).
21. —— vulgaris, *D'Orb.*
22. —— Haidingerii, *D'Orb.*
23. —— ammonoides (*Rss.*).
24. —— ariminensis (*D'Orb.*).
25. Spiroloculina.
26. Quinqueloculina.

VIII. & IX. *White, hard, thick Limestone from the Antilibanon, Syria.* (Monatsbericht, 1842, p. 127.)

This halibiolithic formation also seems to be of Cretaceous age, as stated by Ehrenberg. M. P. E. Botta published some geological observations on the Libanus and Antilibanus in 1833 (4to, Paris); but Russegger's 'Reisen in Europa, Asien, und Afrika, &c.' with Atlas, 1841–42, is the only work we have been able to refer to for a section of the Antilibanus. Russegger explains the structure of that range to consist of:—(1) near Baalbec, Upper Chalk, covered here and there with Tertiary beds; (2) flanking hills, reaching to a considerable height, of Lower Chalk and Greensand, rising up from the west, and resting on the (3) hard anticlinal Jurassic rocks of the lofty central range. On the eastern side, the same succession of strata, in reverse, dip away one after the other among the low flanking hills, and the Upper Chalk disappears under the

Tertiary beds and alluvium of Damascus. We presume that Dr. Ehrenberg's specimen came from one of the upper white limestones.

(VIII.) Pl. XXV. I. A. fig. 1. *Miliola elongata*, a *Lagena* very similar to *L. distoma*, P. & J., but more patulous at the extremities. Figs. 2 & 3, *Nodosaria procera*, 4, *N. lævis*, 5, *N. subulata*, and, 6, *N. turgescens*, are varieties of *N. ovicula*, D'Orb., passing into a more compact form; 3 & 6 = *N. ovicula*; 2, 4, & 5 have more closely set chambers, resembling *N. filiformis*, D'Orb.; 5, in particular, is a thick, coarse, rough shell. Fig. 7, *Frondicularia nodosaria*, is an attenuate simple *Nodosaria* of the *radicula* type (such as *N. subnodosa*, Reuss, 1851, from Lemberg), with overlapping chambers*, which, seen in section, have somewhat of a chevron-like aspect. Figs. 8, *Textilaria globulosa*, α, 9, *T. globulosa*, γ. *amplior*, 10, *T. inflata*, and 11, *T. globulosa*, γ. *amplior*, are *T. globulosa*, Ehr., the small arrested form belonging to *T. gibbosa*, D'Orb. Figs. 12, *Grammostomum subacutum*, and 13, *Text. globulosa* (?) are larger *T. gibbosæ*, with a tendency towards *T. agglutinans*. Fig. 14, *Gram. spatiosum*, is a good *Bolivina punctata*. Fig. 15, *Gr. laxum* (?), with its rather cloudy shell, is probably *Virgulina Hemprichii* (Ehr.). Figs. 16, *Gr. polytheca*? ("compare *G. laterale*"), showing side views of its loop-like apertures, 17, 18, *Gr. caloglossa*, and 19, 20, *Gr. polytheca* (?), all belong to *Bolivina punctata*; fig. 20 has a rather broad shell, therein approaching *B. dilatata*; fig. 21, *Gr. costulatum*, is a *Bolivina*, near *B. costata*, gently sulcate, with pores in the furrows.

Fig. 22, *Gram. micromega*, is a piece of a large *Textilaria* of the *sagittula* group, and fig. 23, *Gr.*? (*Strophoconus*?) *leptoderma*, seems to be its young form. Fig. 24, *Gram. eurytheca*, is *Text. sagittula*. Figs. 25 & 26, *Bigenerina libanotica*, is *Polymorphina compressa*. Figs. 27 & 28, *Rotalia haliotis*, is a thin-walled, thickly perforated *Planorbulina farcta*, with rapidly increasing whorls and the last chamber much produced. Such are common in the Mediterranean.

Figs. 29, *Planulina stigma*, 30, *Globigerina libani* ("compare *Gl. stellata*"), and 31, *Pl. pachyderma*, show three successive sizes of the typical *Glob. cretacea*, D'Orb. Fig. 32, *Planulina argus*, is *Planorbulina farcta*. Figs. 33, *Planulina monticulosa*, and 34, *Rotalia laxa*, belong to a rough variety of *Planorb. farcta*, granular and coarsely perforate. Figs. 35, *Rotalia protolepta*, 36, *Planulina saxipara*, 37, *Pl. leiopentas*,

* Such is the main character of Ehrenberg's genus *Encorycium*, Monatsber. for 1858, pp. 11 & 19.

and, 38, *Pl. eusticta*, are common, young, sublobate and limbate *Planorbulinæ globulosæ* (Ehr.). Fig. 39, *Planulina syriaca*, is a *Planorbulina* like *Pl. Haidingeri*.

Fig. 40, *Planulina umbilicata*, is a small ill-grown *Cristellaria cultrata*. Fig. 41, *Plan. membranacea*, is *Pulvinulina Karsteni*. Figs. 42, *Ptygostomum senarium*, and 43, *Pt. quinarium*, are young specimens of *Planorbulina vulgaris*, coarsely porous, lobate, limbate, and with patulous apertures. Such as these soon take on an irregularly concentric growth, with bi- or multi-osculate chambers. Figs. 44, *Planulina leptostigma*, α, 45, *Rotalia ammonis*, 46, *Pl. cornu*, 47, *Pl. leptostigma*, β, and, 48, *Rotalia depressa*, are young forms of *Planorbulina* (*Planulina*) *ariminensis*.

A. Grains of the limestone (magn. 300 linear), consisting chiefly of Foraminifera, with some Coccoliths (?) and stellate spicules (?). Magnified 300 diam.

This Foraminiferal fauna lived at about 30 or 40 fathoms depth.

(IX.) Pl. XXV. II. B. Figs. 1, 2, *Nodosaria libanotica*, = *N. ovicula*, with thick-shelled and elongate chambers, near *N. Mariæ*, D'Orb., and *N.* (*D.*) *Lorneiana*, D'Orb.

Fig. 3, *Grammostomum polystigma*, is *Textilaria sagittula*. Fig. 4, *Gr. convergens*, is *T. agglutinans*. Fig. 5, *Rotalia ibex*, is *Planorbulina ariminensis*. Fig. 6, *R. senaria*, is a small limbate *Planorbulina*. Fig. 7, *R. laxa*, the same as fig. 4, the young of *Planorb. vulgaris*. Fig. 8, *Nonionina Astræa*, is too porous and has its chambers relatively too large for *Nonionina*: it seems to stand between figs. 28 & 32, more delicate and neater than either in its shell and pores; the setting-on of the chambers is Nonionine or Operculine, and too symmetrical in appearance even for *Anomalina* among the Planorbulines. We must leave it doubtful. Fig. 9, *Rotalia quaterna*, β. *floscularis* ("compare *Planulina flos*"), is a young *Planorb. farcta*. Fig. 10, *Planulina septenaria*, is a young *Pl. vulgaris* with rather falcate chambers. Fig. 11, *Pl. ampliata*, is *Planorb. ammonoides*. Figs. 12–15 are stellate spicules; figs. 16, 17, enlarged Cyatholiths and fragments.

B. Grains of the limestone, consisting of Foraminifera, Coccoliths, &c. Magnified 300 times linear.

Belonging to about 30 or 40 fathoms depth.

Species and notable Varieties of Foraminifera from the White Limestone of the Antilibanon, figured by Ehrenberg.

1. Lagena elongata (*Ehr.*). VIII.
2. Nodosaria ovicula, *D'Orb.* VIII., IX.
3. —— filiformis, *D'Orb.* VIII.

4. Nodosaria subnodosa, *Rss.* VIII.
5. Cristellaria cultrata (*Montf.*). VIII.
6. Polymorphina compressa, *D'Orb.* VIII.
7. Bolivina punctata, *D'Orb.* VIII.
8. —— costulata (*Ehr.*). VIII.
9. Virgulina Hemprichii (*Ehr.*). ? VIII.
10. Textilaria agglutinans, *D'Orb.* VIII.
11. —— sagittula, *Defr.* VIII., IX.
12. —— gibbosa, *D'Orb.* VIII.
13. —— globulosa, *Ehr.* VIII.
14. Globigerina cretacea, *D'Orb.* VIII.
15. Planorbulina farcta (*F. & M.*). VIII.
16. —— vulgaris, *D'Orb.* VIII., IX.
17. —— globulosa (*Ehr.*). VIII.
18. —— Haidingerii (*D'Orb.*). VIII.
19. —— ammonoides (*Rss.*). IX.
20. —— ariminensis (*D'Orb.*). VIII., IX.
21. Pulvinulina Karsteni (*Rss.*). VIII.

X. *Grey Limestone of the Arabian Coast near Haman Faraun, near Sinai.* (Monatsber. 1838, p. 89, table xv. pl. 4. fig. 9.)

Mr. Bauerman supplies some notes on the geology of the coast near this promontory (which he terms "Hammam Faraoun") in the Quart. Journ. Geol. Soc. London, vol. xxv. p. 23, pl. 1. fig. 2. See also Russegger's 'Reisen,' &c.

Pl. xxv. iii. c. Fig. 1. *Textilaria brevis* ("*Textularia brevis*, 1838"), the same as fig. A, 9; the young of *T. gibbosa*.

C. Grains of the limestone (magnified 300 diams.), consisting of Foraminifera and Coccoliths (cyatholiths and discoliths), and comprising *Textilaria striata*, Ehr.; "*T. brevis* and *T. dilatata* (1838)," = *T. globulosa*; and "*Rotalia globulosa* (1838)" = *Planorbulina globulosa*.

These also seem to belong to a fauna inhabiting 30 or 40 fathoms depth.

XI. *White thick Limestone of Cattolica, Sicily.* (Monatsber. Berl. Akad. Wiss. 1838, pp. 176, 192. Abhandlungen, 1838, table vii. pl. 4. fig. vi.)

This halibiolith is regarded as of Cretaceous date by Ehrenberg. Some of its Foraminifera (as *Virgulina paradoxa*) support the view. It was formed in deeper waters than the foregoing, at about 90 fathoms.

Pl. xxvi. fig. 1, *Oolina sicula*, is *Lagena sulcata*. Fig. 2, *Miliola lævis*, may be arranged with *Lagena elongata* (Ehr.).

Fig. 3, *Miliola? (Vaginulina?) pusilla*, is indeterminable. Fig. 4, *Nodosaria? sicula*, = two early chambers of a *Nodosaria* or, rather, of *Glandulina lævigata*. Fig. 5, *Dentalina sphærophora*, is *Nodosaria gracilis*, D'Orb., after Soldani. Fig. 6, *Nodosaria leptosphæra*, is *N. ovicula*, like figs. 1 & 2, in pl. XXV. II. B. Fig. 7, *Vaginulina Hoffmanni*, is one of the simplest forms of *V. lævigata*, Rœm. Fig. 8, *Vag.? tenuis*, is indeterminable. Figs. 9 & 10, *Textilaria globulosa*, *β. obtusa* ("*T. glob.* 1838"), = *T. gibbosa*. Figs. 11 & 12, *Grammostomum? (Strophoconus?) leptoderma*, is *Virgulina Schreibersii*. Fig. 13, *Gram. apiculatum*, is *Vulvulina pennatula* (Batsch), narrow variety, with aculeate ends to the chambers. Figs. 14 & 15, *Gr. phyllodes*, =*Bolivina punctata*. Fig. 16, *Gr. siculum* ("*Text. aciculata*, 1838, in part"), is a rather broad *Bol. punctata*. Fig. 17, *Gr. polystigma*, is *Text. sagittula*.

Fig. 18, *Proroporus siculus*, is probably *Polymorphina Thouini*. Figs. 19, *Gram. turio*, 20, *Strophoconus spicula*, 21, *Str. ovum*, 22, *Str. (Gram.?) stiliger*, 23, *Str.? (Gram.?) acanthopus*, and 24, *Str. efflorescens*, are *Virgulina Hemprichii*, mostly very young; and some are apiculate at the base. Fig. 25, *Stroph. teretiusculus* (?), is a *Virgulina Schreibersii*, becoming biserial. Figs. 26, *Vaginulina? paradoxa*, and 27, *V. obscura*, are cylindrical arcuate *Virgulinæ Hemprichii*, such as are found in Jurassic clays, Gault, and Chalk.

Fig. 28, *Polymorphina uvula*, =*P. problema*. Figs. 29, *Biloculina? incisa*, 30, *B.? tenuis*, and 31, *B.? integra*, are young (Adelosine) *Quinqueloculinæ*. Fig. 32, *Planulina argulus*, is a *Planorbulina globulosa* with large pores. Figs. 33, *Rotalia protolepta*, 34, *R. protacmæa*, 35, *R. globulosa*, and, 36, *R. quaterna?* (all "*R. globulosa*, 1838"), are young individuals and arrested forms of *Planorbulina farcta*.

Fig. 37, *Planulina leiopentas* (?), yellow in colour, looks like *Pulvinulina Menardii*; but its pores are too large; it may be a *Planorbulina* near *Pl. Haidingerii*. Fig. 38, *Rotalia leptospira*, yellow in tint, has the appearance of *Pulvinulina canariensis* (D'Orb.), but is doubtful; it also may be a *Planorbulina*. Figs. 39 & 40, *Planulina porosa* ("*Rosalina lævigata*, 1838, in part") is *Planorbulina Haidingerii*, subvar.; and 41, *a*, *b*, *Pl. ocellata* ("*Rosalina ocellata*, 1838") is almost the same.

Figs. 42, *Planulina incurvata*, and 43, *Pl. membranacea*, are a young and an older specimen of *Pulvinulina Menardii* (D'Orb.). Figs. 44, *Globigerina? cretæ* ("*Rosalina foveolata*, 1838"), and 45, *Gl. stellata* ("compare *Gl. libani*"), are *Globigerina bulloides*, characteristic. Figs. 46, *Planulina angusta*, and 47, *Pl. micromphala*, =*Planorbulina ammonoides*, of slightly varying outlines (see pl. xxiii. &c.). Figs. 48 & 49, *Pl. sicula*, 1838, seem to comprise a *Rotalia?* (48) and a *Planorbulina?* (49). Figs. 50, *Pl. micromphala* (?), and 51, *Pl. marmorata*, are *Cristellaria rotulata*. Fig. 52, *Pl. spira*, is probably a *Planorbulina*. Fig. 53, *Cristellaria? Hoffmanni*, is a beautiful *Crist. cultrata*, with flattened form, thick septa, and very broad keel.

Fig. 54 are stellate spicules (?). A. Some of the powdered limestone, magnified 300 diams., shows, besides Foraminifera, many Cyatholiths &c. B. Foraminifera without the finer particles.

This group also belongs to a sea of moderate depth, about 50 to 90 fathoms.

Species and notable Varieties of Foraminifera from the White Limestone of Cattolica, Sicily, figured by Ehrenberg.

1. Lagena sulcata (*W. & J.*).
2. —— elongata (*Ehr.*).
3. Glandulina lævigata, *D'Orb.*
4. Nodosaria gracilis, *D'Orb.*
5. —— ovicula, *D'Orb.*
6. Vaginulina lævigata, *Rœm.*
7. Cristellaria rotulata (*Lam.*).
8. —— cultrata (*Montf.*).
9. Polymorphina Thouini, *D'Orb.*
10. —— problema, *D'Orb.*
11. Bolivina punctata, *D'Orb.*
12. Virgulina Schreibersii, *Czjz.*
13. —— Hemprichii (*Ehr.*).
14. —— —— stiligera (*Ehr.*).
15. —— —— paradoxa (*Ehr.*).
16. Textilaria sagittula, *Defr.*
17. —— gibbosa, *D'Orb.*
18. Vulvulina apiculata (*Ehr.*).
19. Globigerina bulloides, *D'Orb.*
20. Planorbulina farcta (*F. & M.*).
21. —— globulosa (*Ehr.*).
22. —— ammonoides (*Rss.*).
23. —— Haidingerii (*D'Orb.*).
24. Pulvinulina Menardii (*D'Orb.*).
25. Quinqueloculina (young).

XII. *Foraminifera from the Chalk of Meudon, France.* (Monatsberichte k. Berliner Akad. Wiss. 1838, p. 192; Abhandlungen, 1838, table VI. pl. 4. fig. v.)

The next two plates in the 'Mikrogeologie' are of great interest to geologists at home; for they contain a faithful portraiture of the very minute Foraminifera of the Chalk of Gravesend in Kent, and of Meudon, near Paris. They were therefore taken in hand by us not long since, as the means of correcting and augmenting the catalogue of fossil Foraminifera from the Chalk; and the results appeared in the 'Geological Magazine,' vol. viii. pp. 506 & 563 *et seq.* We have little to add to our remarks there offered, and here reproduced, except that, for the sake of convenience, as usual in the case of Rhizopods, we are willing to enter under catalogue-names a few more of the subvarieties, and to make some slight revision in the lists representing the two plates.

In No. 89 of the 'Geological Magazine,' p. 511, we merely indicated the genera and species of Foraminifera found by Dr. Ehrenberg in the White Chalk of Meudon, near Paris, and figured in his 'Mikrogeologie, 1854. In our list twenty species were enumerated (with the nomenclature now in use) as the result of our study of the fifty-six forms figured and separately named in his plate of Meudon Foraminifera*. To render our work more useful to rhizopodists and bibliographists, we proceeded, in No. 90 of the same Magazine, to take the figures in succession, noting that, as we had before stated, the grouping on the plate has a more natural association of allied forms than that shown by the numerical order.

Pl. XXVII. fig. 1, *Miliola ovum*, =*Lagena globosa*. Fig. 2, *Nodosaria turgescens*, is one and a half of the last chambers of a compact variety of the simple *N. ovicula*. Figs. 3, *Textilaria striata* (1838), 4, *T. sulcata*, and 5, *T. dilatata* ("*T. brevis*?, 1538"), belong to Ehrenberg's *T. striata*, a subspecies or notable variety, worthy of a binomial term. Fig. 6, *Text. globulosa* (1838), is the small or young form of *T. gibbosa*, D'Orb., and for convenience is often referred to by the name given by Ehrenberg. Fig. 7 *a–d*, *T. linearis*, = *Bolivina punctata*. Fig. 8, *Text. aculeata* ("*T. aspera*, 1838, in part"), is a thick-walled form of *Textilaria gibbosa*, produced and aculeate on the edges at the outer angle or base of each chamber, and would be conveniently distinguished by the name here given; but D'Orbigny had previously called it *subangulata*. Figs. 9, *a*, *b*, *Grammostomum pachyderma* ("*Text. aciculata*, 1838, = several thin species of *Grammostomum*"), and 10, *Gr. angulatum*, are specimens of a coarse-shelled *Bolivina punctata*. Fig. 11, *Gr. polystigma*, =*Text. sagittula*. Fig. 12, *Gr. thebaicum*, seems to be an oblong *Textilaria agglutinans*, with a growth like that of *T. sagittula*; but *Gr. thebaicum*,

* The description of this plate is reprinted, with revision, from the 'Geological Magazine,' vol. viii. pp. 563, 564.

pl. xxiv. figs. 20, 21, certainly appears to be *Bolivina dilatata.* Fig. 13, *Gr. platystigma*, is *Bol. dilatata.* Fig. 14, *Polymorphina asparagus*, is *Virgulina squamosa*; so also is fig. 15, *Grammostomum lingua.* Fig. 16, *Gr. macilentum*, is a very neatly Textilariiform *V. squamosa* (*V. tegulata*, Reuss). Fig. 17, *Strophoconus efflorescens*, is a rather twisted *V. squamosa.* Fig. 18, *Grammostomum* (*Polymorphina?*) *myoglossum*, is a fragment of apparently a *V. squamosa* of regular growth.

Figs. 19, *Loxostomum subrostratum*, and 20, *Lox. rostratum*, are varieties of *Text. agglutinans*, becoming Bigenerine (passing into *Bigenerina*) by the aperture getting more and more terminal in successive chambers (fig. 20 shows the more advanced stage of the transition). Figs. 21 & 22, *Lox. aculeatum*, is a pouting Bigenerine *Textilaria*, tending towards *Sagrina rugosa*, D'Orb. (*Heterostomella*, Reuss). The aperture is entire (not ragged or prickly, as in the figures of some *Polymorphinæ* in other plates), and lipped, as in *Uvigerina.* The edges of the shell are aculeate by the production of the base of each chamber.

Fig. 23, *Strophoconus polymorphus*, = *Virgulina Schreibersii.* Fig. 24, *Str. spicula*, = *V. squamosa*; so also fig. 25, *Grammostomum gracile.* Figs. 26 & 28, *Strophoconus polymorphus*, and 27, *Str.* (*Grammost.?*) *ovum?*, are *Virg. Schreibersii.* Fig. 29, *Proroporus cretæ*, = *Polymorphina Thouini.* Figs. 30 & 31, *Grammobotrys? parisiensis*, = *Sphæroidina bulloides*; and probably also 32, *Pleurites cretæ.* Figs. 33 & 34, *Sphæroidina parisiensis*, = (33, probably and 34, certainly) *Sph. bulloides.* Fig. 35, *Guttulina aculeata*, and 36, *Gut. turrita*, are *Verneuilina pygmæa* (Egger); but fig. 35 has the outer margins of its chambers more or less aculeate, therein approaching *V. spinulosa*, Reuss. Fig. 37, *Nonionina? ocellata*, is *Cristellaria cultrata.*

Figs. 38–45 and 47 are various individuals of the neat little variety of *Planorbulina farcta* known as *Pl. ammonoides* (Reuss), very common in the Chalk: thus figs. 38, *a*, *b*, 39, & 40, *Planulina micromphala*, = "*Pl. turgida*, 1838, in part;" fig. 41, *Pl. angusta*; 42, *a*, *b*, *Pl. annulosa*; 43, *Pl. leptostigma*; 44 & 45, *Pl. ampla*; 47, *Pl. ampliata.* Fig. 46, *Pl. euomphala*, is a slightly keeled *Cristellaria cultrata.* Fig. 48, *Pl. umbilicata*, is *Pulvinulina truncatulinoides* (D'Orb.), seen from the upper (flat) surface. Figs. 49 & ? 50, *Pl. heteromphala*, seem to be small varieties of *Planorbulina farcta*, approaching *Pl.* (*Truncatulina*) *lobatula*; such are not rare in the Chalk. It is difficult to correlate the many small *Planorbulinæ* and *Truncatulinæ*, from the Chalk, figured by D'Orbigny, Reuss, and Ehrenberg.

Fig. 49 is perhaps comparable with D'Orbigny's *Rotalina umbilicata* from the Chalk, which we refer to *Rotalia* proper. Fig. 51, *Rotalina umbilicata*, is a side view of *Pulv. truncatulinoides* (D'Orb.), not quite so angular in its profile as the recent specimen figured in 'Hist. Nat. des Iles Canaries &c., Foraminifères,' pl. 2. figs. 25–27. This species is figured also by Soldani, 'Testaceographia,' vol. i. p. 58, pl. 46. fig. *nn*. It is a variety of *Pulv. Menardii*, and closely related to *Pulv. Micheliniana* and *Pulv. crassa*, both found in the Chalk. (See Phil. Trans. vol. clv. p. 393.) Fig. 52, *Planulina picta*, = *Pulv. Micheliniana* (D'Orb.). Figs. 53–58 are young, and 59 an adult, *Globigerina cretacea*, D'Orb., a rather discoidal form of *Gl. bulloides*, D'Orb. (53, *Rotalia quaterna*; 54, *R. rosa*; 55, *R. pachyomphala*; 56, *R. globosa-ampliata*; 57 & 58, *R. aspera*; 59, *Globigerina cretæ*, referred with doubt to *Gl. bulloides* in 1838.) The young flattish *Globigerinæ* closely resemble young *Planorbulinæ*. Figs. 60–64 are young and arrested specimens of *Planorbulina farcta*. (60, *Rotalia globulosa-tenuior*, = "*R. glob.*, 1838;" 61, *R. senaria*; 62, *R. densa*; 63, *R. glomerata*, = "*R. senaria?*" 64, *R. cretæ*, rough-shelled.)

Spongoliths and Coccoliths occur among the other figures on this plate.

The depth of sea indicated by these Foraminifera is from 100 to 150 fathoms.

We must not lose sight of the large number of good-sized Foraminifera from the Chalk of France and England described and figured by Alcide D'Orbigny in the 'Mémoires Soc. Géol. France,' 1840, vol. iv. pt. 1. These were enumerated by Mr. Weaver in 'Ann. & Mag. Nat. Hist.' vol. vii. pp. 395, 396, with transcripts of D'Orbigny's notes on their distribution at Meudon, Sens, St. Germain, and elsewhere in France, and in England as far as he knew at the time.

Of the fifty-four named Foraminifera of D'Orbigny's list we should be inclined to group many as varieties, instead of species; but that does not concern us at present. Some of the generic names, however, should be corrected according to later knowledge. Thus No. 54, *Sagrina rugosa*, should be *Heterostomella rugosa*; for D'Orbigny had already named a peculiar Uvigerine form "*Sagrina*" (*S. pulchella*), and for this Textilarian form, departing from its true type, no name but Reuss's *Heterostomella* has been satisfactorily given. See Geol. Mag. vol. viii. p. 508. Nos. 53–51, Prof. Reuss prefers to separate the sandy *Textilariæ*, such as these, under the name *Plecanium*. No. 48, *Pyrulina*, is merged in *Polymor-*

phina. No. 47, *Uvigerina tricarinata*, is one of the Textilarian Foraminifera that has not only departed from the common type, and become three-sided (*Verneuilina*), but has taken on a pouting form of aperture (in this resembling *Uvigerina*): thus it lays claim to a distinct subgeneric name, and has been called *Tritaxia* by Reuss. Nos. 46–42, *Buliminæ*: these, being rough and somewhat sandy, are grouped under *Ataxophragmium* by Reuss. Nos. 39, 38, 37, 34, 33, 32, 31, & 30, grouped as *Truncatulina*, *Rosalina*, and *Rotalina*, are more or less characteristic forms of the subfamily *Rotalinæ* (Carpenter), and may be thus grouped:—

Planorbulina Voltziana (30, *Rotalina*), belonging to the same group as *Pl. kalembergensis* (D'Orb.).
—— Lorneiana (38, *Rosalina*), belonging to the same group as *Pl. ammonoides* (Rss.), and *Pl. badenensis* (D'Orb.).
—— Clementiana (39, *Rosalina*), an ornate variety of *Pl. tuberosa* (F. & M.).
—— (subgen. Truncatulina) Beaumontiana (37, *Truncatulina*), merely a thick convex *Tr. lobatula* (W. & J.).
Pulvinulina Micheliniana (31, *Rotalina*). } See above,
—— crassa (33, *Rotalina*). } p. 294.
—— Cordieriana (34, *Rotalina*). Feebler than *P. Micheliniana*.
Rotalia umbilicata (32, *Rotalina*). Of the same group as *R. Soldanii* and *R. orbicularis*; and not only existing in the Adriatic, as stated by D'Orbigny, but found fossil in the Tertiary beds of Italy.

We can now-a-days indicate many more living analogues, and, indeed, identical representatives, of the Chalk Foraminifera than M. D'Orbigny recognized in 1840; and we believe he was wrong in supposing that *Frondiculariæ* like those of the Chalk live in the Adriatic*. Doubtless, however, he was quite correct in saying that the sea in which the Chalk was formed continued from western Europe into the English area, was of a warm climate, free from shore-currents, and contained species of Foraminifera that have lived on to the present day. We may well add:—that it was of very great extent and of considerable depth, though not so deep as our Atlantic; that some uninterrupted water-areas have continued its oceanic existence, under various and great modifications, to the present day; that the Foraminiferal *species* which have persisted in its depths throughout the enormous time required for such changes of land and sea, were not uniformly represented

* He seems to have met with some *derived* fossil forms in the sea-sand.

by the same *varieties* that existed when the Chalk was formed; and that the Atlantic ooze, in which other Mollusks, Echinoderms, Crustacea, and Vertebrata than those of the Chalk occur, cannot be regarded as "Chalk" in a strictly geological or palæontological sense. In a lithological (or halibiolithological) sense—that is, with reference to their general origin from calcareous organisms, and regarded as having been all similarly formed in successive, never quite disconnected, but partially continuous oceans—nearly all limestones would come under the geological name of the oldest of the known series; but, although supported by the known occurrence of persistent Foraminiferal types through period after period, such a classification would be vague and useless.

On this interesting geological subject see also Mr. Prestwich's Anniversary Address to the Geological Society of London, Feb. 17, 1871 (Quart. Journ. Geol. Soc. No. 106). The number of species and notable varieties of Foraminifera common to the Chalk and the North-Atlantic ooze, as shown by our table in that Address, is now known to be greater, since our correlation of the Chalk specimens figured in the 'Mikrogeologie' with other published forms. Both in this instance and in the description of the North-Atlantic Foraminifera (Phil. Trans. 1865) we had to refrain from reference to Dr. Ehrenberg's 'Mikrogeologie' and previous memoirs, not having had the opportunity of working over this great store of information, and at the same time having recognized how little the apparent conclusions of the veteran naturalist coincided with those arrived at by others. Now that our bibliographic studies bring us, in chronological order, to the earliest of Dr. Ehrenberg's memoirs, we have willingly entered on the somewhat arduous and responsible labour of comparing and identifying as far as possible all the Foraminifera he has so abundantly provided in his successive publications.

Species and notable Varieties from the Chalk of Meudon, figured by Ehrenberg.

1. Lagena globosa (*Montagu*).
2. Nodosaria ovicula, *D'Orb.*
3. Cristellaria cultrata (*Montfort*).
4. Polymorphina Thouini, *D'Orb.*
5. Bolivina punctata, *D'Orb.*
6. Virgulina squamosa, *D'Orb.*
7. —— tegulata, *Reuss.*
8. —— asparagus (*Ehr.*).
9. —— Schreibersii, *Czjzek.*
10. Textilaria agglutinans, *D'Orb.*

11. Textilaria sagittula, *Defrance.*
12. —— gibbosa, *D'Orb.*
13. —— subangulata, *D'Orb.*
14. —— globulosa, *Ehr.*
15. Heterostomella aculeata (*Ehr.*).
16. Verneuilina pygmæa (*Egger*).
17. Sphæroidina bulloides, *D'Orb.*
18. Globigerina cretacea, *D'Orb.*
19. Planorbulina ammonoides (*Reuss*).
20. —— globulosa (*Ehr.*).
21. Pulvinulina truncatulinoides (*D'Orb.*).
22. —— Micheliniana (*D'Orb.*).

XIII. *Foraminifera from the Chalk of Gravesend, in Kent, England.* (Monatsberichte Berl. Akad. Wiss. 1838, pp. 193, 194. Abhandlungen, 1838, pp. 92, 133–135, table iv. pl. 4. fig. 4.)

In Pl. XXVIII. of the 'Mikrogeologie' are figured numerous Foraminifera, mostly very small, discovered by Dr. Ehrenberg in English Chalk, soft and white, from Gravesend, near London*; they are magnified 300 times in linear dimensions. These are referred to in the 'Monatsberichte' of the Berlin Academy for 1838 (where some of them are stated to have been found in the Chalk of Brighton also), and in the 'Abhandlungen' for 1838. An able abstract of this and another memoir in the 'Abhandlungen' was made by the late T. Weaver, F.R.S., F.G.S., in 1841, and published in the 'Phil. Mag.' ser. 3. vol. xviii. pp. 375 & 443 &c., and in the 'Annals and Mag. Nat. Hist.' vol. vii. pp. 296, 374, &c. In Taylor's 'Scientific Memoirs,' vol. iii., is a full translation, with the original plates, of Ehrenberg's memoir "on the numerous Animals of the Chalk Formation which are still found living," from the Berlin Acad. Transact. for 1840.

The results of our careful examination of Ehrenberg's figures are as follows:—

Fig. 1, *Miliola lævis*, is probably a single joint or a detached chamber of a *Nodosaria.* Ehrenberg's "*Miliola*" is for the most part the same as *Lagena* and *Orbulina* of other authors. Fig. 2, *Nodosaria anglica*, is *N. ovicula*, D'Orb., with a rather excentric aperture. Fig. 3, *N. monile*, is a variety of *N. ovicula*, D'Orb., with rather short chambers. Fig. 4, *Vaginulina nodulosa*, is a variety of Rœmer's *V. lævigata*, with a peculiar

* The description of this plate is here revised and reprinted from the 'Geological Magazine,' vol. viii. no. 11, November 1871.

(concretionary?) shell-structure. Fig. 5, *Vaginulina cretæ* (*brachyarthra*), seems to be (if really flat, as is probable) *V. longa* (Cornuel). Fig. 6. *Textilaria striata*, Ehr. 1838; more fully illustrated in pl. xxxii. I. figs. 4 *a*, 4 *b*, 7, and II. 6, 18, from the Missouri and Mississippi Chalk. Fig. 7. A broad individual of *T. striata*. Fig. 8, *Text. ampliata* ("*T. aspera*, 1838"), is a young *T. gibbosa*, D'Orb., with roughish shell. Figs. 9 & 10, *Text. globulosa** (1838), arrested *T. gibbosæ*. Figs. 11, *T. leptotheca*, and 12, *T. globulosa ampliata*, are individuals of *T. gibbosa*. Fig. 13, *Loxostomum curvatum*, is an arcuate *T. agglutinans*, the later chambers of which have the aperture higher and higher up, thus passing, in its quasi-generic character, from *Textilaria* proper into *Vulvulina*. Indeed it may be the young of Ehrenberg's *Lox. anglicum* (fig. 19 of the same plate), which is a rather narrow and neat *Vulvulina pennatula* (Batsch). Fig. 14, *Grammostomum scabrum*, seems to be only a small coarse-shelled *T. agglutinans*, D'Orb. Figs. 15 & 16, *Gr. polytrema*, is *Virgulina Schreibersii*, Czjzek. Fig. 17, *Gr. aculeatum*, is a variety of *Verneuilina triquetra* (Münster), with aculeate edges, like *V. spinulosa*, Rss., Denks. Akad. Wien, 1850, vol. i. pl. 47. fig. 12: it is seen from one of its three flat sides. Fig. 18, *Textilaria aculeata* is a small rough *T. agglutinans*, with flattish chambers, such as D'Orbigny has named *T. subangulata*. Fig. 19. See above. Fig. 20, *Proroporus cretæ*, is *Polymorphina Thouini*, D'Orb. (see the "Monograph on *Polymorphina*" † by Brady, Parker, and Jones, Linn. Soc. Trans. 1870, vol. xxvii. p. 232). Figs. 21, *Bigenerina cretæ*, and 22, *B. acanthopora*, are also *P. Thouini* (*loc. cit.*). Fig. 23, *B. apiculata*, is *P. compressa*, "Mon. Polym." p. 227. Fig. 24, *Loxostoma vorax*, is also *Polym. compressa*, and should be added to the synonyms in the "Monograph Polym." p. 227.

Figs. 25, *Loxostomum tumens*, and 26, *Lox. aculeatum*, are slightly differing individuals of *Heterostomella aculeata* (Ehr.). This may be described as a prickly loose-grown *Textilaria*, which, having ceased to grow in the typical manner (with a double row of alternating chambers), has continued with a single row (as a *Bigenerina*); and these have not only got terminal instead of lateral apertures, but have become lipped as in *Sagrina rugosa*, D'Orb. (1840). D'Orbigny, however, had applied the name "*Sagrina*" to a Uvigerine Foraminifer

* Well figured in Eley's 'Geology in the Garden,' 1859, pl. 2. fig. 9, pl. 9. fig. 9 *c* and in figs. 39 & 39 *c*, of pl. 7; p. 194 &c. Geol. Mag. vol. ix. p. 124.

† Some of Ehrenberg's figures quoted in this Monograph as *Polymorphinæ*, we find, on fuller consideration, to be *Virgulinæ* &c.

(*S. pulchella*) in 1839. In 1866 Reuss published the name *Heterostomella* as distinctive of the Textilarian *Sagraina* (Sitzungsb. Akad. Wien, vol. lii.). Ehrenberg's "*Loxostomum*," though older (1854), is so misapplied by him (to *Polymorphina*, *Vulvulina*, and a transitional form between the latter and *Textilaria* proper) that naturalists may well hesitate to use it. *Heterostomella aculeata* is figured also in pl. xxvii. figs. 21, 22.

Fig. 27, *Polymorphina turio*, is a narrow and typical specimen of *Virgulina Schreibersii*, Czjzek, which is subgenerically related to *Bulimina*. Figs. 28 & 29, *Pleurites? calciparus*, 30, *Sphæroidina cretacea*, and 32, *Grammobotrys anglica*, are broad and flattish individuals of *Virgulina Hemprichii* (Ehr.). This species is well figured (under many different names) in the 'Mikrogeologie.' It is very variable in form, but constant in the cloudy, or seemingly muddy, opacity of its shell—a structure beautifully engraved in pl. xxix. fig. 38, and elsewhere. This species is very common in the Indian seas, with its misty, dull shell, of variable growth, sometimes regularly Virguline, with alternate chambers, sometimes passing into *Bulimina* proper, sometimes short and nearly round, like *Cassidulina* and in other subvarietal shapes. It is the only *Virgulina* that takes on a sandy condition, becoming subarenaceous, and thereby very delicately rugose. Ehrenberg appears to have first noticed it in the Tertiary Limestone from Thebes, Egypt. In pl. xxiv., illustrating the Foraminifera from that rich rock, he gives the name *Strophoconus Hemprichii* to a fine complanate specimen (fig. 32); some smaller individuals (figs. 29, 30, 31) he puts under the same genus, and another as "*Textilaria?* or *Grammobotrys*." His "*Strophoconi*" are all either *Virgulinæ* or *Buliminæ*; therefore the name is not required. Other instances of *Virgulina Hemprichii* (fossil) occur at pl. xix. fig. 86 (?), Ægina; xxi. fig. 88, Oran; xxiii. fig. 19, Mokattam; xxv. fig. 15 (?), Antilibanon; xxvi. figs. 19–24, 26, 27, Cattolica; xxix. figs. 32–36, Moën Chalk; xxx. figs. 18, 19, 21, Rügen Chalk; xxxii. II. figs, 18, 20, Mississippi Chalk; xxxiii. XIII. fig. 27 (?), San Francisco. Of these some are remarkable; for instance, the *Vaginulina? paradoxa* and *V. obscura* (pl. xxvi. figs. 26, 27) are nearly cylindrical and subarcuate, such as occur in the Jurassic Clays, in the Gault, and in the Chalk*; they are old "Secondary" *Virgulinæ*. A variety (pl. xxx. fig. 18), termed "*Polymorphina nucleus*," shows a passage into *Cassidulina*. An out-

* Such a *Virgulina* from the English Chalk is figured in Eley's 'Geology in the Garden,' 1859, pl. 2. fig. 12, and pl. 8. fig. 12 *c*; p. 195 &c.

spread, rhomboidal, and suboblong Textilariiform variety is seen in pl. xxxii. II. figs. 18 & 20, termed "*Grammostomum tessera*" and "*Pleurites? americanus.*"

Pl. XXVIII. figs. 31, *Heterostomum cyclostomum*, and 33, *Grammostomum platytheca*, are young, broad, coarse-shelled *Textilariæ gibbosæ*. Fig. 32. See above. Figs. 34–42 *a*, variously named "*Rotaliæ*" (including *Rotalia globulosa*, 1838, figs. 40, 41), are so many individuals of *Globigerina cretacea*, D'Orb., an outspread flattish variety of *Gl. bulloides*, D'Orb., smooth in the youngest (41, 42), coarser and prickly in older specimens.

Fig. 43, *Planulina omphalolepta* (*Pl. turgida*, 1838), is a small and somewhat complanate *Cristellaria rotulata* (Lamk.) or feebly keeled *Cr. cultrata* (Montf.). Fig. 44, *Pl. annulosa*, is a still smaller specimen. Fig. 45, *a*, *b*, *Pl. odontophæna*, is *Crist. cultrata* (Montf.). Fig. 45 *a* has tear-like and ridgy exogenous growths of shell-matter near the umbilicus, but no umbo. Fig. 46, *Pl. hexas* (*Rosalina globularis?*, 1838), is *Cr. cultrata* with a small keel. Fig. 47, *Rotalia prætexta*, is a produced suboval individual of *Crist. cultrata*. Fig. 48, *Planulina adspersa*, is probably a small *Cr. cultrata* or *rotulata*: in fact figs. 43–48 show various stages and conditions of growth of the common *Cristellaria* of the Chalk in its umbilicate condition, and with more or less of a keel or crest. Fig. 49, *Pl. umbilicata*, also 54, *Cristellaria megalomphala*, and 55, *Cr. anglica*, are limbate specimens of *Cr. cultrata*—that is, having the shell thickened over the septal lines.

Figs. 50, *Rotalia lenticulina*, 51, *R. londinensis*, and 52, *R. lepida*, are small individuals of *Planorbulina ammonoides*.

Fig. 53, *R. picta?* This is *Pulvinulina Micheliniana* (D'Orb.), seen from its flat (upper) spiral face. The same species is represented in pl. xxvii. fig. 52, by a rather larger specimen ("*Planulina picta*") from the Chalk of Meudon, viewed through the vertical thickness of the shell from its high umbilical (lower) face. This belongs to a large family of Rotaline Foraminifera, which group themselves around *Pulvinulina repanda* (Fichtel & Moll). It belongs more especially to the subgroup of which *P. Menardii* is the type. This attains its best growth at about 100 fathoms in the existing seas, but lives well at abyssal depths, even at more than two miles depth; whilst, on the contrary, in shallow water it degenerates into *bizarre* varieties. D'Orbigny's *Rotalia crassa*, figured on the same plate (Mém. Soc. Géol. Fr. iv. pl. 3. f. 7, 8), is also a variety of *Pulvinulina Menardii*. These are found in existing seas under the conditions mentioned above, and are abundant in the Gault, Chalk-marl, and Chalk.

The other objects from the Chalk shown in this interesting plate are some siliceous and calcareous Sponge-spicula, some Morpholites, or Coccoliths (a Cyatholith without its centrum), and two Diatoms, *Fragilaria rhabdosoma*, 1838, and *Fr. pinnata*, 1844 (*Fr. striolata*, 1838).

The sea-depth for these Foraminifera was from 100 to 150 fathoms.

Species and noteworthy Varieties from the Chalk of Gravesend, figured by Ehrenberg.

According to our views, as explained above and in our papers "on the Nomenclature of the Foraminifera" in the 'Ann. Nat. Hist.,' and in other memoirs, we regard Dr. Ehrenberg's figures of the Foraminifera from the Chalk of Gravesend as referable to:—

1. Nodosaria ovicula, *D'Orb.*
2. Vaginulina lævigata, *Rœmer.*
3. —— longa (*Cornuel*).
4. Cristellaria cultrata (*Montfort*).
5. Polymorphina Thouini, *D'Orb.*
6. Virgulina Schreibersii, *Czjzek.*
7. —— Hemprichii (*Ehr.*).
8. Textilaria agglutinans, *D'Orb.*
9. —— gibbosa, *D'Orb.*
10. —— subangulata, *D'Orb.*
11. —— striata, *Ehr.*
12. —— globulosa, *Ehr.*
13. Heterostomella tumens (*Ehr.*).
14. —— aculeata (*Ehr.*).
15. Verneuilina spinulosa, *Reuss.*
16. Vulvulina* pennatula (*Batsch*).
17. Globigerina cretacea, *D'Orb.*
18. Planorbulina ammonoides (*Rss.*).
19. Pulvinulina Micheliniana (*D'Orb.*).

We must not lose sight of the fact that the specimens figured in the 'Mikrogeologie' are for the most part very minute, such as lie among the finer débris of washed Chalk; whilst those treated of by D'Orbigny, Reuss, Williamson, Eley, and

* This is a *Grammostomum* with Ehrenberg. Supposing that "*Grammostomum*" was intended for the compressed Textilarian forms with terminal slit-like apertures, we formerly adopted it in preference to the name given by D'Orbigny. But, as it is indiscriminately applied by its author to *Polymorphina*, *Bolivina*, *Virgulina*, and *Textilaria*, as well as to the subgenus above indicated, there are strong reasons against its use in our nomenclature.

others have been larger individuals picked out by means of hand-lenses from the coarser dust of the disintegrated material. The great difference of size, however, among individual Foraminifera carries but little weight in the determination of species; for the conditions, not only of growth, but of feeding-ground, depth of water, and climate affect them so greatly, that a form which may be gigantic in one *habitat* will be arrested or dwarfed in another, retaining all the essential characteristics of shape and structure which are required for its specific identification.

With respect to the *Foraminifera Rotalina* (Carpenter) of the English and European Chalk, we may notice that among Ehrenberg's figures we recognize:—

Planorbulina farcta (*F. & M.*).
—— Haidingerii (*D'Orb.*).
—— ammonoides (*Rss.*).
—— ariminensis (*D'Orb.*).
—— globulosa (*Ehr.*).
Pulvinulina spatiosa (*Ehr.*).
—— truncatulinoides (*D'Orb.*).
—— Micheliniana (*D'Orb.*).
—— caracolla (*Rœm.*).

D'Orbigny found in English Chalk all the Rotalines he got from the French Chalk (see above, p. 295). In our own collection we have from—

1. *The Upper Chalk of Thorpe, near Norwich*:—

Planorbulina ammonoides (*Rss.*).
—— Ungeriana (*D'Orb.*).
—— Haidingerii (*D'Orb.*).
—— (Truncatulina) lobatula (*W. & J.*).
Rotalia umbilicata, *D'Orb.*

2. *The Chalk of Gravesend*:—

Planorbulina ammonoides (*Rss.*).
—— Ungeriana (*D'Orb.*).
—— (Planulina) ariminensis (*D'Orb.*).
—— (Truncatulina) lobatula (*W. & J.*).
Pulvinulina Micheliniana (*D'Orb.*).
Rotalia umbilicata, *D'Orb.*

Of most of these there are also local subvarieties, corresponding more or less closely not only with those named by D'Orbigny, but also with many of the numerous *Rotaline* varieties and subvarieties figured and described by Reuss and others.

On close examination of specimens and collation of lists, we find that, as with *Globigerinæ*, so with *Rotalinæ*, it is by the *increase of varieties* the distinction is chiefly made between the Foraminiferal faunæ of the past and of the present seas.

[To be continued.]

XXX.—*On a Four-bearded Water-Terrapin from North Australia.* By Dr. J. E. Gray, F.R.S. &c.

The British Museum has received a very young freshwater Terrapin belonging to the family Hydraspidæ, from Cape York, North Australia. It agrees with the genus *Elseya* in having no nuchal shield, and in having the back of the neck furnished with regular longitudinal rows of small conical spines. The skin over the temporal muscles is divided into irregular convex tubercles; the crown of the head is covered with a continuous soft skin, which becomes hard when dried.

This specimen differs from all the known species of *Elseya* in having four beards—that is to say, two short cylindrical beards on each side of the hinder edge of the lower beak. The two front are in the place where beards are usually found in the genus, the two hinder at some distance behind them.

The head and back of the neck are dark olive; the beaks are greyish white, with a broad white streak from the angle of the mouth extending behind towards the shoulders. This streak is separated from the white throat by a black streak on its lower side, which is extended in front, and forms a narrow margin to the back edge of the lower beak. The back of the shell is dark olive, the areolæ occupying nearly the whole of the plates; the front marginal shields with numerous minute spines; nuchal shield none. The underside of the marginal shields and the sternum white, with a very narrow edge to the marginal plates; a dark oval spot on each side of the suture between the second and third and hinder plates.

This may be the type of a new genus characterized by the four beards; but I think it is most likely an accidental variety of *Elseya latisternum*. We must wait until we obtain more specimens to determine this point, more especially as the top of the head wants the hard surface of the older specimen of that genus.

XXXI.—*On a probably new Species of* Actinia.

To the Editors of the Annals and Magazine of Natural History.

Gentlemen,

I am anxious to call the attention of collectors of sea-anemones and keepers of aquariums to a very handsome variety of *Tealia* which occurs in considerable quantities in deep water along this coast, with but few variations in appearance. It seems to be either a new species or at least a good local variety. It is not noticed in Mr. Gosse's work on British Sea-Anemones, and is the only deep-sea *Actinia* which I have seen in these waters. I got it from the hooks of the fishermen's deep-sea cod-lines, sometimes two or three at a time on one stone. My observations have been made this winter on a large number of specimens, some of which have been kept in my tanks for two or three months. I should be happy to forward specimens for inspection if requested to do so. Mr. Gosse, to whom I sent a description, suggests, "It is pretty certain to be either a new species or at least a well-marked local variety worth describing." So I send the following description to you, and am

Your obedient Servant,

Robert Kyle.

Portrush, co. Antrim, Ireland.
March 7, 1872.

Form.

Base adherent to old shells or stones, not exceeding *column*; *disk* and *tentacles* similar in shape to those of *Tealia crassicornis*; but the column is destitute of warts, except on the upper portion, on which they are very few and small, and is smooth and soft.

Colour.

Column brilliant scarlet and yellow, similar to "*Stomphia Churchiæ*" (Gosse, pl. viii. fig. 5).

Disk very pale reddish brown or buff; *radial bands* few (or wanting), inconspicuous, white.

Tentacles pellucid, pale pink, with opaque white bands.

Varieties.

α. Above condition.

β. *Column* crimson and drab.
Tentacles crimson-red, with buffish bands; *radial bands* very conspicuous, crimson. (A very showy variety.)

γ. *Column* and *tentacles* plain red-orange or scarlet; *radial bands* white, or wanting.

δ. *Column* yellowish white; *tentacles* and *disk* pellucid white, with a very pale blush of rose when not fully expanded; *radial bands* opaque white, very few. (A single specimen.)

Size.

When fully expanded, from 2 to 5 inches across.

The whole appearance strongly resembles a *Tealia*; but its almost total want of *warts* distinguishes it from *T. digitata*, another deep-sea species (which I have not seen). It may, perhaps, be a link between *Tealia* and *Stomphia* var. *pyriglotta* (Gosse, p. 223).

XXXII.—*Description of a supposed new Species of Cuckoo from Celebes.* By Arthur, Viscount Walden, P.Z.S.

Hierococcyx crassirostris, n. sp.

A collection of birds recently made in North Celebes by Dr. Meyer contains two examples of a Cuculine form which appears to be undescribed. They severally represent a distinct and very marked phase of plumage. Yet neither can be affirmed to have attained its full livery. One example is in the "hepatic" stage, the other may be wearing the adult garb.

Example No. 1, hepatic plumage, has the nape, back, upper tail-coverts, upper surface of the wings, and the quills bright chestnut. The nuchal feathers, which are white at their base, are broadly fringed with black, giving a barred appearance to the nape. The interscapulars are obscurely edged with brown. The shoulder-coverts have black subterminal marks, or are else faintly clouded with black markings. The quills are almost of a uniform chestnut above and below; subterminally they are more or less clouded with brown. The inner webs at their insertions are pure white, which descends for about one-third of their length. There are no bands or bars on either surface of the quills. The under shoulder- and tail-coverts are pure cream-colour, devoid of any markings. The middle pair of rectrices are broadly banded with black. The intervals between the black bands, and which are much narrower than the black bands, are bright chestnut on the outer edges, but pure white near the shaft. The two portions of each band divided by the intervening shaft are unsymmetrical. The remaining pairs are also broadly banded with black, but the intervals are less chestnut, becoming nearly all white in the fifth pair. In this outer pair the bands are nearly symmetrical. All the rectrices are broadly tipped with pure white. The shafts assume the colour of the webs they support. The under surface of the body is rich creamy white, a few of the feathers with a broad, bold, black, transverse band. On the breast a black band or collar, formed by each feather being crossed by a subterminal black bar. Head black mixed with ferruginous, the base of the feathers being pure white. Cheeks and sides of the head and neck covered with creamy-white feathers tipped with black. Bill horn-brown. Legs, feet, and nails yellow.

Example No. 2 has the under surface pure white, each feather with a broad black band or spot, which is again edged with white. Under tail- and shoulder-coverts and inner webs of the quills for half their basal length pure white. Head and cheeks ash-grey. Nuchal feathers white at base, with greyish-brown terminations. Back, wings, and upper tail-coverts ferruginous brown, the ferruginous tint predominating. Upper surface of the quills brown, with ferruginous borders. Under surface paler brown, tinged with light ferruginous. Middle pair of rectrices ferruginous brown, with one broad subterminal black band. Faint traces of pure white on each side of the shaft at intervals. The outer rectrices are broadly banded with black and white. In some the white is irregularly clouded with ferruginous brown. All are narrowly tipped with white. Bill horn-brown; lower mandible at base greenish yellow. Legs, feet, and nails yellow.

Longitudo

	Rostr. a nar.	Alæ.	Caudæ.	Tarsi.
No. 1.	·87	7·75	8	1
No. 2.	·87	8	8	1

In both examples the third and fourth quills are equal and longest; the second is equal to the fifth. The outer pair of rectrices are much shorter than the others. The bill is exceedingly high and stout. The total absence of markings on the quills and under shoulder-coverts, and the extremely stout bill, distinguish this cuckoo from all known forms. Although a much smaller bird than *H. sparverioides* (Gould), its bill is fully twice as deep.

XXXIII.—*On the Skin &c. of the* Rhytina, *suggested by a recent Paper of* Dr. A. Brandt's. By James Murie, F.L.S. &c.

[Plate XIX.]

Save one, the admirable Steller*, no naturalist has left a

* "De Bestiis marinis," Nov. Comm. Acad. Imp. Petropol. t. ii. 1749–51.

written record describing in the flesh that extraordinary animal the Morskaia Korowa, or northern sea-cow, which existed in abundance about a hundred years ago in the neighbourhood of Behring Straits. Few, indeed, are the travellers or hunters who have mentioned, even in a few words, facts concerning this animal when alive. Spite of this paucity of attestation to a sight of the creature, Steller's most excellent description of its appearance, habits, and anatomy has supplied such succinct evidence of the *tout ensemble* and internal structure as to have long satisfied the needs of zoologists. Still it is to be regretted that he only left a couple of sketches of the remarkable horny palatine plates, the jaws being edentulous, of this now extinct Sirenian form.

Thus rested the knowledge of *Rhytina* among zoologists and comparative anatomists until the subject was taken up by the eminent *savants* of St. Petersburg. Between 1836 and 1869 a series of papers and memoirs were issued from the hands of Professors K. E. von Baer* and Johan Friedrich Brandt†, which enriched our knowledge of the animal to a wonderful extent. The former elucidated much concerning its geographical distribution. The latter, fortunate in the receipt of a skull, and ultimately a skeleton, worked out well-nigh the complete osteology in a manner deserving the highest encomiums as a perfect model of descriptive skeletal detail and just careful comparison. Not content with only a survey of the bones, Prof. Brandt has summarized the entire structure of *Rhytina*, weighed this step by step with the other members of the Sirenia, with Cetacea, and with the Pachydermata, recent and fossil. Finally, he has added to its literary history, to its geographical range, and treated of the hypothesis of transformation amongst the Sirenian family.

Professor Alexander v. Nordmann‡, of Helsingfors, moreover, has contributed a fair monograph on the bone-structures of a specimen which came under his observation.

* "Untersuchungen über die ehemalige Verbreitung und die gänzliche Vertilgung der von Steller beobachteten nordischen Seekuh (*Rytina*, Ill.)," Bull. St. Pétersb. 1838, t. iii., and Mém. Acad. St. Pétersb. sér. 6, tom. iii. 1840.

† Of this gentleman's numerous papers in the Bulletins and Memoirs of the Imperial Academy, it is sufficient for me to quote two as comprising in their extensive range a perfect mine of wealth on the subject, and fourteen plates with illustrations of a superb kind:—"Symbolæ Sirenologicæ, quibus præcipue Rhytinæ historia naturalis illustratur," Mém. d'Acad. Imp. d. Sci. d. St. Pétersb. 6e sér. tom. v. 1849; and "Symbolæ Sirenologicæ, fasciculus ii. et iii.," *ibid.* 1861–68–69, sér. 7, tom. xii.

‡ "Beiträge zur Kenntniss des Knochen-Baues der *Rhytina Stelleri*," 1861, aus Acta Soc. Scien. Fennicæ, tom. vii. mit 5 lith. Taf.

There is an organic structure which may be separately mentioned, as misconception at one time existed regarding its function and homology; I allude to the jaw-plates. The palatine or premaxillary mass, and mandibular plate, from their density and situation, Steller appears to have considered a kind of striated bony tooth-representative (*l. c.* p. 302, "Sed duobus ossibus validis, candidis, seu dentium integris massis." "Oris striati ossis"). Others have been inclined to look upon these manducatory laminæ as the homologues of the baleen-plates of Cetacea.

It is to J. F. Brandt that we are indebted for a correct notion of their intimate structure and a distinct conception of their true homology. A fragment of a cranium in the Zoological Museum of St. Petersburg, with part of the said plates *in situ*, enabled that anatomist to institute a thorough microscopic investigation of their minute texture &c. In his 'Symbolæ Sirenologicæ,' laid before the Imperial Academy, January 1845, published 1849, he has demonstrated the cellulo-epithelial and partly tubulo-papillar nature of the plates, and justly correlated them with the horny tuberculate plates in the mouths of the Dugong and Manatee.

With Prof. Brandt's views I heartily concur; but I moreover regard the upper of these plates as the precise equivalent of the anterior palatine pad of ruminants &c. I even go further* in tracing the homologue of the baleen-plates of Cetacea in the Sirenian mouth in those bundles of hairs and bristles which spring from the buccal aspect and angle of the mouth of *Manatus*, the intervening papillæ of the mucous membrane corresponding to the "soft intermediate substance" betwixt the baleen at its root—the combination of these structures, their elementary composition, relation to each other, situation, &c. agreeing in most particulars with the whalebone and its basal matrix.

In his capital description of the soft parts of the Longniddry whale, Prof. Turner† discusses the homology of whalebone, and suggests its agreement with the transverse folds of mucous membrane and fore pad in the palate of Ruminantia, more particularly citing the giraffe. So far as regional proximity and textural constituents are concerned, doubtless there is much to be said in favour of such a notion. But in both toothed and toothless whales there is a rugose thickening of the soft palate anteriorly, identical in position

* See my forthcoming memoir, now in the press, "On the Form and Structure of the Manatee," Trans. Zool. Soc., read November 1870.

† "An Account of the Great Finner Whale (*Balænoptera Sibbaldii*) stranded at Longniddry," Trans. Roy. Soc. Edinb. 1870, vol. xxvi. p. 221.

and texturally with the ruminant pad; hence the homologue of the whalebone must be looked for laterally, *i. e.* in the situation heretofore mentioned.

Two ideal representations* of the *Rhytina* have hitherto been attempted, and these based on Steller's description. In my judgment neither are satisfactory as regards either shape or composition of the external surface of the hide. A few years ago I dissected the carcass of a Manatee, whereof I took a number of photographs of the exterior. Several of my representations were of the natural size; and, what with a study of these, preparations in spirit of parts of the Dugong, and a familiar acquaintance with the cetacean skin fresh and otherwise, I became convinced that Steller's description of that of *Rhytina* indicated its coriaceous tegument as but a magnified example of that of *Manatus*. My further researches among the Sirenia led me to an examination of the remains of the fossil *Halitherium* in several of the continental as well as our own museums. In brief, I had drawn on stone a representment both of *Halitherium* and *Rhytina*, founded on my knowledge, on the external appearance of their allies, their own skeletal framework, and Steller's passages respecting the derm of *Rhytina*. Though some time in my possession, it is only lately I showed the plate to a few friends ere finishing my nearly complete MS. Among others cognizant of my illustration, I mention Dr. J. E. Gray, Mr. Busk, and Mr. Dallas. But a day after (2nd March), conversing on the subject with the latter gentleman, he intimated to me, "By-the-by, Murie, our library (Geol. Soc.) has just received some memoirs of the Academy of St. Petersburg, and among them one on the skin of *Rhytina*, which you ought to see, as it may interest you."

As may be supposed, I lost no time in referring to the paper†. To my surprise I found a splendid plate, illustrating a real *bonâ fide* piece of *Rhytina*-skin—one of the figures, a photograph from the original, almost exactly resembling what I had already conceived and depicted. Thus an hiatus of very considerable importance towards a knowledge of this *outré*-Sirenian has been attained through Dr. Alexander Brandt's paper. As the Russian author, moreover, has enlightened us with a fresh description and figures of the parasite (first discovered by Steller) which lodged on the skin of the *Rhytina*, I purpose giving an epitome of, with remarks on, his

* J. F. Brandt, monographs quoted, Taf. v. (1849), and woodcut p. 282 (1861–68).

† "Ueber die Haut der nordischen Seekuh (*Rhytina borealis*, Ill.)," von Dr. Alexander Brandt. Mém. l'Acad. Imp. d. Sci. de St. Pétersb. 7e sér. tom. xvii. No. 7 (1871).

valuable contribution to science. It deftly supplements the rich labours of J. F. Brandt and Von Baer on this interesting extinct form, of which not a fragment has yet found its way to this country.

After allusion to the fact of no specimen of the skin of *Rhytina* being known to have been preserved by Steller, or brought home by the early northern adventurers, Dr. Alexander Brandt proceeds to record a strange discovery of his. He states that in January 1871, on rummaging amongst the cabinets of corals of the Zoological Museum of the Academy, he came across a curious specimen, which, at off-hand glance, struck him as being a blackened portion of the bark of a *Cycas*. It, however, turned out to be no tree fern or plant at all, but absolutely a piece of the long-wished-for *Rhytina*-skin. This was proved by a label in the handwriting of the defunct traveller Middendorff, with the words "Ochotskysches Meer" (the corals in the case being from the Sandwich Islands), and verified by the microscopical structure of the specimen.

Dr. Brandt then quotes Steller's description of the skin of *Rhytina* at full length, prefixing some critical remarks of his own.

He proceeds to give an account of the size, outward appearance, &c. of the specimen he himself had been fortunate in finding. It measures 55 centims. long (about $21\frac{1}{4}$ inches), and 40 centims. broad ($15\frac{1}{2}$ inches). The shape of the piece will be best understood by reference to the present fig. 1, Pl. XIX., an exact copy of Brandt's reduced photograph. Its rough, gnarled character and irregularly knobby and channelled surface in most ways agree with Steller's account. There is this difference, as far as my comprehension of the case goes, that whilst Steller has in his mind's eye the fresh texture Dr. Brandt appeals to the same dried. But with such a coriaceous dermal substance, as I can vouch for in the Manatee, the rendering of the latter to nature is not far from the truth as compared with the skin when on the animal's back. As if supporting the above statement, I may note that Brandt says his piece is blackish brown; Steller alludes to the colour as black; the same change of aspect I have myself witnessed in the dried and moist skin of the recent Manatee.

In this place I may refer the reader to the illustration, fig. 2, Pl. XIX., which figure represents my ideal of the appearance of the Rhytina's skin, given in my delineation of the animal, reduced to very considerably under the natural size. If this be compared with fig. 1 of the same plate (after Brandt), it will be acknowledged I have made (as the phrase runs) "a long shot."

Unfortunately Dr. A. Brandt's figures of the skin's structure in its natural dimensions are too large for me to reproduce here; I can only afford room, therefore, for a little bit, and that where the elevations and furrows are smallest, *vide* fig. 3. He shows in other views enlargement of the papillary and scaly prominences, and widening and greater continuity of the furrows.

Short finer hairs and coarser bristles are sparsely dispersed among the crevices; but, as I gather from the text, they, relatively to the size of the animal, are neither so long nor so abundant as in the Manatee.

The inner surface of the piece of skin in the St.-Petersburg Museum, whilst almost smooth compared with its exterior surface, yet shows slight inequality by circular, flat, dome-shaped areas. These are more regular in size and shape, but withal appear to correspond somewhat to the external papillary elevations.

Steller's original description of the intimate composition of the skin, namely its marked tubular character, led in part to the idea of its being a cuticular substance *sui generis*. It was suggested that its peculiar composition, an outer scabrous coat and cylindrical layer beneath, might be an adaptation designed to protect the animal from ice-floes &c. and retain internal heat in an inhospitable climate, so different from the tropical regions inhabited by *Manatus*.

Prof. J. F. Brandt, however, previously to the finding of the piece of skin in question, wisely, I think, correlates the dermal covering of *Rhytina* to that of the Manatee.

Dr. Alex. Brandt's recent thorough microscopical examination of the Rhytina's skin renders clear all difficulties as to its constituents. He demonstrates by well-drawn figures the nature of the so-called tubules &c. A vertical section, viz. a small piece dragged off by the nail from the specimen softened in water (fig. 4 in our Plate), shows three layers, whereof the middle, thickest and darkest one is composed of upright, closely set, linear columns, the supposed tubules. Under a higher magnifying-power the cuticular papillæ are found to be composed of a series of epithelial cells. These, from being more densely packed in some parts than in others, give the cylindrical character to the derm, which is more or less of horny consistence. In other figures of horizontal slices from the surface downwards, irregular-shaped vacuola with pigmental margins are displayed; these Brandt compares to the Haversian system of fish-bone, to which, indeed, they have much likeness. Deeper they narrow, are rounder and more apart. Their composition is also epithelial, close- or wide-meshed. No trace of glands was met with.

It results that the skin of *Rhytina* conforms in the main to that of the Manatee (many sections of the latter having been examined by myself), yet with a sufficient distinctness of its own. As Brandt seems to infer from its corneous density, it is a kind of compromise between ordinary dermal texture and horn material.

Another important addition to previous memoirs, as given by Dr. A. Brandt, is the fresh description, and, for the first time, illustrations of the parasite which infested the skin of the *Rhytina*. After treating of Steller's and J. F. Brandt's notices, without agreeing with the latter in the adoption of the genus *Sirenocyamus*, Dr. A. Brandt regards this parasitic crustacean as most nearly allied to the *Cyamus ovalis* of Roussel de Vauzème*. He further describes the characters &c. of the two sexes (*vide* figs. 5, 6, 7, Pl. XIX., after his designs).

According to our author, the differential diagnosis between *Cyamus ovalis* and *Cyamus Rhytinæ* is as follows:—"*C. Rhytinæ* distinguitur a *C. ovali*, cui valde affinis, primo articulo corporis antice minus emarginato; manu pedis primi paris latiori; dente anteriori secundi paris longiori, digitiformi; appendicibus branchialibus laminis corneis nigro-fuscis incrassatis munitis."

Remarks concerning Dr. Lütken's† genus *Platycyamus*, the young stages of *Cyamus*, and derivations of these and kindred forms conclude his section on the parasite.

Before summing up, some statements of Herr Pekarsky and others are given relating to the experiences of the old northern hunters. In their expeditions the flesh of the *Rhytina* was freely eaten, the fat regarded as equal to butter, and also used for lamps; and out of the skin capital boots were manufactured.

Dr. Alex. Brandt concludes by three propositions:—

1. Contrary to the common wide-spread acceptation, the *Rhytina*, originally similar to the rest of the Sirenia and Cetacea, possessed a smooth superficial layer of skin.

2. The ridges and furrows of the *Rhytina*-skin are mainly due to the ravages of the *Cyamus ovalis*, Rouss.

3. In its histological structure, the skin of *Rhytina* does not essentially differ from that of Cetacea and Sirenia; it is constructed, like the head-plate, of elongate filamentary cuticular papillæ, which, by Steller naming them canals, gave rise to misconception.

From the first two of these deductions I would venture to dissent. In all the Cetaceans which have come under my

* Ann. d. Sci. Nat. 2e sér. tom. i. 1834, p. 259, pl. 8; and Spence Bate, Cat. Amphipod Crust. B. M., Lond. 1862, p. 367, pl. 58.

† Conspectus Cyamidarum borealium.

own scalpel, *Phocæna*, *Lagenorhynchus*, *Physalus*, *Grampus*, and *Globiocephalus*, the skin is tense, smooth, and free from tubercular rugosities, the peculiar longitudinal belly-ridges and furrows and folds of the axillæ being the only marked elevations and depressions. In the Sirenian *Manatus*, on the other hand, the skin, throughout the entire body, is characterized by innumerable transverse, large and lesser wavy grooves and ridges. Moreover, as in some pachyderms, the elephant for example, there are circular and irregular-shaped elevations of derm, giving a rough warty appearance to the skin. These elevated areas in the Manatee are distributed here and there, but are particularly pronounced about the head, shoulders, and outer surface of the fore limb. That they existed with something of the same distribution and pattern in the *Rhytina* I infer from Steller's exact description; only in that animal they of course would be proportionally of greater magnitude. That the parasites would cause a certain amount of irritation I am prepared to admit, but cannot at all believe that to their ravages alone the dermal excoriations of the corneous *Rhytina*-skin are due.

My own views regarding the relations of *Rhytina* towards other Sirenia, the Cetacea, and Pachydermata I treat of in my forthcoming memoirs on *Manatus* and *Halitherium*.

EXPLANATION OF PLATE XIX.

Fig. 1. Copy of Dr. Alexander Brandt's figure of the piece of Rhytina's skin found by him in the St.-Petersburg Museum. The illustration has been taken from a photograph of the original specimen, reduced to one fifth of its natural dimensions. It represents the outer surface.

Fig. 2. This shows a portion of the skin of *Rhytina* as I have delineated it in my representment of the animal. Faithfully following Steller's description, and applying my knowledge of the skin of *Manatus* and *Halicore*, I have produced, without a knowledge of Brandt's paper, an epiderm almost identical with his photograph. That here shown is from the region of the back, above and behind the fore limb.

Fig. 3. A view in part of the upper third of fig. 1, but of natural size. It exhibits the peculiar protuberances and clefts, which are even of greater magnitude at the lower end of the specimen, where, as Brandt has delineated (*loc. cit.* figs. 4 & 5), the elevations elongate and run into one another, whilst the furrows of more regular continuity have here and there hairs springing from them.

Fig. 4. A vertical section of the skin, of natural magnitude, and displaying its columnar-like character. After A. Brandt, who states it is a piece torn by the finger-nail from the skin after being partially softened.

Fig. 5. Under surface of the female *Cyamus Rhytinæ* (Brandt), nat. size.

Fig. 6. Upper surface of the male of the same species, nat. size.

Fig. 7. A magnified view of the male parasite from the *Rhytina*, as delineated by Brandt; abdominal aspect.

XXXIV.—*A Trip to Queensland in search of Fossils.* By Dr. George Bennett, F.L.S.

To the Editors of the Annals and Magazine of Natural History.

[Gentlemen,

I have been favoured by my friend Dr. George Bennett, F.L.S., of Sydney, New South Wales, to whom I was indebted for the specimen described in my 'Memoir on the Pearly Nautilus,' and for valuable materials while investigating the generative economy of the Marsupialia and Monotremata, with the following account of his excursions in quest of materials for the work on which I am now engaged, descriptive of the fossil mammals of Australia.

The notes of the localities and conditions under which these fossils are found may be, perhaps, not uninteresting to the readers of the 'Annals.'

Richard Owen.]

"My dear Owen,

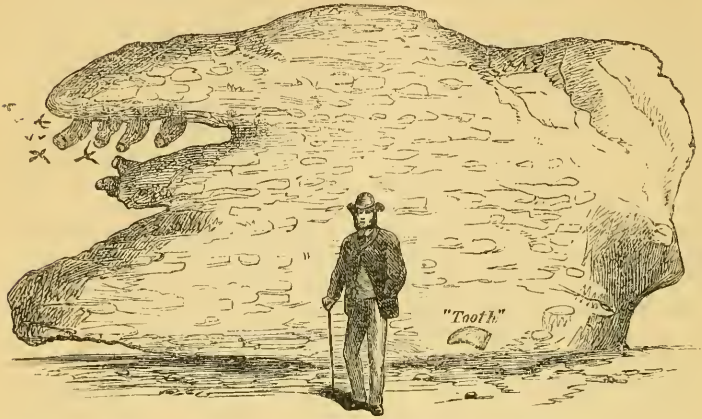
"It will no doubt cause you some surprise when you receive this communication informing you of my having visited Queensland, the principal object of my visit being with the view of examining the fossil deposits, collecting what I could during my short sojourn, and making arrangements with friends to aid me, by pointing out to them the localities on the creeks &c. most likely to be attended with success. That I was correct in considering those places I selected suitable was shown by the successful results attendant on my explorations, to the no little surprise of my companions. I left Sydney for Brisbane on the evening of the 3rd of November, and arrived at Brisbane on the morning of the 6th. The following day I was introduced to the Hon. J. P. Bell and other members of the Government; and Mr. Walsh, the Minister for Works, finding my visit was for scientific purposes, gave me a free pass over all the railways of the colony. Mr. A. B. Buchanan, M.L.A., also gave me a letter to Mr. Beattie, the superintendent of his station at Chinchilla, where he expected I should find some fossil deposits. The principal places I visited for fossils, and where I found, as others some years previously had also discovered, the richest deposits, were the Gowrie Creek, on the Gowrie station, the property of George King, Esq., M.L.A., of Sydney, and King's Creek, Clifton station, the property of W. B. Tooth, Esq. At the former place I received the kindest assistance from the proprietor's sons, Mr. George Beresford King and Mr. Henry King; at the latter a welcome and every aid from Mr. W. B. Tooth himself. The consequence was, in the very brief time allowed me to explore the creeks, the weather being fortunately very favourable, I made a collection which I hope you will find of some utility; moreover promises have been made to me by those gentlemen and many others to send me from time to time such specimens as they may be able to collect; and this has already been done by Mr. G. B. King, first by a fossil crocodile's tooth having been left for me at Gowrie Junction station, on my return from Warwick, and afterwards by the discovery of some fossil jaws with teeth *in situ*, and an important tradition respecting these extinct animals obtained from one of the aborigines: this was embodied in a letter addressed to me at Ipswich, previously to my departure from Brisbane. The letter is dated 'Gowrie, December 1, 1871,' and is as follows:—'Since you left we have discovered a few very valuable fossils; one, apparently belonging to the *Diprotodon*?, is almost a complete jaw, with all the molar teeth and the two front teeth similar to those in the lower jaw of the kangaroo as far as position is concerned, but being more round and without the sharp cutting-edges. Another is part of the left side of the lower jaw, seemingly part of the jaw-bone above described, and this has two perfect (molar?) teeth and one broken tooth; the others are vertebræ and smaller bones. I have had a long conversation with "Charlie Pierce," an aboriginal, relative to these fossils; and he avers that they are those of an animal long since extinct, known to the natives by the name of "Gyedarra." Tradition among them has handed down the appearance and habits of this animal for generations; but Charlie says he never paid much attention to the descriptions that have been given to him, but imagines the animal was as large as a heavy draught-horse, walked on four legs, the same as any other four-footed beast, eating grass, never went any distance back from the creeks to feed, and spent most of its time in the water, chiefly in enormous holes excavated in the banks. I told him he must mean some other animal; but he spoke most positively, and asserted that the bones we have been finding are those of the animal of which he was speaking, and that at one time the bones were very numerous about the Gowrie water-holes, where his forefathers had seen the animals themselves sporting about. I again asked him if they did not live on the leaves of trees; and his reply was that they were never seen to feed on them, but always on grass, the same as a horse or bullock. I will see if more specimens can be procured, and send them after you to Sydney.'

"On the 9th of November I left Brisbane for Ipswich by coach, and from Ipswich to Dalby by the railroad, where I arrived at 7 P.M. On the following morning I left Dalby for Jimbour, the station of the Hon. J. P. Bell, who had kindly invited me. There are no fossils to be obtained at this and other stations in the vicinity, except when wells are dug. A small jaw with well-preserved teeth was given to me by Mrs. Bell (probably of a kangaroo), which had been found on Jimbour Plains, 140 feet beneath the surface, when digging a well; a large bone had also been found with it, but was lost. A tusk given by Mrs. Bell to Mr. Anthony Trollope, when visiting this place a short time since, was also found on this station when forming another well. At another station near Jimbour, Mr. G. Morris Simpson, of 'Bon Accord,' near Dalby, presented me with some fossil teeth and bones procured there, and with a memorandum accompanying them, dated Nov. 21, 1871, as follows:—'The accompanying bones were dug out of a well which I have had made in the centre of the large plain which extends from Jondaryan on the Oakey Creek, on the north, to Yandilla, on the Condamine, on the south. They were got at a depth of about fifty feet from the surface, imbedded in a sort of sandy drift. It would seem to me as if the head of the animal had come in the line of shaft, the rest of the bones being probably on one side.' I have all these bones kept together for your examination, with Mr. Simpson's memorandum respecting them; they are fine tusks, but broken, and one perfect molar tooth, fragments of the skull, and other parts. On passing a station of Mr. Simpson's, on the 16th of November, on my return from Jimbour to Dalby, I met him superintending the sinking of a well: no water had been found at a depth of 131 feet, but a quantity of small fragments of fossil bones, of no utility, and some teeth; the latter were small; he gave them to me, and they are sent to you.

"On the 14th of November, my son, Mr. G. F. Bennett, and myself left Jimbour for the Chinchilla station, the property of A. B. Buchanan, M.L.A., and arrived there on the 16th. Mr. Buchanan's superintendent was absent; but one of the men pointed out to us a rock which Mr. Buchanan supposed contained a fossil head: this was not apparent; but several other rocks of a similar formation cropped out of the ground about 200 yards from the Condamine river, and near a deep gully which, during heavy rains, carried off the water from the higher range of hills into the river. The particular rock alluded to, said to contain fossils, was of small size, being only eight feet long by six feet in breadth; and the only fossils visible were fragments imbedded in a hard grit or breccia. The surface of the rock was with some force removed in flakes by the use of the pick, and with them some fragments of fossils; but the mass of the rock was so very firm as to resist all our efforts, and to completely blunt the edge of the pick. At this part, sloping down towards the gully, a quantity of fragments of fossil bones were found scattered over the surface, among which was a fossil kangaroo's incisor tooth: all these are sent to you in the collection made at Chinchilla, together with some tusks, teeth, &c., collected by Mr. T. J. Beattie. We left Chinchilla on the morning of the 15th of November, and arrived at Warrawarra, the station of Mr. Henry Thorne, who informed me that he had a long time since some fossil bones, which he supposed were still about the house; but when he went in search of them, he found the children had thrown them away, he could not find out where; and thus, no doubt, many important fossils are lost to science. He, however, very kindly (more so as they were busy shearing at the time), took some men and drove with us to the banks of the river Condamine, on the station, where he thought some fossils might be found, when in a short time we procured those in the collection sent from the Warrawarra station. We returned to Jimbour in the evening, a distance of fifty miles. On the 17th of November I arrived at Gowrie station, where, in the creek running through the station, so many important fossil bones had previously been obtained. I was at first at a loss how to commence my explorations; having no one with any previous knowledge of the places to direct me, I was thus left to my own resources. So I drove to the creek, but beheld at first only high banks, either with plain surfaces of red loam or rich black alluvial deposits, with a few plants scattered about, in some parts grooved with water-channels more or less deep, but nothing to indicate deposits, fossil or otherwise; or I came upon other portions of the banks dense with vegetation, where even the narrow running stream was in many places almost choked with the dense masses of reeds and rushes: all combined formed a scene most uninviting to an explorer of fossil remains. I soon left this useless part of the creek, and, driving a few miles further down, stopped, and then descending, walked along the banks for a short distance, and at last came upon a bank which excited my attention: it consisted of alluvial soil, with concretions of marl, strata of water-worn pebbles, and remains of perfect and broken univalve and bivalve shells. This locality I regarded as favourable for commencing my search for fossils; and I was right in my conjecture; for I was gratified, and still further induced to persevere, by finding several fragments of fossil bones imbedded in this bank. I then observed two teeth projecting from the soil, with the well-known dull-blue colour, from vivianite, and, by careful digging around it, obtained the portion of the jaw marked, in the collection sent to you, 'Gowrie, A'—the first acquisition of any importance. On excavating some distance around this specimen, not a vestige of any other portions of the jaw or any other kind of fossils could be discovered; but, extending my search in the same line to the bed of the creek, and close to where the water was flowing, I found a large lower portion of a femur deeply imbedded in the soil (marked Gowrie, B); and this explains how so many of the fossil bones are found in the bed of the creek, having been washed down from the banks during perhaps years of heavy rains and floods; and then, during the intense heat of summer, the creek became dry; for, as the man (an old shepherd) who drove me said, he was present when Mr. Isaac found and dug out the large head and other remains from the creek; but then, he stated, 'there was no running stream then, but only dried-up water-holes.' It was observing this peculiar formation of water-worn pebbles and shells on the banks that led me to suppose that the fossil remains were to be found in those localities where this stratum was found; and wherever I observed similar appearances on the banks of creeks, I explored them, attended with more or less success, and at last obtained a key to more successful explorations, which I afterwards followed up during my visits to Gowrie, and also when at King's Creek. Clifton, not forgetting, also, to examine the bed of the creek near those positions when the dry season would permit. By pointing out these localities to others, they have been equally successful, as the acquisition of valuable specimens can testify; and my friends both at Gowrie and Clifton have promised to follow up the researches from time to time, and forward the specimens obtained to me. The univalve and bivalve shells, before alluded to as found both entire and in fragments in the strata, are still living in the creeks; and I have sent one of a species of *Unio*, or river-mussel, obtained in King's Creek, where both living and dead shells could be obtained in any quantity. The Darling Downs are plains of great extent, more or less undulating, with a background of hills of various picturesque forms, and ranges of mountains, some open forest, others densely wooded and in many parts edged with open forest, and diversified with dense scrubs of various species of *Eucalypti*, *Casuarinæ*, *Acaciæ*, &c. &c. The plains are rich in grass, growing in a fertile black soil, which extends to a great depth (to judge from some of the banks of the creek, from 30 to 40 feet, and from the digging of wells, from 121 to 157 feet), imbedded in which are often found concretions of carbonate of lime, many of which were shown to me. Dispersed through the grass are a number of beautiful flowering shrubs and plants, which enhance the beauty of the plains, especially after rains. Marl was also obtained both on the banks of the creek and in digging wells; and as marl consists of clay containing a small admixture of lime, binding it together into a loose crumbling kind of stone, it assumed various forms when dug out or seen on the banks; and it was often mistaken for fossil bones. I am inclined to consider that the plains of Darling Downs were originally lakes, similar to a lake now existing on the boundaries of the Halliford and St.-Ruth stations, called the 'Broadwater,' which is said to be about four miles in circumference and two miles across; but it is not of a great depth. When I saw it, the surface of the water was covered with a number of wild ducks swimming about, and at some distance I could perceive several black swans. This lake is surrounded by large trees of *Eucalypti* &c.; and in the water close to the flat shore dense masses of the white and also of the blue water-lilies (*Nelumbium*) were growing. It is probable that in the course of time this piece of water will also be filled up, and become similar to the downs.

"When sinking wells, after finding a great depth of rich black soil, the clay and sandy drift is arrived at, and then again an alluvial deposit (so it has been mentioned to me) to the depth of nearly 200 feet. When fossils are found in the bed of the creek or in the banks, they have no doubt been disturbed by the heavy rains which occur in this tropical climate, and have gradually drifted with the percolating water, together with pebbles, fragments of stones, shells, &c., through the soft soil towards where the waters naturally flow—that is, towards the creeks, where they have been found, and in most instances in a very friable condition; whereas when procured by digging wells, they are found in a perfectly dry condition, or nearly so. Thus, from what I have seen of the soft nature and scattered state of the bones when found, I do not consider it at all likely that a complete skeleton will be found at one place, not even of the comparatively smaller extinct species of mammals, unless by some extraordinary chance an excavation should be made on a sandy drift, which is not very probable. My reason for stating this is, that, when a large bone or portion of a head is discovered, on examining about the immediate locality it is seldom or never that any further remains are found, though perhaps, a few yards distant some remains of a perfectly distinct animal are detected; but several miles distant, or in another creek, such as Oakley, Gowrie, or King's Creek, more portions of a similar kind of animal would be discovered, as if they had drifted miles away, and the decayed portions of the animals, before becoming fossilized, had passed through the soft alluvial soil in various directions, aided by the action of water. This may account also for the bones of various species of the extinct animals being found about the same locality. Judging from the fossil remains, the mammals now extinct must have existed in great numbers; for the quantity of small fragments of bones that could be collected is enormous, and there is not so much difficulty in procuring specimens in situations I have before mentioned as in obtaining them in a perfect or partially perfect state. It often occurs, when collecting fossils, that one observes a bone projecting from the soil, and, on digging around it, the slightest concussion, although apparently remote, will cause it to crumble into minute fragments. When excavated from the soil in a soft state, it is advisable to leave them untouched and exposed to the air, when they soon become hard and capable of removal. The height of the banks where the fossils were found varied from one to six or seven feet.

"On the 20th of November I left Gowrie for Dalby and Halliford station, having made during my short visit a very interesting collection of fossils, which are forwarded to you; and on the 23rd I returned to Gowrie, where a few fossils, collected during my absence, awaited my arrival, and were added to my collection. In the evening I left for Clifton station, by railroad, where I arrived at 7 P.M. On the following morning, in company with Mr. W. B. Tooth and his son, we explored 'King's Creek.' At this place, as at Gowrie, I pointed out the most probable places in which fossil remains might be found. King's Creek in many places is a noble stream of water; and it was only in the more shallow parts that we could pursue our researches with success. After a drive of some miles we observed an isolated conglomerate pebbly rock of some size, with the creek running close to it; we alighted and examined it. This boulder appeared as if it had been detached many years before from the adjoining bank; and under a shelving portion of it 'fairy martens' (*Collocalia Ariel* of Gould) had constructed their curious and elaborate bottle-shaped nests, in which white eggs and young just hatched were observed. This species always builds inland, and congregates about the squatters' verandas and near the water. This conglomerate rock (of which I have given a rude sketch) appeared to be likely to have fossils; and after some search, resulting only in a few fragments, the perfect tooth (Clifton, A) was found at the base. This rock consists of marly concretions, in which



A conglomerate Boulder on the bank of King's Creek.

large and small pebbles or fragments of stone were imbedded, more or less rounded by the action of water. No more fossils were obtained from this rock after a further search. We afterwards explored other portions of the banks of King's Creek; but as this creek extends by its winding course over a large tract of country, much was left for future investigations. From my previous experience, I only explored those sites where I observed a similar stratum and appearance of the banks as obtained at Gowrie; and the result in a short time far exceeded my expectations. One circumstance I remarked at this place was, that, at the particular sites alluded to before, more fossils were found imbedded in the soft soil near the running stream of water in the creek than at Gowrie, having most probably been long since washed down by the heavy rains and floods from the banks, and left undisturbed. The collection obtained from this creek is sent to you; and having pointed out to Mr. W. B. Tooth the places where fossils might most likely be obtained, he has promised to send me any he may be able to procure. Thus in my brief visit to Queensland I so far attained the object I had in view when I left Sydney, not only to observe and judge for myself respecting the localities where the fossil remains you have described had been found (which I did not see, as no one at the station could identify the sites), but observe for myself in what particular situations additional fossils could most readily be found. This I did discover, and pointed out to others the areas most likely to yield them without unnecessary fatigue and loss of time. In this I consider I have in a great measure succeeded.

"I took with me to Queensland your memoir on *Diprotodon*, the engravings of which excited the admiration of all who saw them. Many readily recognized several of the bones delineated, and expressed their surprise at the great accuracy with which they were represented, even, as many remarked, to the 'marks of age upon the bones.' The 'old bones' (by many considered useless, and thrown away, or which, as some informed me, were broken to discover if they were really bones or stones assuming their forms) they never imagined could be so treated by palæontologists, who they were not aware possessed the power, until they saw these works, of depicting the ancient race of Australian animals, re-forming them into living structures, imparting to these long extinct animals the motion of animated life, and, as fossils bear the marks of their relative antiquity, are enabled to fix the date of the rock in which they are found.

"I remain, my dear Owen,
"Your sincere Friend,
"George Bennett, M.D."

"Sydney, New South Wales.
"Dec. 22, 1871."

MISCELLANEOUS.

Osteology of the Solitaire.

To the Editors of the Annals and Magazine of Natural History.

Gentlemen,—Prof. Owen remarks on a statement in my former letter concerning an inquiry made of him:—"Had this been so, I could not have forgotten the circumstance." Now "this" *was* "so;" and I can therefore only regret his memory has so sadly failed him.

Whatever "incidental mention of the Solitaire's bones" might have been made "in one of the basement storerooms" of the British Museum, the particular inquiry in question was expressly put to him in his own room upstairs.

My brother, writing from Mauritius in December 1860, informed me that these bones had been sent to Prof. Owen; and when it became necessary for us to enumerate all the known remains of the Solitaire, we of course endeavoured to obtain particulars of them from him. To obtain these was one of the chief objects of our calling upon him at the time he mentions. He had previously by letter kindly made arrangements whereby we could examine the bones of the Dodo in the "storeroom," for which arrangements we thanked him.

Prof. Owen repeats the assertion that "he first learnt" our "interest in the subject" from our paper in the 'Philosophical Transactions.' This, as I have already said, is not the case any more than that he can have "satisfied" any inquirer into the fate of the specimens by the "information" he has given. His final disclaimer, in the same sentence, of intending any "imputation of carelessness" requires acknowledgment from me. I only wish it had been expressed sooner, but trust that, now made, it will end the matter.

I remain, Gentlemen,
Your obedient Servant,
Alfred Newton.

Magdalene College, Cambridge.
9 March, 1872.

On the Grey Seal (Halichœrus gryphus). By Dr. J. E. Gray, F.R.S. &c.

Many years ago I was informed that the large seals lived on the west coast of South Wales. I observed them with an opera-glass in St. Bride's Bay, and I was convinced they were the grey seal. I offered a reward for the animal alive or dead, or for its skin and skull, but was never able to obtain one. Several have been shot, but they either escape or sink. This winter I received a note from Mr. Stokes, of Cuffern in Pembrokeshire, informing me that Thomas at St. David's had two young seals. I immediately sent the note to the Secretary of the Zoological Society, stating that the usual St.-David's seal was the grey seal, which I believe has never been in the Gardens, and the Society had better send a person to see the seals and procure them. Neither Mr. Stokes nor I ever received any account of the result; but I am told there are two grey seals from St. David's in the Gardens, which are doubtless those I referred to.

The grey seal was first observed in Ireland by Mr. Ball, who made several figures of it. Now we have specimens from the west coast of Wales; and I believe that it is found in various parts of the Irish Sea and St. George's Channel. I have heard of specimens being seen in the Isle of Man; and I have reason to believe, from parts of skin which I have seen, they occur as far south as the Land's End and Scilly Islands.

I have not been able to procure an animal, or any part of one, from the east coast of Scotland. We have one from the Fern Islands in the British Museum. It is found in the North Sea, and also in the Baltic.

On the Acclimatization and Anatomy of Perichæta diffringens, *Baird*. By M. L. Vaillant.

Dr. Baird was the first, in 1869, to indicate this worm as living in a hothouse in North Wales. A little later I presented several specimens of it to the Philomathic Society*, when the peculiarities connected with the locomotion of this annelid were confirmed. The individuals collected by M. Guinard in the neighbourhood of Montpellier were obtained from M. Fage's hothouses, where they had been introduced in vessels containing Orchideæ sent by M. Mazel from Monsauve (near Anduse), with whom this curious species has also become acclimatized. It is remarkable that both in England and in France it is with Orchideæ that the transportation appears to have been effected. Being persuaded that this circumstance must be very general, I have endeavoured to extend these observations; and last year I requested M. L. Rousseau to ascertain whether this curious animal did not also occur at the Museum. Several horticulturists have also kindly lent me their aid; and almost everywhere my previsions have been realized; and we may now assert that

* Bull. Soc. Philom. tom. vii. p. 25 (1870).

this *Perichæta* is very widely spread, its resemblance to the true *Lumbrici* alone causing it not to be recognized.

According to my observations this worm, whilst seeking moisture and warmth, delights in light and aërated soils. Under conditions of captivity in which the earthworms easily live, *P. diffringens* does not thrive well; in damp moss it survives for a considerable time, but in a wet clay or marly clay soil it dies in a few days. When placed in water, suffocation takes place comparatively quickly. When this annelid is dead the middle part of its body is already decomposed, whilst the two extremities, having retained their normal appearance, are still capable of contracting under the influence of excitants. In *Lumbricus terrestris*, as is well known, decomposition under these circumstances advances with more regularity from behind forwards. When irritated, the animal, like various *Lumbrici*, emits from its dorsal perforations a greenish-yellow liquid, full of Psorospermiæ, measuring 0·026 by 0·018 millim., and having very granular contents.

Anatomically *P. diffringens* differs but little from *P. cingulata* and *posthuma*, which I described in 1867. The nervous system is constructed on the same plan. Behind the testes, in the midst of the great dorso-ventral vascular trunks, I have found lateral, pyriform, ganglionic inflations, measuring 0·128 by 0·092 millim., situated upon the course of the nerves, which recalls to mind an arrangement well known in some *Hirudineæ*. The nerves which spring from the connectives uniting the ventral ganglia are very distinct, as in *Lumbricus*. In the last four or five segments the ganglia become less distinct, and the two lateral halves of the apparatus tend to separate.

The gizzard presents interiorly a translucent chitinous apparatus, of an opaline white colour, with iridescent reflections, forming a section of an hexagonal pyramid, nearly 4 millims. in height; and this apparatus, singularly enough, does not adhere to the wall of the digestive canal, a fact which in my previous researches I believed (but, as it seems, wrongly) was to be ascribed to the state of preservation of the individuals submitted to my examination, The intestinal part of the digestive cavity, less simple than in *Lumbricus terrestris*, varies in colour in the course of its passage; and in this respect we may distinguish in it three portions: the first, extending to the lateral cæca, already well known in *P. cingulata*, is reddish, as are also these cæca at their adherent portion; the second and the bottom of the cæca are yellowish; and the third portion, which is less inflated than the preceding, is brownish red. The dissepiments which sustain this last appear more distinct.

In this species I have not met with the large gland which, in the species previously studied, unites by its duct with the deferent duct towards its opening; on the other hand, the latter, which is 0·08 millim. in width during its course, becomes inflated into a club at its termination, where its diameter attains 0·48 millim. This dilated portion is recurved in the form of an S; the wall, which is very thick, seems to contain some glandular cells, but is chiefly composed of contractile fibres. There are four pairs of spermatic reservoirs*, each consisting of a double vesicle, the outer one much larger than the inner, and both furnished with a duct; these ducts unite, to open externally at the intersections of the third, fourth, fifth, sixth, and seventh segments, by orifices which are rendered visible by pale latero-central spots. The two vesicles and their ducts are situated behind each of the dissepiments. These reservoirs contain granular cells, with spermatozoids and Psorospermiæ of 0·010 by 0·006 millim.; the latter abound especially in the largest vesicles of each pair.

In short, *P. diffringens*, in all the essential parts of its organization, resembles the species which have already been studied, and confirms the views expressed by me in previous memoirs.—*Comptes Rendus*, August 7, 1871, pp. 385–387.

On the Animal of the Glass-rope. By Dr. J. E. Gray, F.R.S. &c.

Mr. F. Kitton, in Hardwicke's 'Science Gossip' for March 1872, makes some "Remarks on *Palythoa* investing the Glass-rope Sponge," and figures some of the animals growing on the surface of a ray's ova-case, evidently considering that this proves their parasitic nature. He mentions a second case, in which they were growing on a riband frond of some species of Algæ.

I regard both these instances as proving just the contrary. "The Algæ had become entangled with the glass-rope." The egg-case of the ray is very often to be found attached by its elongated ends to the glass-rope. I believe the figure only represents some of the eggs or buds of the polypes growing on its surface, to which they have become accidentally attached; and that they will never come to perfection so as to form a crust or develope the rope-like spicules. My reason for believing this to be the case is that the polypes are isolated; they are of very different sizes, some being very small and others being large; some are crowded one upon the other, so as to deform their shape, very unlike the uniform crust they form on the glass-rope; and I have no doubt of their being incapable, from their position, of developing the usual rope.

Mr. Kitton states "that the examination of the *Palythoa* when found apart from the sponge has enabled him to ascertain the spicules peculiar to it. Figs. 24 & 25 of his previous paper appear to be the only forms of spicula really belonging to the *Palythoa*." He omits to state that these spicules are siliceous, like the other spicules found in the rope and bark of *Hyalonema*, which have not hitherto been found in *Palythoa*; and the two forms he mentions from a polype only differ from those found in other parts of that coral in being thicker and more spinose.

* I think it necessary to indicate that the improper name of *capsuligenous glands* must no longer be employed, or at least referred to D'Udekem, who has formally reverted to the opinion of Leuckart in his well-known work on the genital organs of *Æolosoma* and *Chætogaster*.

In a previous number of 'Science Gossip,' Mr. Kitton figures the *Hyalonema* with its parasitical sponge (fig. 19), and the various spicules which he has observed in different parts of it (figs. 21–31): these figures are good, except fig. 20, representing the ends of a broken fibre of the rope. He does not seem to be aware that *Hyalonema* is more common without its parasitic sponge at the tip than with it; but the specimens with the sponge were formerly more sought for by travellers and brought to England, whilst the Russian specimens, being collected by naturalists, were chiefly without this parasite; and now we constantly receive them without any appearance of sponge, covered with living polypes up to the tip of the rope.

On Prognathodus Güntheri (*Egerton*), *a new Genus of Fossil Fish from the Lias of Lyme Regis.* By Sir P. DE M. GREY EGERTON, Bart., M.P., F.R.S., F.G.S.

In this paper the author described a new form of fossil fish, having a broad premaxillary plate somewhat resembling the incisor tooth of a gigantic Rodent, a single maxillary plate like that of *Callorhynchus*, and a mandibular dental apparatus closely resembling that of *Cochliodus*. For this form he proposed the establishment of the new genus *Prognathodus*, and named the species *P. Güntheri*. *Ischyodus Johnsoni*, Agassiz, also probably belongs to this genus, as it agrees with *P. Güntheri* in the characters of the premaxillary teeth. The author was doubtful as to the exact position of this genus, which had a head extended in a horizontal instead of a vertical plane, suggesting a resemblance to *Zygæna*, but covered with hard plates like the head of a sturgeon, and exhibited in the dental apparatus the curious combination indicated above.

Dr. GÜNTHER pointed out the interest attaching to the dentition of this fossil fish as being an additional evidence in favour of the connexion between the Ganoid and Chimæroid forms. The existence of three teeth instead of one on each side of the jaw, as in *Ceratodus* and others, presented in it a generic character; but the type was still the same. On one point he slightly differed from the view of the author; and that was as to the application of the terms maxillary and premaxillary to the teeth. He thought the former belonged rather to the pterygo-palatine arch, and that the teeth in the front of the jaw should be regarded as vomerine. He illustrated this by reference to the jaws and dentition of sharks, Chimæroids, and certain Ganoids, such as sturgeons. In these the teeth, instead of being connected with the maxillary and premaxillary bones, were, in fact, connected with the pterygo-palatine arch. He considered that this furnished additional grounds for including all three forms in one subclass.—*Proc. Geol. Soc.* March 6, 1872.

Felis pardinoides. By Dr. J. E. GRAY, F.R.S. &c.

In the Minutes of the Meeting of the Zoological Society on the 20th February last, Mr. Sclater observes, a paper was read "by Mr. D.

G. Elliot on a cat described by Dr. Gray in the 'Proceedings of the Zoological Society' for 1867 as *Felis pardinoides* from India, which Mr. Elliot considered to be identical with *Felis Geoffroyi* of South America." If Mr. Sclater had referred to page 400 of the 'Proceedings' above quoted, he would have found that the specimen there described was received from the museum of the Zoological Society, marked as having been brought from "India by Capt. Innes." So if there be any mistake as to the habitat, the Society is responsible. It is curious that *Felis Geoffroyi* is said to be the same as *F. pardinoides* and *Pardalina Warwicki*, which have very different skulls.

Discovery of a remarkable Fossil Bird. By Prof. O. C. MARSH*.

One of the treasures secured during our explorations this year was the greater portion of the skeleton of a large fossil bird, at least five feet in height, which I was fortunate enough to discover in the Upper Cretaceous of Western Kansas. This interesting specimen, although a true bird (as is clearly shown by the vertebræ and some other parts of the skeleton), differs widely from any known recent or extinct form of that class, and affords a fine example of a comprehensive type. The bones are all well preserved. The femur is very short; but the other portions of the legs are quite elongated. The metatarsal bones appear to have been separated. On my return, I shall fully describe this unique fossil under the name *Hesperornis regalis*.—*Silliman's American Journal*, Jan. 1872.

Pigs of the Society Islands.

"Down by the sea [at Tahiti] was an enormous yard full of pigs, and such pigs! of all sizes, from a Guinea-pig to a Shetland pony—of all colours, from a zebra to a negro. And as for shape, they were thin where they ought to be fat, long where they ought to be short, more like great wedges with the sharp end uppermost than any thing else I can think of. Such gaunt horrible monsters were never beheld; the scene was like the nightmare of a dyspeptic farmer.

"The pigs [of Huahine] presented to us turn out to be hideous little animals of some aboriginal breed, at least one third head, and very ugly head too. They gave one the general impression of having been squeezed from their youth up between two tight boards. And their manner corresponded with their appearance: wickeder pork, for its age, I never saw alive. When Stevedore Mitchell civilly offered one a banana, it flew at him and barked like a dog, to his no small discomfiture. Then it dropped on its fore knees, and seemed for some time to be wrapped in religious contemplation. After fortifying its soul with prayer, it quite suddenly, and quite

* From a letter to Professor Dana, dated San Francisco, Cal., Nov. 29th, 1871.

à propos des bottes, attacked one of our little Maori porkers, who was poking about the deck, thinking no evil; and a tremendous fight ensued. Maori was so fat and round, that for some time the new 'chum' could not raise a bite out of him, more particularly as he steadily presented the fattest and roundest part of his person to his adversary. At last a new idea seemed to strike the latter, and he took poor Maori by the tail, and made him squeak again. Maori, paralyzed for a time, retired into a quiet corner ,thought the thing over, and, his native fighting blood gradually rising to boiling-point, he came out with a rush, and, with many a prod and poke and bite, finished off his slab-sided assailant in one last and decisive round.

"He said that the queen (of Raiatea) had asked him to ask me whether I would give her one of our 'little round pigs,' as she expressed it, which, of course, I did, with many expressions of good will. I have often been asked for a photograph on leaving, or perhaps a lock of my hair, but never before for 'a little round pig.' These Society Islands are certainly original places."—Earl of Pembroke, '*South-Sea Bubbles,*' pp. 43, 87, 120.

Flyingfish.

"Sailed for Huahine. Saw a very long-flighted flyingfish, with large red pectorals, like a gurnet, which possibly it was. Flyingfish *do* fly, moving their pectoral fins with extreme rapidity, like a pair of twin screws. Moreover they raise and lower themselves over the tops of waves, and do *not* dip into them to wet either their whistles or their wings. I do not think that their flight is necessarily the proof of submarine persecution: of course they fly if the bonito is after them; but I suspect that, as often as not, they fly for the mere fun of the thing. Why else do they make such wild dabs at the bits of light in a ship's side at night? I remember, between Panama and Rapa, I used to see the cabin 'bulls'-eyes' surrounded by a circle of scales every morning, left there by flyingfish attracted by the light within, and possibly asking for a passage.

I should consider two hundred yards a very good flight for a flyingfish; and very few there be who do it, twenty or thirty being the general range. It seems limited, in some degree, by the difficulty of keeping the body horizontal. The tail droops more and more and more, and at last, splash! he goes into the sea. It struck me that as the flyingfish grew scarcer they grew larger, as if only the very big and strong individuals could reach the outside of the circle. Whenever I have seen them in the New-Zealand seas they have been large and solitary. The largest I ever saw (22 inches, if I recollect right) flew on board the 'Tauranga,' a small steamer in which I was taking a passage to the Bay of Islands in New Zealand. It went slap into the engine-room, and smote the engineer a smart rap on the cheek. He, supposing that his stoker had assaulted him, used language which I need not repeat, and threatened reprisals. On explanation being given, however, the fish was discovered, and handed over to Dr. Hector for preservation in the Colonial Museum, where it may now, I have no doubt, be seen by the curious.

"From Panama to Wellington, from New Zealand to New Caledonia, from Auckland to Tahiti and back again, a fair number of miles, I have watched the flyingfish carefully, and I never saw one seized by a bird in its flight. Nor have I ever seen such an occurrence in the Atlantic or West-Indian seas. I cannot doubt that it happens somewhere, because I have seen pictures of it; but in the seas I know it must be rare. Possibly other lands other manners, and, likely enough, other flyingfish and sea-fowl. I should as soon think it possible for a kiw to catch a rifle-ball in full flight, as for any real sea-bird to seize a flyingfish on the wing. The albatros I dismiss at once, his chances of trying are too few to bring him into question, as far as the South Pacific is concerned. The frigate-bird, or man-of-war hawk, decidedly the swiftest flier amongst sea-birds I have ever seen, seems to have given up fishing on his own account altogether, and makes use of the tern as his fishmonger. The tern, if the sea be smooth, has a neat little way of picking up small morsels from its surface, and, if necessary, makes a very respectable gannet-like splash; never, however, as far as I have seen, immersing himself, and always keeping his wings in motion to get him up again.

"The gannet, a splendid yellow-headed species of which is common in the South Pacific, is, I think, the finest of all fishing-birds from John o' Groat's House to the Chatham Islands. But even he could never catch a flyingfish, his strong point being 'perpendicular,' not the horizontal pace. Soaring high, he marks his prey beneath him, and shutting up his wings (like a wood-pigeon darting into cover) he plunges downwards with a splash that makes one's head ache to look at; and after a semicircular dive of five or six yards he emerges, sneezing and flapping with his prey safely lodged in his throat."—Earl of Pembroke, *South-Sea Bubbles*, pp. 62–64.

Sunfish.

"Whilst sitting in the canoe, something passed us swimming about a foot under the water, which I took for a turtle, but which Joe declared to be a sunfish. I have often seen sunfish (at Bora Bora) basking upright in the water; but this one was swimming, not quite on its side, but at a certain angle in the water; and the wavy motion of its fins gave it a very remarkable appearance, quite unlike any fish I have ever seen. Unluckily we had no heavy spear in the boat; or we might easily have secured it. Joe tells me that about a month ago a very large one was killed in the harbour, and that it had three live young ones in it: so much alive that they began to swim as soon as they were put into the water. I cross-questioned him on the subject; but he declared that there was no mistake, there were three live little sunfishes in the old one. I do not remember to have heard before that the sunfish was viviparous."—Earl of Pembroke, *South-Sea Bubbles*, pp. 130, 131.

THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[FOURTH SERIES.]

No. 53. MAY 1872.

XXXV.—*On* Oneirodes Eschrichtii, *Lütken, a new Lophioid Fish from Greenland.* By Dr. Chr. Lütken*.

[Plate IX.]

Some years ago Dr. Günther† described and figured, under the name of *Melanocetus Johnsonii*, a remarkable Lophioid fish 3·8 inches in length, which Mr. J. Y. Johnson had obtained at Madeira. This differed from all previously known (or properly systematized) Batrachioid fishes, with the exception of *Ceratias Holbölli* ‡, in wanting the ventral fins, and from the rare and large Greenland Lophioid just mentioned, amongst other things, by its perfectly smooth and naked skin. It may be regarded as a great rarity; for neither Mr. Johnson nor Mr. Lowe, both of whom have occupied themselves so much and with such great results about the marine animal-life of Madeira, had heard it spoken of previously, and, besides, the fish was quite unknown on the spot. Dr. Günther thinks that it is a deep-sea fish; and this may certainly be accepted with perfect justice with regard to this as with regard to so so many others which are of rare occurrence in literature and collections, because it is only accidentally or under very peculiar circumstances that they are drawn from their usual habitation in the nearly inaccessible depths of the sea. In the specimen described by Günther, apparently the only one of which any thing is at present known, the belly was very strongly distended, like a great pendent sac,

* Translated by W. S. Dallas, F.L.S., from a separate copy of the paper in the 'Oversigt over det Kongl. Danske Vidensk. Selsk. Forhandl.' 1871, pp. 56–74, communicated by the author.

† Proc. Zool. Soc. Lond. 1864, pl. 25.

‡ Described by Kröyer in the 'Naturhistorisk Tidsskrift,' ser. 2. vol. i. pp. 639–649, and figured in the 'Voyage en Scandinavie, en Laponie &c. Zoologie, Poissons,' pl. 9.

and the stomach contained a spirally rolled Scopeline fish, 7½ inches long—a prey, therefore, which was nearly twice as long as the voracious fish which had swallowed it.

Under these circumstances it seems to me of interest to become acquainted with a nearly allied fish, which undoubtedly likewise has its home in the deep abysses of the sea, but in the high northern latitudes near the coasts of Greenland, the same from which (and, indeed, from the considerable depth of 80 fathoms) we have obtained the fish which clearly comes nearest to *Melanocetus* in structure and form; nay, it is also to the same man who has done such service to our knowledge of the fauna of Greenland, that we are indebted for the discovery of *Ceratias* and of the new arctic Lophioid, for which I propose the name of *Oneirodes** *Eschrichtii*. The specimen to which this communication relates was sent by Captain Holböll to Professor Eschricht, and is entered in the journal of accessions to the Physiological Museum of the University under date of 7th November, 1845, with the perfectly correct designation "N. G. generi *Ceratiæ* aff.," but, unfortunately, without any more exact information as to where in Greenland, or under what circumstances, Holböll came into possession of it. After the superintendence of the above-mentioned museum had passed into the hands of the present physiological professor, and it had been removed into its new locality in the Academy of Surgery, its collection of fishes was given to the Zoological Museum of the University, which was thus enriched with many beautiful and interesting specimens, and this valuable addition to the fauna of Greenland incorporated in the ichthyological collection of the museum. After lying in concealment, or in any case undescribed, for more than twenty-five years, this remarkable form of animal may well deserve to be fully elucidated and introduced into the ichthyological system; and I need scarcely apologize for seizing the first opportunity that offers itself for this purpose, without deferring it until I might have brought together and worked up other additions to northern ichthyology which are accessible to me. As the nearly allied *Ceratias* already bears the name of their common discoverer, I have thought that we might attach Eschricht's to the new form, in order to preserve in ichthyology also the memory of his persistent zeal and universal interest in the collection of material for the elucidation of the animal life of our high northern latitudes.

That the Greenland form is specifically distinct from the deep-sea Lophioid from Madeira which has been so often mentioned, is seen at the first glance. Their differences, not-

* Ὀνειρώδης, dream-like.

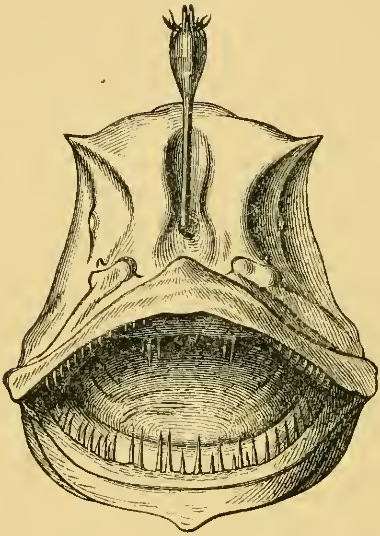
withstanding their resemblance in many essential features, are very sharply marked; nay, I consider that it will even be admitted that they are great enough for the establishment of a generic distinction. Before I pass to the detailed indication of these differences, I may state that the specimen before us, unfortunately, wants both the pectoral fins, but in other respects is well preserved. As, of course, I could not sacrifice the single existing specimen for the purpose of examining the bony structures, I cannot say any thing about them, except that in the solidity of its skeleton *Oneirodes* seems to be similar to *Lophius*: in this respect, however, it shares the fate of the two genera between which it will have to take its place, namely *Melanocetus* and *Ceratias*, in which the bony structures are likewise entirely unknown*. If in the following description I chiefly compare the new form with Günther's *Melanocetus* (so far as this can be done without directly laying them side by side), this is a simple consequence of their near affinity and great resemblance in many respects.

The form of the body in *Oneirodes* (Plate IX.) may be most correctly described as compressed, although by no means to the same degree as in *Ceratias*: and it is probable that this compression may seem greater in the dead than it would be in the living fish; for in an animal of a consistency so soft and flaccid and molluscoid, the collapse consequent upon death may certainly exert a sensible influence in this direction. Although the belly is very flaccid and pendent, and perhaps in the living body might have been more strongly distended than is now the case, it is still far from forming such a large pendent sac as in *Melanocetus*; and although the head (reckoned to the branchial clefts) does not perhaps make up a smaller part of the whole animal than in *Melanocetus*, the mouth is certainly much less in proportion to the size of the whole animal, as is best seen from the fact that the length of the jaw is not contained quite 3 times (namely 2·7) in the total length in *M. Johnsonii*, but nearly 4 (3·8) times in *O. Eschrichtii*. In the next place, the mouth is not perpendicular (as in *Melanocetus* and *Ceratias*), but horizontal (as in most other fishes). Seen from the side, the outline of the fish nearly forms a tolerably regular oval, somewhat pointed in front (in the facial part), but with the snout itself truncated, and posteriorly (at the root of the tail) somewhat produced. Seen from be-

* Since Kröyer published his description of this fish, the museum has come into possession of some material towards the knowledge of its bony structure—namely, of two skeletons broken into their constituent parts, the separate bones. I hope to work up this material at some other opportunity.

fore (fig. 1), its physiognomy is very peculiar. The *head* is quadrangular, with a broad, sloping, frontal surface, which is hollowed out by a broad and deep furrow, and bounded at the sides by an incurved wall, which projects strongly behind and above on each side in an acute frontal spine, and anteriorly and beneath, on each side of the apex of the snout, runs out into a double tubercle (probably, to judge from *Lophius*, belonging to the palatal bones). No other tubercles or spines besides those here enumerated occur upon the head, except that the rami of the lower jaw run out into a little spine on

Fig. 1.



Head of *Oneirodes Eschrichtii*, seen from the front, three fourths nat. size.

each side. Immediately over the rostral tubercles a small nasal papilla may be observed on each side*.

The total length of the fish, from the snout to the apex of the tail, is 205 millims. (or about 8 inches, more than double that of *Melanocetus Johnsonii*), to the base of the caudal fin 160 millims.; the greatest depth, which will about coincide with a line dropped from the isolated soft dorsal ray, to which we shall refer further on, over the point of attachment of the pectoral fin to the ventral margin, is about 105 millims., consequently fully half the total length. The thickness, measured between the two frontal spines, is 45 millims., and between the angles of the mouth about 55 millims., consequently ap-

* This occurs also in *Ceratias*.

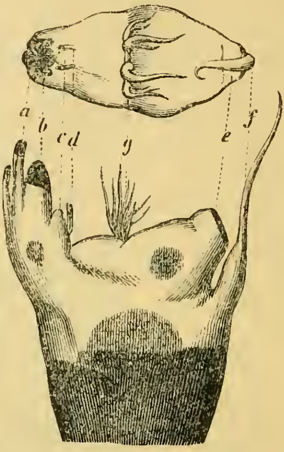
proximately one fourth of the total length; and this applies also to the length of the jaws (about 54 millims.), to the height of the fully expanded mouth, and to the distance from the apex of the snout to the frontal spines (about 54 millims.), or from the latter to the angles of the mouth (about 52 millims.). When the mouth is shut, the apex of the lower jaw falls within the upper jaw. The *branchial clefts* are situated at about an equal distance from the tips of the snout and tail; they are comparatively not small (about 30 millims. high), and are placed entirely below the attachment of the pectoral fin and beneath a horizontal line drawn from the snout to the apex of the tail. The *eyes* one would perhaps expect to occur in the deep depressions at the sides of the head under the lateral walls of the forehead; but they are to be found rather further back, at the boundaries of these depressions; they may easily be overlooked, partly because they are very small, partly because they are nearly hidden under the skin, which forms over them a small, white, translucent, oblong spot (3 millims. in diameter). An eye-cleft does not seem to be present *. The distance of the eye from the frontal spine is about equal to half its distance from the angle of the mouth. Behind the anus, immediately in front of the anal fin, a small anal papilla is observed. The *skin* is everywhere black or blackish brown, soft, loose, and smooth, without any traces of scales, bony tubercles, or cutaneous lobes; the cavity of the mouth also has everywhere the same dark colour.

At a small distance from the apex of the snout, in the lowest (foremost) part of the cavity of the frontal surface, there is inserted a *frontal ray* (first dorsal ray) of an extremely peculiar form, differing considerably from that in *Melanocetus Johnsonii*, in which it is described as a simple filament dilated at the apex into a little plate. The free part of this ray is about 38 millims. in length; when laid back, it does not extend beyond the frontal pit; it consists of two parts, the "shaft" and the clavate "head," which are both compressed; and the shaft is attached by a kneed joint to a similar horizontal piece (representing the "interspinous bone" in *Lophius*), which projects only by its outermost skin-covered part from

* What Günther states of the eye in *Melanocetus*—namely, "the eye is situated high up on the side of the head; it is very small, covered by but appearing through the skin," consequently applies perfectly to *Oneirodes*. In *Ceratias*, on the contrary, a very distinct and well-developed eye-cleft is present; the eyes in it are also very small, and "seem to be surrounded by an annular muscle, by the aid of which the skin may be drawn together over them like an eyelid, and almost entirely conceal them" (Kröyer, *l. c.* p. 643).

the channel between the forehead and the skin which serves as its bed: the uppermost part of the head (fig. 2) is white (colourless), with a sharp limit, and thus contrasts strikingly with the otherwise black colour of the fish; it is, moreover, furnished with several fine processes resembling tentacles, and with some pigment-spots, the distribution and other peculiarities of which will be better understood from the figures and detailed description: here it may be sufficient to state that, on the upper surface of the clavate head there are first three short filaments (fig. 2, *a*) with black tips, placed before and below the base of a black tubercle (*b*), and behind and below the latter and a lower light-coloured tubercle (*c*) two similar but much smaller tentacles (*d*). At the posterior end there is also a strong tubercle (*e*) with a black apical surface, and behind and below this a tolerably long tentacular filament, thin and fine towards the apex and thickened at the base (*f*); and in the middle of the upper surface of the clavate head a transverse series of four fine tentacular filaments (*g*), two longer ones in the middle and a shorter one on each side, which might be described as bifid or furnished with a shorter lateral branch, if the two on the left side did not differ in having the inner one simple and the outer, in compensation, trifid. Both these and the unpaired hindmost tentacular filament are destitute of the black pigment which characterizes the foremost set*.

Fig. 2.



The clavate head of the frontal ray, seen from above and from the side, enlarged.

* I am, of course, not in a position to indicate the purpose of this singular structure; but I will not conceal that the whole arrangement has above all produced a "mimetic" impression upon me, as if it were intended to resemble, *e. g.*, the head of a Nereid; and I have been compelled to think of the old notions of the employment by the fishing-frog of its homologous frontal appendage as a means of attracting other fishes, which, indeed, have given origin to its scientific specific name (however little we can place unconditional confidence in them).

I may admit that hitherto I have paid no particular attention to the conjectures that the tentacular filaments, barbels, &c. of various fish are employed merely as a means of attracting smaller fish of prey by their resemblance to worms playing in the water; and it is therefore very possible that positive observations in this direction may have escaped me.

This frontal ray is followed, about the middle of the back, by a conical (second) dorsal ray, about 50 millims. in length, somewhat depressed from before backwards, tolerably thick, and entirely soft (which is entirely deficient in *Melanocetus*, whilst in *Ceratias* there is a corresponding structure). Although it seems to be entirely soft and flaccid, and deprived of all rigidity, it is supported internally by a thin bony ray; when laid forward, it meets the clavate head of the frontal ray when this is laid down in its bed the excavation in the frontal surface; posteriorly it reaches the base of the *dorsal fin*. The fleshy base of the latter rises somewhat over the rest of the dorsal line; the fin is composed of six thick, conical, soft, and rather short rays, undivided and unjointed as in *Ceratias*, and terminating in a fine point (*Melanocetus* has fourteen such rays, while *Ceratias* has only four). On the other hand, the *anal fin*, as in the two genera just mentioned, has four rays of the same nature, and the *caudal fin* eight, of which the four middle ones are deeply cleft*. The caudal fin is not remarkable for its length (as in *Ceratias*); its length (45 millims.) is equal to the breadth of the head between the frontal spines, less than the length of the soft (second) dorsal ray &c.

When, for example, we read in Heckel and Kner's 'Süsswasserfische der östreichischen Monarchie' (1858, p. 311) of the Silure (*Silurus glanis*), "In this the play of its barbels is of advantage to it, as it makes use of them to capture fishes which snap at them," we might easily suppose that the authors had before them some definite information of this kind, perhaps from fishermen of the Danube.

The difference between the frontal ray in *Oneirodes* and *Ceratias* is probably less than it seems at the first glance. It is due in part to the fact that the part which lies below the articulation, and which in *Oneirodes* has a horizontal position, is nearly hidden in its sheath of skin, while in *Ceratias* it is free, erect, and consequently attached higher up on the head (above the eyes), and at the same time elongated in quite an extraordinary degree, partly to the clavate head being but little developed and therefore described as an "elongate ovate lobe of skin;" its upper part here has also a lighter colour; and in the original specimen it is plain enough that there have been more tentacular filaments than the one that Kröyer figures at the apex of the cutaneous lobe (the second one at its base is certainly due, as Kröyer himself states, only to an injury). I have likewise seen traces of pigmented tubercles, and have in general reason to think that when a specimen is obtained in which this part is well preserved, it will appear to have no small resemblance in its whole structure to the club in *Oneirodes*. With regard to the analogy which, notwithstanding much difference, exists between the frontal ray in *Oneirodes* and the frontal crest in *Himantolophus grœnlandicus*, I may refer to the older Reinhardt's description in vol. vii. of the 'Videnskabernes Selskabs Skrifter,' 4th series, p. 139, pl. 4. In *Melanocetus* the frontal ray has no joint at the base, and its terminal flap is destitute of all traces of the tentacular filaments &c. which adorn the corresponding part in *Oneirodes*.

* In *Melanocetus* the six intermediate rays are cleft.

The *teeth*, as in the allied genera, and especially as in *Melanocetus*, have the slender, conical, slightly curved form which is already so well known in *Lophius*, and they are, as in this, movable, so that they yield before a pressure coming from without, and lie down within the cavity of the mouth; but, to judge from the figures of *M. Johnsonii*, they are comparatively much smaller than in it, which, indeed, is in accordance with the circumstance that the mouth in the northern species is considerably smaller in proportion than in its southern ally. They form a single, not particularly close series both in the upper jaw (on the intermaxillary bone) and in the lower jaw; in the latter they are on the whole larger, largest (about 6 millims.) in the vicinity of the symphysis of the lower jaw; I count 14–18 in each half of the jaw above, and 15 below. On each of the anterior lateral expansions of the vomer there are two or three teeth; on the other hand they are entirely deficient on the palatal and pterygoid bones*. The same form of tooth occurs upon the upper pharyngeal bones; but, as in *Ceratias*†, the inferior pharyngeals, the branchial arches, and the hyoid are completely destitute of teeth. The first (outermost) branchial arch bears no branchiæ, and there is no fissure between the fourth and fifth branchial arches; on the second and third arches the branchial lamellæ are seated in a double series, but on the fourth only in a single one, as in *Ceratias* and *Melanocetus*; and there are thus, in *Oneirodes*, as in several other Lophioid fishes, only 2½ pairs of branchiæ ‡. Of

* In *Ceratias*, as is well known, they are also deficient on the vomer. On the supposed teeth of the palatal and pterygoid bones in *Melanocetus*, see the postscript to this memoir (p. 343).

† As Kröyer only mentions pharyngeal teeth in general without remarking that only the superior ones are present, it is not quite superfluous to call attention to the fact that the two genera also agree in this point.

‡ In this respect, therefore, the three above-named Lophioid fishes agree perfectly with each other and with the *Malthæa*-group (*Malthæa* and *Halieutæa*). *Lophius*, as is well known, has three pairs of branchiæ; but they are borne on the first, second, and third branchial arches (the fourth being here destitute of branchiæ); and *Antennarius* has three and a half pairs of branchiæ. When Kröyer says (*l. c.* p. 644) that *Ceratias* has three branchial arches, *all* with branchial lamellæ *in double series* (which is repeated in the Latin diagnosis, p. 648), he is in the wrong; the third branchia consists only of one row of branchial lamellæ, which is the ordinary consequence of there being no fissure between it and the lower pharyngeal bone (fifth branchial arch), which is expressed, but perhaps less clearly, by Kröyer in the words that the third pair of branchial arches "is attached by its inner side."

The absence of the opercular branchiæ does not, indeed, distinguish *Oneirodes* from the Lophioids most nearly allied to it, but certainly from *Lophius*, in which these organs have generally escaped observation: both Kröyer and Valenciennes expressly deny their presence; and Dr. Günther ascribes this structure to the whole family Pediculati ("pseudobranchiæ *branchiostegal rays* it is not easy without dissection to observe more than the two tolerably strong ones, of which the tips reach the anterior margin of the branchial cleft; but over these there are besides two similar ones on each side, and below them two much thinner ones, of which the lowest especially is very easily overlooked; there are consequently (so far as I could ascertain by very cautious dissection) six pairs of branchiostegal rays, as in *Ceratias*, or one more than are ascribed to *Melanocetus*. Opercular branchiæ are wanting.

What I can state with regard to the *internal structure* is briefly as follows. The lining of the ventral cavity is coal-black. The *liver*, which occupies the greater part of it, is not (as in *Lophius*) divided by notches into several lobes, and terminates on each side in a short, thick, obtuse, conical process, which is more developed on the left than on the right side. The *gall-bladder* is of considerable size, lies nearer to the liver than in *Lophius*, and opens through the gall-duct into the intestine at a very considerable distance from the stomach. On each side of the external lateral walls of the *stomach* we see three elegantly sinuous narrow bands which spring from the aponeuroses which externally almost entirely cover the œsophagus; the foremost and the hindmost of these bands are shorter, and terminate at some distance from the lower surface of the stomach; but the middle one is twice as long, bends round at a right angle, and continues, giving off a smaller lateral branch, and following the curvatures of the stomach, quite to the pylorus. (Upon the dark ground formed by the wall of the stomach this yellowish band forms as it were an elegant embroidery.) The stomach itself is of considerable size, pyriform or sacciform, symmetrical, thick-walled and muscular, dark-coloured, with its mucous membrane finely folded and curled; from the short and spacious œsophagus it descends in a straight line, constantly enlarging, so that the bottom of the sac is formed by its hindmost and lowest extremity, whilst the pylorus is situated quite in front under the liver. At this point, in fact, the narrowed (but not produced) pyloric portion of the stomach passes into the much more spacious intestine, from which, however, it is sharply distinguished. The *intestine*, which at first turns upward and to

absent"). On the other hand, we read as follows in Johannes Müller's celebrated treatise on the respiratory organs of fishes (Vergleichende Anatomie der Myxinoiden, dritte Fortsetzung, p. 75):—"*Pediculati.* All the genera examined had *free* pseudobranchiæ—namely, the genera *Lophius*, *Chironectes*, and *Malthe*." As regards the first-mentioned genus, at any rate, the thing is certain and easy to ascertain.

the right, and afterwards forms several smaller convolutions, would, if fully extended, be more than half longer than the total length of the fish (from the snout to the tip of the tail), but far from twice as long; at the commencement it is very wide (diameter about 14 millims.), afterwards considerably narrower (about 4 millims.), but wider again in its last portion (9 millims.). There are no pyloric cæca (*Ceratias* has two short cæca pylorica, according to Kröyer); a swimming-bladder is also wanting. The hindmost part of the ventral cavity is occupied by two large, oval, somewhat flat *ovaries*; when the outer membrane of these is removed, masses of ova are seen, forming as it were a chaplet in each of them, composed of a plate contorted into close folds. The ova are small and excessively numerous.

The essential differences between *Melanocetus* and *Oneirodes* which have come out under the preceding comparative examination of the new arctic Lophioid will be as follows:—

1. The *mouth* in *Oneirodes* is not vertical, but horizontal, and proportionately less than in *Melanocetus*; the length of the jaws is in it at the utmost one fourth of the total length; and the teeth are comparatively smaller.

2. The *frontal ray* is clavate, and its thick "head" furnished with various delicate tentacular filaments; its shaft is articulated to a horizontal "interspinal," resembling it in form, inserted under the skin of the forehead.

3. The thick, isolated, soft (second) dorsal ray is wanting in *Melanocetus*, which has fourteen, and *Oneirodes* only six, rays in the true dorsal fin.

To these we may also perhaps add a small difference in the number of the branchiostegal rays; and, finally, we might say that the belly in *Oneirodes* does not form a large pendent sac, if it did not seem probable that this peculiarity was only due to the fact that the specimen upon which the genus *Melanocetus* is established had accidentally, a little before it was captured, furnished an exceptionally strong proof of its voracity. Perhaps at another time it would not have presented a belly more remarkably pendent than it is in our *Oneirodes*; nor, perhaps, should we have any more ground for surprise if the latter should at some other time make its appearance with its belly not much less distended than that of *Melanocetus*. But even if we attach but little importance to this peculiarity (which Günther has, however, and, in my opinion, rightly, included in the generic characters of *Melanocetus*), there still remain sufficient characters to justify the opinion from which I have started here, namely, that *Oneirodes* and *Melanocetus* belong to two different genera. Whether we adhere to the principle that when in two allied species there are expressed two different "ideas"*, two independent thoughts of the creative power of nature (if I may so express myself), they should be placed in different genera, or express the rule more practically thus, "si quædam species ab aliis, quam maxime ipsi affinibus, characteribus tamen ejusmodi differt, qui in aliis, ad genus stabiliendum valent, non conjungenda est cum aliis, sed generice distinguenda"†, we shall certainly recognize in *Oneirodes Eschrichtii* a type different from *Melanocetus Johnsonii*, although very nearly allied to it; and in order to have something more definite to hold to, something that is not merely a matter of more or less, we may appeal to the differences in the direction of the mouth, to the presence of the peculiar (second) dorsal ray in the one species and its absence in the other, and to the characteristic development of the frontal ray in *Oneirodes*. On the other hand, it would seem at present (probably as an immediate consequence of the Darwinian ideas which are spreading so rapidly) that science is passing through a reaction against a generic differentiation which has been carried too far—a feeling with which I can entirely sympathize (although I cannot altogether accept its motive), simply because I must always see in the idea of the genus an expression of a nature-thought, for which reason I can by no means sympathize unconditionally with the modern notion of the merely relative value of the idea of the genus. The present case is one of those upon which opinions *may* be divided. There are no fixed criteria as to which "characters" have and which have not *absolute* validity as generic distinctions: what experience proves to be good generic characters in one family are of no value in another ("scias characterem non constituere genus, sed genus characterem!"); and we are thus referred to a subjective, and therefore to a certain extent less certain, judgment as to what is the right conception in a given case. Now, as regards especially the relation between *Oneirodes* and *Melanocetus*, I am not blind to the fact that there is so thoroughgoing a resemblance between them in all the more essential features, that one might perhaps feel hesitation about weakening the impression of their intimate alliance by placing them in different genera. Would it not be very natural to include two such nearly allied forms under the same generic name? What would there be against species within one genus of such abnormal fishes as the Lophioids

* See Brunner von Wattenwyl, 'Revue et Magasin de Zoologie,' 1870, pp. 118, 119. "A genus is a divine idea" (E. Forbes).

† Van der Hoeven, 'Philosophia Zoologica' (1864), p. 276.

unquestionably are, presenting a certain difference in the size and direction of the mouth, in the strength of the dental armature, in the number of fin-rays, &c. &c.? And in this whole group are not the number and development of the free dorsal fin-rays so different and so variable that it would be less natural to lay so great a stress upon the differences of the two fishes under consideration in these respects?

I will not here insist that in any case it would be necessary to alter the generic characters of *Melanocetus* considerably in order to make a place for the Greenland species within its boundaries, because I feel so much less inclination to undertake any such alteration of the definition originally given for that genus, as I have not been able to lay together *side by side* the forms in question, and thus to weigh similarity and dissimilarity in the fine scale of direct observation; but to this hesitation we might in general only concede a subordinate and merely subjective importance. What appears to me to settle the question of the relation of *Oneirodes* to *Melanocetus* is the relation of both to *Ceratias*; for under all circumstances it is evident that *Oneirodes* (*Eschrichtii*) will have its natural place between *Melanocetus* (*Johnsonii*) and *Ceratias* (*Holbölli*), certainly *much nearer* to the former than to the latter, but yet distinctly pointing from the one to the other; and this to a certain extent intermediate position must receive its most adequate expression by proposing to elevate the new form into the type of a distinct genus. I therefore entertain but little apprehension that future investigations of new intermediate forms should cause its abolition. As the facts stand now, it seems to me that *Oneirodes* has not merely a *formal* right to stand over against *Melanocetus*, but also a *real*, or, if you will, an *ideal* one; *Melanocetus* is a not much less extravagant modification on one side of the common trunk-form (to adopt the speech of recent times) which we may here suppose represented by *Oneirodes*, than *Ceratias* is on the other. Between all these there is the nearest affinity; and they seem to form a very natural little group of deep-sea Lophioids, of weak vision and destitute of ventral fins, within the great family of the Halibatrachi. This group is again divided into two—the smooth, naked-skinned forms (*Oneirodes* and *Melanocephalus*) and those with bony tubercles in the skin (*Ceratias* and *Himantolophus*).

Ceratias and *Oneirodes*, indeed, are not the sole representatives of the Lophioids, and especially of the subdivision of that family here under consideration, in the deep seas off the Greenland shores. There is also here a third form, which the elder Reinhardt described under the name of *Himantolophus* *grönlandicus**, from a specimen which was thrown upon the shore near Godthaab, in 1833, after a violent storm, and, unfortunately, much injured by crows and gulls: it was sent to him by Captain Holböll. The imperfection of the knowledge of the species that could be gained from this incomplete specimen was the reason that this distinguished ichthyologist did not venture to refer this remarkable fish to a definite place in the system; but I think that, now that we have become acquainted with *Ceratias*, no one having read Reinhardt's description can doubt that we have in it to do with an apodal Lophioid fish very nearly allied to the above-mentioned genus: doubt may rather arise whether *Ceratias* and *Himantolophus* might not possibly be identical; nay, one may perhaps be inclined to ask whether *Ceratias* may not be the female and *Himantolophus* the male of the same fish, so that the remarkable "frontal tuft" which gave rise to the latter name may be a peculiarity of the male sex. Unfortunately, there is nothing of *Himantolophus* preserved except the "frontal tuft," and the unmistakable resemblance between the bony tubercles which closely cover its skin and those occurring in *Ceratias* would rather confirm than weaken the supposition of such a connexion between them. An attentive reading of Reinhardt's description, however, will remove this doubt; for there appear in it such essential differences that their union becomes impossible. Thus I shall indicate:—that the teeth in *Himantolophus* formed *several* irregular rows—in *Ceratias*, on the contrary, only one, except at the front of the mouth, where there are two; that the pectoral fins contained 12 rays, in *Ceratias* 19; the dorsal fin 9 rays, in *Ceratias* 4; and, finally, that the spinous tubercles of the skin in the latter have at the utmost a diameter of 2 lines, whilst in *Himantolophus* they are 10–14 lines! I can therefore by no means entertain any doubt that it differs specifically and also generically from *Ceratias*, and that it forms a fourth member of the apodal Lophioid group of the deep sea. As Kröyer did not find occasion to refer to *Himantolophus* in the introduction to his description of *Ceratias*† (perhaps because he entertained doubt as to their

* "Ichthyologiske Bidrag til den grönlandske Fauna," Vidensk. Selskabs math.-naturv. Afhandl. 4de Række, vii. Deel, pp. 132–136.

† Only to those who are not well acquainted with the subject will it be necessary to indicate that the two new Norwegian Lophioids the existence of which Kröyer likewise made known in a note to this work (p. 639), and which were subsequently described by Düben and Koren (Ichthyologiska Bidrag, Kongl. Svenska Vetensk. Akad. Handl. 1844, pp. 63–79, pl. 3. figs. 1–5) as *Lophius eurypterus* and *Chironectes arcticus*, may be regarded as struck out of the catalogue of species, the former as probably the young of *L. piscatorius*, the latter as identical with *C. pictus*

difference, and could furnish no new information about it), and Günther entirely omits it in his 'Catalogue of Fishes,' I have thought that I ought not to miss this opportunity of again calling attention to it.

The circumstance that for our knowledge of all these three remarkable Greenlandic Lophioids we are indebted to one man, Carl Holböll, deserves to be noticed as an indication of what can be effected in this way by indefatigable attention and intelligent zeal, and also of what may be expected from the future, in proportion as interest in and knowledge of nature spreads from the cultivators of science to a greater public.

Our new genus and species may be characterized as follows, in accordance with what has been stated in detail in the preceding pages:—

Oneirodes Eschrichtii, Ltk.

Genus et species nova e familia Lophioideorum (Halibatrachorum), nec non e tribu Lophioideorum apodum nudorum. Corpus breve, crassum, mediocriter compressum. Caput maximum, tetragonum, fronte declivi, profunde excavato; rictus oris mediocris, horizontalis; oculi minuti, absconditi; dentes mediocres, graciles, elongati, conici, subincurvi, mobiles in maxillis, in vomere et in pharynge supra; in palato nulli. Apertura branchialis sat magna, infra insertionem primarum pectoralium; pseudobranchiæ operculares nullæ; arcus branchialis primus branchiis destitutus; branchiorum paria $2\frac{1}{2}$, cute arcum branchialem quartum cum osse hypopharyngeali conjungente; radii branchiostegi utrinque sex. Pinnæ ventrales nullæ (pectorales ignotæ). Radius frontalis cum osse interspinali horizontali subcutaneo articulatus, haud procul ab apice rostri insertus, sinum frontalem longitudine haud superans, clavæformis; caput clavæ compressum, tentacula plura minuta gerens; radius dorsalis (secundus) summo dorso impositus, conicus, depressus, flaccidus, frontalem longitudine superat. Pinna dorsalis vera et analis breves, caudali approximatæ, sed distinctæ; caudalis mediocris, haud elongata. Pinnarum formula radiorum: D. 1+1+6, P.?, V. 0, A. 4, C. 8; radii molles, cartilaginei, haud articulati, caudales mediani quartuor soli fissi. Squamæ nullæ; cutis nuda, mollis, nigra totum corpus obtegit. Vesica natatoria et appendices pyloricæ nullæ; ossa sceleti mollia, semispongiosa, ut in piscibus affinibus, spinis binis frontalibus et mandibularibus exceptis nullibi in tubercula vel spinas prodeuntia.

(see Günther in Ann. & Mag. Nat. Hist. 1861, p. 190, and Steenstrup in 'Videnskabelige Meddelelser fra den naturhistoriske Forening,' 1863, p. 208). I refer to this only in order that this note may not produce the notion that this family of fishes is more strongly represented in the northern seas than it really seems to be.

To facilitate comparison with similar forms which may hereafter be described, I will here collect in one place most of the measurements scattered through the preceding description. To give more seems to me to be superfluous and of little use: in animals of this nature no importance can be ascribed to small discordances in comparative measurements; and greater ones will always be sufficiently prominent by a comparison with the figures.

Dimensiones speciminis descripti.

	millims.
Longitudo corporis totius ab apice rostri usque ad extremitatem pinnæ caudalis	205
Longitudo corporis totius ab apice rostri usque ad originem pinnæ caudalis	160
Altitudo maxima	105
Latitudo capitis inter spinas frontales	45
„ „ „ sinus oris	55
Longitudo maxillarum	54
Spinæ frontales ab apice rostri distant	55
„ „ a sinibus oris „	52
Aperturæ branchialis altitudo	30
Radii frontalis longitudo	38
„ dorsalis „	50
Pinnæ caudalis „	45

EXPLICATIO ICONUM.

Fig. 1 (p. 332). Caput *Oneirodis Eschrichtii,* antice visum; magnitudine tres partes veræ efficiente pictum.

Fig. 2 (p. 334). Clava radii frontalis cum tuberculis et tentaculis, superne et ex latere visa; magnitudine aucta picta.

Plate IX. *Oneirodes Eschrichtii*; magnitudo iconis tres partes piscis ipsius; pinna pectoralis deest; clava radii frontalis separatim picta, magnitudine aucta.

Postscript.—After the printing of this little memoir was commenced, I had, by Dr. Günther's kindness, during a short residence in London, the opportunity of seeing and examining the original specimen of *Melanocetus Johnsonii.* Whilst this examination confirmed my conviction of its generic distinctness from *Oneirodes*, and strengthened my confidence in the perfect correctness of Günther's description and the figure accompanying it, my suspicion increased with regard to the right interpretation of the groups of teeth in the upper part of the mouth, which Günther had described as palatal and pterygoidal teeth. It seemed to me far more probable that it was the superior pharyngeal bone, which otherwise must be supposed to be deficient. I communicated my suspicion to Dr. Günther, who had the kindness to examine the conditions more closely, by clearing away the soft parts, and confirmed my conjecture. As regards the toothlessness of the palate, therefore, there is no difference between these two genera.

XXXVI.—*Remarks on several Species of* Bullidæ, *with Descriptions of some hitherto undescribed Forms, and of a new Species of* Planaxis. By EDGAR A. SMITH, Zoological Department, British Museum.

IN comparing the specimens belonging to the family Bullidæ contained in the collection of the British Museum with the monograph by A. Adams in the 'Thesaurus Conchyliorum,' vol. ii., and with the monographs by Sowerby of various genera included in this family in the 'Conchologia Iconica,' vols. xvi. & xvii., I have met with some errors, chiefly in the latter work, some of which I am enabled to correct, since the typical specimens of many of the species described in these publications are in the Cumingian collection, now in the British Museum.

Atys ferruginosa.

Adams (Thes. Conch. ii. p. 585, pl. 124. f. 110) describes and figures a shell from Cuming's collection, which he considers the same as that figured by Martini, Conch.-Cab. i. pl. 22. f. 209, 210, and assigns to it the name *A. ferruginosa* of *Chemnitz*, which should be of *Gmelin*, Syst. Nat. p. 3432.

This is certainly an error; for, as Dillwyn (Cat. Rec. Shells, i. p. 477) has long ago intimated, the figure of Martini is doubtless that of an immature *Cypræa*.

On careful examination of Adams's type, which only differs from *A. naucum* in possessing longitudinal irregular brown stripes, it proves to be but a small example of that species, which has retained the epidermis, the whole of which might be removed, and with it the markings, for they are only epidermal.

Atys cylindrica.

Bulla cylindrica, Helblings, Chemn. Conch.-Cab. x. pl. 146. f. 1356–7.
=*Bulla solida*, Brug. Enc. Méth. pl. 360. f. 2.
=*Atys elongata*, A. Ad. Thes. Conch. ii. p. 587, pl. 125. f. 121.

These three forms are figured by Adams in the last-named work. The latter two must be considered varieties of *cylindrica*, and, as their names imply, are respectively, the one more solid and somewhat shorter than it, and the other more elongate and a trifle less solid. This conclusion is arrived at after a careful study of a good series of specimens, among which the connecting links are found. Sowerby (Conch. Icon. xvii. sp. 4) says, in reference to *solida*, "it may possibly be a dwarf variety" of *cylindrica*.

Atys ovoidea, Quoy & Gaimard, *fide* A. Ad. Thes. Conch. ii. p. 585, pl. 124. fig. 111; and Sowerby, Conch. Ic. pl. i. f. 3.

The shell figured in the above works is not the *Bulla ovoidea* of Quoy and Gaim. Voy. Astrol. pl. 26. f. 18, 19.

These authors describe it as a fragile species, "très-légèrement striée en long avec d'autres stries transverses et peu nombreuses *en avant seulement*." These characters, together with the figures, at once separate it from the species referred to it by Adams, which is the *Atys obovata*, Menke, Malak. Blätter, 1854, p. 46. Sowerby, in the remark on this shell (sp. 3), says it "may only be a dwarf variety of *Atys naucum*," in which opinion I concur.

Atys muscaria, Guilding; Sow. Conch. Icon. xvii. sp. 5.

For *Guilding* substitute *Gould*, Proc. Boston Soc. Nat. Hist. vii. p. 138.

Atys semistriata, Gould; Sow. *l. c.* sp. 27.

Hab. North America.

Substitute *Pease*, Proc. Zool. Soc. 1860, p. 20, for *Gould*; and the above locality change to Sandwich Islands.

Atys debilis, Pease.

Add:—Proc. Zool. Soc. 1860, p. 20.

Hab. Sandwich Islands.

Atys porcellana, Guilding; Sow. *l. c.* sp. 30.

Hab. Kagosima, Western States.

For *Guilding* substitute *Gould*, Proc. Boston Soc. Nat. Hist. vol. vii. p. 138.

Alter habitat to Kagosima, Niphon, Japan.

The specimen from which Mr. Sowerby figured this species is fixed to a tablet, on which the name and locality are written thus:—"*Atys porcellana*, Gld. Kagosima, W.S.," *Gld.* being the contraction of *Gould*, and *W. S.* the initials of William Stimpson, who collected the shells, and not signifying Western States. I give this explanation to show that the error does not exist in the Museum collection.

Atys canariensis.

A. testa ovata, alba, pellucida, incrementi lineis irregulariter, et transversim medio leviter, superius inferiusque profundius striata; vertex aliquanto depressus; apertura superius mediocre angusta, super verticem paululum producta, basim versus sensim dilatata; labium tenue ad verticis medium (quo jungitur) incrassatum; columella arcuata parum reflexa; umbilici regio distincte perforata.

Long. 7 mill., diam. $4\frac{1}{3}$.

Hab. Teneriffe, Canary Islands.

Of the form of the young state of *A. naucum*; but the striæ are less distinct and not so far apart; also very like *caribæa*, D'Orb., but rather broader.

Atys M'Andrewii. B.M.

A. testa elongato-ovata, superius truncata, pellucida, fasciis angustis numerosis lacteis et medio una latiore cincta, transversim superne basique distanter striata; interstitium læve; vertex excavatus, margine aliquanto acuto circumdatus; apertura augusta, super verticem parum producta, basi sensim paululum dilatata et effusa; labrum tenue verticis medio junctum et ibi sinuatum; columella brevis, incrassata, haud torta; umbilici regio leviter perforata.

Long. 5 mill., diam. $2\frac{1}{2}$.

Hab. Lancerote.

I feel much pleasure in dedicating this species to Mr. R. M'Andrew, by whom it was dredged at the above locality and most liberally presented to the British Museum, together with a complete series of all the various species of Mollusca he there collected.

It is at once recognized by the numerous lacteous bands upon a pellucid ground.

Atys angustata. B.M.

A. testa parva, alba, semipellucida, nitida, elongato-ovata, superius basique aliquanto attenuata et fortiter striata, medio lævi; apertura angusta, basim versus vix dilatata; labrum tenue, verticis medio junctum et ibi valde incrassatum et sinuatum; columella curta, recta, leviter reflexa.

Long. 5 mill., diam. $2\frac{2}{3}$.

Hab. Gulf of Suez (*R. M'Andrew*), dredged.

A very narrow species, attenuated at each end and obscurely angulated in the middle; the labrum is very thick at its junction with the middle of the vertex, and strongly sinuated; the superior and inferior striæ are each about twelve in number.

Atys miranda. B.M.

A. testa elongato-ovata, pellucida, transversim tenuiter et incrementi lineis irregulariter striata; vertex depressus, medio (ex quo surgit labrum) perforatus; apertura superius angustissima super verticem parum producta, basim versus sensim dilatata et effusa; columella brevissima, arcuata, subito (ut in genere *Achatina*) truncata.

Long. 10 mill., diam. 4.

Hab. Gulf of Suez. Dredged by Mr. R. M'Andrew.

It is questionable whether the peculiar truncation of the columella, which is very like that of the genus *Achatina*, is not of subgeneric character; but as there is but a single specimen at hand, it is advisable to wait until there are more to judge from.

Haminea oryza, Gould; Sowerby, Conch. Icon. xvi. sp. 1.

Substitute for *Gould*, *Totten*, Silliman's Journal, xxvii. p. 350, f. 5.

This is already noticed by Tryon, Amer. Journ. Conch. iv. p. 283.

Haminea natalensis, Sowerby, *l. c.* sp. 7.

This is not *H. natalensis* of Krauss, Südafr. Mollusk. p. 71, pl. iv. fig. 14. On comparing it with the types of *H. peruviana*, D'Orb., in D'Orbigny's collection, they prove to be almost identical. This species, not mentioned by Sowerby in his monograph, is described in the 'Voyage dans l'Amérique méridionale.'

Haminea rotunda, A. Ad.; Sowerby, *l. c.* sp. 9.

= *Haminea rotundata*, A. Ad. Thes. Conch. ii. p. 583, pl. 124. f. 5.

Haminea pemphix, Phil.; Sow. *l. c.* sp. 12.

= *Haminea pemphis*, Phil. Zeitschrift f. Mal. 1847, p. 122.

Adams (in Thes. Conch. ii. p. 580) places "*zelandiæ*, Gray, MS. Brit. Mus." as a synonym. This name is not a manuscript one. It was published in 1843 in Dieffenbach's 'New Zealand,' p. 243; and thus it would have precedence over *pemphis*, Phil., should they prove to be identical; but, from the descriptions and localities, I consider them distinct. However, it is certain, on comparing the specimens referred to *pemphis* by Adams and Sowerby with the type specimens of *H. zelandiæ* presented to the British Museum by Dr. Dieffenbach, that these are the same species. In the Museum there are two specimens from the Red Sea (the locality cited by Philippi) which are identical with the types of *H. tenella*, A.

Ad. Thes. Conch. ii. p. 583, pl. 124. f. 104, of doubtful locality; and although considerably like *zelandiæ*, they are nevertheless a little narrower, with the columella not so arcuate, and "e rufescente alba, lineolis transversis exilissimis sculpta" (*Philippi*), thus differing from *zelandiæ*, which is irregularly scratched across, and of a white colour under a light-brown epidermis.

Sowerby (*l. c.* sp. 13) has given a good figure of a full-sized *zelandiæ* under the name of *obesa*, Sow., not being aware that it had already been described by Dr. Gray.

Haminea constricta, A. Ad. MS.; Sowerby, *l. c.* sp. 16.

This is not a manuscript name, it being published in the Thes. Conch. ii. p. 581, pl. 124. f. 95.

Haminea ferruginea, Chemn.; Sowerby, *l. c.* sp. 30.

Sowerby, in his monograph of the genus *Atys* (Conch. Ic. xvii. sp. 2) figures a species of this genus which he calls "*A. ferruginosa*, Chemnitz, Hist. Conch. i. tab. 22. f. 209, 210." See previous remarks on this.

Again, he cites the same two figures as representing a species of another genus, *Haminea ferruginea*, Chemn., thus referring two distinct genera to the same figure, which is absurd, and only shows the hurry in which the monograph in question appears to have been prepared, and also the little amount of care bestowed upon it.

The shell figured *l. c.* f. 30 is *H. fusca*, A. Ad., Thes. Conch. ii. p. 581, pl. 124. f. 94, from Cagayan, Island of Mindanao, Philippines.

Haminea angustata, Gould, MS.; Sowerby, *l. c.* sp. 32.

This should be *angusta*, Gould, Proc. Bost. Soc. Nat. Hist. vii. p. 139.

Hab. "Simonda, Western States of North America" (*Sow.*). This should be Simoda, Niphon, Japan.

This is another instance of the general want of care which characterizes many of the monographs published in this work.

The shell Mr. Sowerby took his description and figure from is in the Cumingian collection, and is placed on a tablet with the name and locality thus written:—"*Haminea angusta*, Gld. Simoda, W. St." The W. St. signifies William Stimpson, the collector of the specimens, and not Western States of North America. It is necessary to give this explanation, lest it might be thought that the error really occurred in the Museum collection.

Haminea novæ eboraci, Sowerby, *l. c.* sp. 6.

Corrected, in the index, *novi eboraci.* Tryon, in the American Journ. Conch. vol. iv. says:—"This is surely the *Bulla insculpta* of Totten; and the species figured by Sowerby as *insculpta* is the *solitaria* of Say, if, indeed, the two are really distinct." I may add that Sowerby's figures 1 *a* & 1 *b*, taken from Cumingian specimens, are magnified, being half as long again as the actual shells. Fig. 6 (*novi eboraci*) is of the natural size. The only observable difference in the two forms is that of size.

Haminea galba, Pease.

Add:—Proc. Zool. Soc. 1860, p. 432.

Hab. Sandwich Islands.

Haminea crocata, Pease.

Add:—*l. c.* p. 432, not 19.

Hab. Sandwich Islands.

Haminea glabra, A. Ad.

Add:—*Hab.* West Indies.

Haminea serica. B.M.

H. testa rotunde ovata, tenuissima, pellucida, albida, vix nitida, incrementi lineis et transversim concinne confertim striata; apertura latiuscula, super verticem aliquanto producta, ad basim dilatata; columella parum incrassata, spiraliter intorta; umbilici regio callo tenui haud nitido (qui ad verticem pertendit) obtecta.
Long. 11 mill., diam. 9.

Hab. ——?

This is a remarkably roundly ovate species, very finely transversely striated, which produces a somewhat silky appearance, and having the region of the umbilicus covered by a very thin dull callosity, which is extended along the whorl to the vertex.

Although the sculpture is very like that of the *H. insculpta*, Totten, the form is very different.

Haminea malleata. B.M.

H. testa albida, subpellucida, quadrato-ovata, irregulariter malleata, transversim tenuiter incrementique lineis striata; apertura latiuscula, basi dilatata et aliquanto effusa; labrum super verticem complanatum vix productum medioque junctum; columella valde arcuata, callosa, reflexa.
Long. 12 mill., diam. 8.

Hab. ——?

This species is remarkable for its short squarish form, the irregular malleation, the reflected columella, and the flattened vertex. Here and there are longitudinal depressions, giving the shell a somewhat wrinkled appearance.

Haminea cuticulifera. B.M.

H. testa elongato-cylindracea, superius inferiusque rotunde quadrata, tenui, alba, epidermide albido, nitente, verticem basimque versus luteo tincto, induta, incrementi lineis et superius basique transversim subdistanter striata; apertura latiuscula, basi dilatata, super verticem vix producta; columella brevis, subrecta, reflexa, umbilici regionem obtegens, callo tenuissimo haud nitido vertici juncta; labrum tenue, verticis medio junctum et ibi incrassatum.

Long. 14 mill., diam. 6½.

Hab. New Zealand and Port Jackson.

The lateral outlines of this species are nearly straight; the superior striæ are about six in number, the inferior about eighteen. *H. papyrus*, A. Ad., is its nearest ally; but it is narrower, more elongate, with the striæ not covering the whole of the shell, the vertex is more depressed, and the aperture is less broadly dilated and more effused at the base.

Haminea perplexa. B.M.

H. testa ovato-cylindracea, cæruleo-alba, pellucida, superius inferiusque opaca, lactea, transversimque distanter striata, medio lævi, incrementi lineis striata; vertex valde depressus, medio subperforatus; apertura angusta, super verticem vix producta, basi aliquanto latior; columella simplex, leviter reflexa.

Long. 14 mill., diam. 7½.

Hab. ——?

This species has much of the aspect of the genus *Atys*; but it is without the sinuosity of the labrum at the vertex, and is there slightly perforated. The superior striæ are about seven in number, the inferior about twice as many.

Haminea æquistriata. B.M.

H. testa oblonga, cylindracea, lateribus rotundatis, alba, pellucida, tenui, nitida, incrementi lineis irregularibus transversimque striata; striæ (circiter 36) sub- et æquidistantes; vertex aliquanto depressus; apertura latiuscula, basi dilatata; labrum tenue verticis medio junctum; columella curvata, leviter reflexa.

Long. 12 mill., diam. 6.

Hab. Gulf of Suez. Dredged by Mr. R. M'Andrew.

This species has much of the form of *H. rugosa*; but it is much larger, the lines of growth are very slight, and the equidistant transverse striæ which are over the whole surface at once separate it.

Haminea rugosa. B.M.

H. testa cylindracea, lateribus curvatis, alba, pellucida, superius leviter inferiusque distinctius striata, incrementi lineis irregulariter rugosa; vertex parum depressus; apertura latiuscula, basi dilatata; labium tenue, superius subangulatum verticis medio junctum; columella brevis, reflexa, rimam parvam fere tegens, subtruncata.

Long. 6 mill., diam. 3.

Hab. Gulf of Suez and Persian Gulf.

This shell belongs to the same group as *brevis*, Q. & G. It is peculiar for the longitudinal irregular wrinkles formed by occasional deep lines of growth.

Cylichna nitens. B.M.

C. testa ovata, semipellucida, cæruleo-alba, nitente, longitudinaliter indistincte et transversim superne basique striata; vertex exigue umbilicatus; apertura angusta, aliquanto ad basim dilatata; labrum solidum, crassum; columella crassa, medio dente parvo vel tuberculo munita; umbilici regio subperforata.

Long. 5 mill., diam. $2\frac{1}{2}$.

Var. Testa major, minus solida. Long. 6 mill., diam. 3.

Hab. Fiji Islands.

A small, semitransparent, bluish-white species, chiefly characterized by the thick labrum and columella, which has a small tooth or tubercle on the middle of it.

Cylichna propinqua. B.M.

C. testa elongata, cylindracea, paululum medio contracta, alba, epidermide pallide brunnea, quæ superne inferneque brunnior est, induta; transversim exilissime undulatim striata; vertex excavatus, medio anguste perforatus, margine acuto succinctus; apertura superne angusta, inferne dilatata; labrum anfractui fere parallelum; columella spiraliter tortuosa.

Long. 13 mill., diam. maj. 5.

Hab. Vancouver's Island.

This species in general aspect reminds one of the common *C. arachis*, Q. & G.; but it is considerably narrower, with the vertex only excavated with a minute perforation, not umbilicated, and the basal margin of the aperture is roundly truncate.

Cylichna fijiensis. B.M.

C. testa perelongata, angusta, cylindracea, paululum medio contracta, alba, transversim exilissime striata, striæ versus verticem distantiores quam cæteræ, incrementi lineis indistinctis longitudinaliter striata, vertice (qui margine acuto circumdatus est) profunde umbilicata, basi subperforata; apertura superne angustissima, inferius dilatata; columella crassiuscula, spiraliter torta, apici callo tenui juncta.

Long. 6 mill., diam. 2.

Hab. Fiji Islands.

A pure white shining species, of nearly the same form as *C. biplicata*, A. Ad., but rather narrower, with the columella only spirally twisted, and the transverse striæ finer.

Cylichna lacteocincta. B.M.

C. testa minuta, cylindracea, pellucida, fasciis pluribus interruptis lacteis cincta, longitudinaliter exilius curvatim, et transversim modo inferius striata; vertex umbilicatus, margine rotundato circumcinctus; apertura superne angusta, basim versus sensim dilatata; columella incrassata, oblique subtruncata.

Long. $2\frac{1}{2}$ mill., diam. $1\frac{1}{4}$.

Hab. ——?

This species may be at once recognized by the lacteous bands upon a hyaline ground, and by the peculiar subtruncation of the columella, which almost forms a short channel with the outer lip.

Cylichna pumilissima. B.M.

C. testa minutissima, breviter cylindracea, aliquanto medio contracta, superne quadrata, alba, longitudinaliter curvatim lirata; vertex umbilicatus, margine rotundato; apertura superne angusta, ad basim perdilatata; columella spiraliter torta.

Long. $1\frac{1}{4}$ mill., diam. $\frac{3}{4}$.

Hab. Persian Gulf (*Col. Pelly*).

This species was dredged by Col. Pelly in great numbers at a depth of 14 fathoms. It is remarkable for its minuteness, the longitudinal curved ridges, and the very dilated aperture towards the base.

Cylichna consanguinea. B.M.

C. testa minutissima, elongato-cylindracea, alba, longitudinaliter curvatim striata; vertex umbilicatus, carina acuta circumcinctus; apertura superne angusta, inferne modice dilatata; labrum paululum medio contractum; columella spiraliter torta.

Long. $1\frac{1}{2}$ mill., diam. $\frac{2}{3}$.

Hab. Persian Gulf, 14 fathoms (*Col. Pelly*).

This species differs from *C. pumilissima* in being much more elongate, and in having an acute keel around the vertical umbilicus; the basal part of the aperture is also less dilated.

Cylichna perpusilla. B.M.

C. testa minutissima, oblongo-ovata, superne latiore quam ad basim, pellucida, omnino lævi, nitente; apertura superne modice lata super verticem producta, basi paululum dilatata; vertex imperforatus, medio (ex quo surgit labrum) leviter depressus; columella crassiuscula, haud torta.

Long. $1\frac{1}{4}$ mill., diam. $\frac{3}{4}$.

Hab. Persian Gulf, 14 fathoms (*Col. Pelly*).

One of the smallest forms yet discovered. It is quite smooth, white, and shining, of an oval form, rather narrower at the base than towards the vertex.

Cylichna (*Mnestia*) *puncto-sulcata.* B.M.

C. testa late ovata, basi paululum angustata, tenui, haud pellucida, fusco-alba, transversim tenuiter sulcata; sulci 27, æquidistantes, confertim punctati; vertex umbilicatus, intus striatus, margine rotundato circumdatus; apertura lata, super verticem aliquanto producta; labrum tenue; columella incrassata, sinuosa; umbilici regio subperforata.

Long. $4\frac{1}{2}$ mill., diam. 3.

Hab. Tunis, North Africa.

This appears to be very distinct from any other species; and it is at once recognized by the 27 closely punctured striæ, which are at equal distances from each other.

Cylichna (*Mnestia*) *alboguttata.* B.M.

C. testa ovata, aliquanto basi attenuata, tenui, semipellucida, albida, confertim guttis lacteis opacis ornata, lævi, nitente, incrementi lineis et transversim exiliter striata, superne basique distinctius; vertex valde umbilicatus, intus transversim striatus, margine rotundato circumdatus; apertura superne latiuscula, basi latior; labrum tenue; columella incrassata, alba, reflexa, fissuram parvam fere tegens.

Long. 8 mill., diam. $4\frac{1}{2}$.

Var. Testa pallide rosea, guttis numerosis rotundis albis variegata.

Hab. West Indies.

This species is at once known from *marmorata*, A. Ad., by the difference of form. It is without the contraction just below the vertex, the apical umbilicus is smaller and not surrounded by so sharp an edge, the striæ above and below are not so strongly marked, and the aperture is not so produced upwards as in that species.

Cylichna (*Sao*) *Pellyi.* B.M.

C. testa pyriformi, basim versus duplo latiore quam ad verticem, alba, basi transversim distanter striata; vertex umbilicatus, extrinsecus lira (quæ striis longitudinalibus curvatis semsim evanescentibus decussata est) circumcinctus; apertura superne angusta, super verticem producta, inferius valde dilatata; columella brevis, incrassata; umbilici regio perforata.

Long. 4 mill., diam. maj. 2.

Hab. Persian Gulf (*Col. Pelly*).

This species is rather like *C. nitida*, A. Ad., in form; but it is considerably larger, and proportionally narrower towards the upper end.

Messrs. H. & A. Adams, in their 'Genera of Recent Mollusca,' vol. ii. p. 21, give the following characters to *Sao*, which they place as a subgenus of *Atys*:—"*Shell pyriform, umbilicated; apex not perforated.*"

Of these characters the first two certainly apply better to some of the species of the genus *Cylichna* than to those of *Atys*, and the third is a false one; for in the descriptions of the species characterized by A. Adams, he mentions the vertex as being "subumbilicata" or "profunde perforata:" therefore I think *Sao* should be removed from *Atys*, and be placed as a subgenus of *Cylichna*, from which it differs chiefly in being pyriform.

Tornatina liratispira. B.M.

T. testa cylindracea, superius parum latiore quam basi, alba, nitida, incrementi lineis curvatis striata; anfract. 5, superius acute marginati, primus tubercularis; spira brevissima, turrita, sutura late canaliculata, medio lira filosa divisa; apertura angusta, basi sensim dilatata; columella spiraliter uniplicata.

Long. 6 mill., diam. 3.

Hab. Rio Janeiro.

This species is nearly allied to *T. Knockeri*, Smith, Proc. Zool. Soc. 1872, from West Africa; but it may be known from it by its larger size, and the absence of the plications at the upper part of the body-whorl; the columellar fold also is less strongly developed. The very fine ridge in the middle of the sutural channel produces the appearance of a double edge to the whorls.

Tornatina persiana. B.M.

T. testa minutissima, breviter cylindracea, alba, incrementi lineis curvatis rugosa; anfract. 3, primus ex tuberculo magno constat, cæteri superius lira magna rotundata circumcincti; sutura depressa; apertura latiuscula, brevior quam anfractus ultimus, basi sensim dilatata; columella brevis, incrassata, haud torta.

Long. $1\frac{1}{3}$ mill., diam. $\frac{3}{4}$.

Hab. Persian Gulf, 14 fathoms (*Col. Pelly*).

Its minuteness constitutes the principal distinctive character of this species. The tubercle which forms the apex is proportionally very large.

Planaxis puncto-striatus. B.M.

P. testa acuminato-ovata, nitida, alba, lineis spiralibus rufis, partim interruptis (in anfr. ult. circiter 9), cincta; spira elongata, apice obtuso; anfract. 6, parum convexi, primi 3 basimque versus transversim sulcati, cæteri crebre puncto-striati; apertura ovata, alba, spiram æquans; columella arcuata cum labro callositate juncta; labrum incrassatum, intus denticulatum; canalis basalis brevis.

Long. $7\frac{1}{2}$ mill., diam. $3\frac{2}{3}$.

Hab. Gulf of Suez (*M'Andrew*).

This pretty species may be recognized from any other by the nine transverse red lines and the punctured striæ, about twenty in the body-whorl.

XXXVII.—*On the Affinities of Palæozoic Tabulate Corals with Existing Species.* By A. E. Verrill.*

The works of Milne-Edwards and Haime upon corals are so extensive and important, and their classification is so well understood and generally adopted, especially by geologists, that it is of great importance that their errors of classification should be pointed out and fully understood.

A very unfortunate mistake was made when they instituted the exceedingly heterogeneous and artificial group known as "Madreporaria Tabulata." This division was based wholly upon a single character of uncertain value, found in certain corals differing very widely among themselves in all other respects. This character, regarded by them as of such fundamental importance, was merely the existence of complete transverse septa or plates across the coral-tubes, or cells, occupied by the lower parts of the bodies of the coral-polyps, thus dividing the lower unoccupied portion of these coral-cells into a series of closed chambers, each plate in turn marking a former position of the base of the polyp which occupied the cell, as it grew upward. In most of the other corals, on the

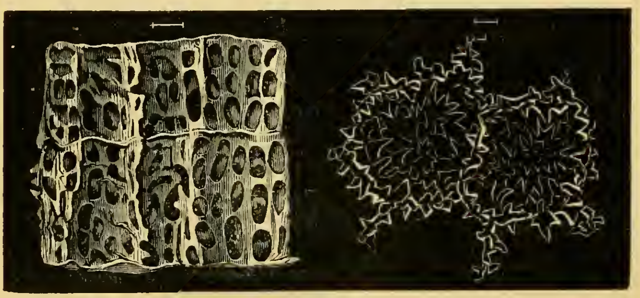
* Communicated by the Author from the 'American Journal of Science' for March 1872.

contrary, there are either no transverse plates, or else they exist between the radiating lamellæ or septa, thus dividing each of the *radiating chambers* into a series of transverse cavities, which are *usually* not exactly on the same level in the different chambers. At the time when this classification was proposed, the polyps of but few of the "tabulate corals" had been examined, and no characters were drawn from the soft parts. The explanation of the transverse septa seems to be, judging from my own dissections and also from analogy with other animals, that they are formed after each discharge of ova; the vacuity thus produced, being useless, is cut off from the visceral cavity above it by the formation of a septum. Therefore, if the eggs be discharged from all the radiating chambers simultaneously, or if from any other cause the polyp abandons all the chambers simultaneously, it is obvious that a complete septum or transverse plate will be formed across the entire tube; but if the eggs be discharged at different times from the ovaries occupying the various radiating chambers, the septa formed below them in the different chambers will not be coincident or exactly at the same level in all. It would seem, therefore, that the existence or non-existence of complete transverse plates is simply a matter of periodicity in the discharge of ova.

We should naturally expect to find such variations in periodicity among the species and genera of many diverse groups; and this, I think, can easily be shown to be the case. Thus, for example, the genus *Cœlastræa*, V., an undoubted Astræan coral, has the septa in all the chambers on the same level, thus forming true tabulæ; the genus *Alveopora* (fig. 1, *a*), and

Fig. 1.

a *b*



a, a longitudinal section of *Alveopora spongiosa*, Dana; *b*, a vertical view of some of the cells: both much enlarged, copied from Dana's Atlas of the Zoophytes of the U. S. Expl. Exp. For the use of this cut I am indebted to Messrs. Dodd and Mead, the publishers of Professor Dana's new work on Corals and Coral Islands.

others allied to *Porites* and *Madrepora*, have true tabulæ; also the genus *Astræopsammia*, V., of the *Eupsammidæ*; the species of *Pocillopora*, a genus closely allied, in its animals and otherwise, to *Oculina* and *Stylophora*, have very numerous and perfect transverse septa; even among the Alcyonaria, the genus *Tubipora* occasionally has transverse internal septa; and the same is true of *Millepora*, belonging to the class of Acalephs.

Notwithstanding the very slight basis upon which the group of "Tabulata" was established, and disregarding the very great and important differences which exist among the corals thus unnaturally brought together, most writers upon corals, whether recent or fossil, during the past twenty years have adopted this classification without hesitation.

And yet this is but another instance forcibly illustrating the general rule that classifications based on single characters are very likely to be artificial and erroneous. It also illustrates the manner in which such an error often leads to others of still greater importance.

In 1857 Professor Agassiz made the very important discovery that the animals of *Millepora* are not true *polyps*, but genuine *hydroids*, belonging to the class of Acalephs or *Medusæ**. But, since *Millepora* is a genus belonging to the "Tabulata," he immediately concluded that all the "Tabulata" are, therefore, hydroid Acalephs! And, not content with this sufficiently bold generalization, he extended it likewise to the extinct "Rugosa" or Cyathophylloid corals†, at first apparently with some hesitation, but more recently without qualification‡.

From this conclusion, if admitted, it followed that in the Palæozoic ages there were few, if any, true polyp-corals, but, on the other hand, the class of Acalephs was abundantly represented by a great variety of coral-making forms, some of them of great size, and capable of building extensive coral-reefs, similar to those made by true polyp-corals in modern times! Thus the geological importance of these two classes of animals would be completely reversed, as well as our ideas of the nature of corals and coral-reefs.

These views have been held and advanced by Professor Agassiz for many years, and have been urged quite recently,

* Proceedings of the Boston Society of Natural History, vol. vi. p. 373, 1859. See also Pourtales, in Illustrated Catal. of the Mus. of Comp. Zoology, no. 4, p. 56, 1871.

† Contributions to the Natural History of the United States, vol. iii. pp. 61–63, and vol. iv. pp. 292–296 & 338.

‡ Bulletin of the Museum of Comparative Zoology, vol. i. no. 13, p. 384, 1870.

notwithstanding the great amount of evidence that has been published to show that the "Tabulata" include corals very diverse in structure and affinities. The proposition of Professor Agassiz to regard all "Tabulate" and "Rugose" corals as Acalephs has not been very generally adopted, but has been received with more or less hesitation and doubt by many zoologists and geologists. In fact it is not easy to see how Professor Agassiz could reconcile, in his own mind, the structure of many of the Tabulata and Rugosa with his own definitions of the two classes Polyps and Acalephs. The distinction upon which he and others have chiefly insisted is the existence in the former of radiating fleshy lamellæ, dividing the interior of the body into a number of radiating chambers, in the centre of which, in coral-making species, the radiating plates are formed; while in Acalephs no such radiating lamellæ and chambers exist. Therefore it would not be possible for an Acaleph to form a coral having distinct radiating plates or septa, unless we alter our definition of an Acaleph. In that case I do not know what distinction would remain. And yet we find many Tabulate corals, both recent and ancient, with twelve or even twenty-four well-developed radiating septa; and among the Rugosa there are very many genera in which numerous radiating septa are as highly developed as in the ordinary modern corals of undoubted polyp-origin, while in some there are not even traces of *transverse* septa. If we regard the relations of the soft parts to the corals, it will therefore be necessary to consider all corals in which *distinct radiating plates* are formed as true polyp-corals; but the absence of such plates is not of itself proof that the coral was not made by a polyp; for many corals now living, and formed by genuine polyps, have no radiating septa (e.g. *Tubipora*, some species of *Pocillopora*).

In the present state of science, the only stony corals which are *known* to be formed by hydroids are the several species of *Millepora*. We can reasonably infer that a few other genera having essentially the same structure, or belonging properly to the same family, are also the corals of Hydroids. But as to the great majority of the "Tabulata" and "Rugosa," there can no longer be any reasonable doubt that they were made by true polyps, essentially similar to those of the existing corals*.

* The following quotation from the 'Bulletin of the Mus. of Comp. Zoology,' vol. i. no. 13, p. 384, Nov. 1869, will serve to illustrate the views of Professor Agassiz:—

"If we now remember that the Acalephian affinities of the Tabulata are unquestionable, and that, with them, the Rugosa must be removed from the class of Polyps and referred to that of the Acalephs, and if we further take into consideration the fact that *Palæodiscus* belongs to the

But among the Tabulate corals, after excluding the *Milleporidæ*, great diversities of structure still remain ; and no doubt representatives of several families that ought to be widely separated in a natural system are thus combined together on account of a single unimportant character. Many of these genera are extinct and apparently have no very closely allied representatives among living corals. The affinities of such genera may long remain doubtful. But in other cases there are living corals having very close relations with certain Palæozoic genera, and these we are even now able to classify with as much certainty as we can the ordinary forms of existing corals.

Among the best-known of the tabulate corals are the numerous species of *Pocillopora* and allied genera, which evidently constitute a distinct family (*Pocilloporidæ*), largely represented in the tropical waters of the Pacific and Indian oceans. These corals are characterized by rather small tubular cells, usually with 6, 12, or 24 radiating septa, which, even in the same specimen, may be obsolete in some of the cells, by *imperforate* compact walls, and by a more or less abundant compact cœnenchyma between the lateral cells, which may, however, be absent where the cells are crowded, as at the ends of the branches. The writer has shown in several previous papers* that the *Pocilloporidæ* are the corals of *true polyps*.

---

type of Rugosa, and not to the family of Fungians, it becomes evident that in their order of succession from the Mesozoic era, in which they first make their appearance, the great types of the class of Polyps have succeeded one another in the following order:—first Turbinolians, next Fungians, next Astræans, and last Madrepores—in exactly the sequence in which these types stand to one another, as far as their structural gradation is concerned, and in exactly the same order in which, during their growth, these corals pass from one stage to another."

But on the other hand, since we now find that the Acalephian affinities of the Rugosa and most of the Tabulata are wholly imaginary and without the slightest foundation in nature, all this beautiful theory of geological sequence falls to the ground, and we find the Madrepores represented even in the Lower Silurian rocks by *Favosites* and other *Alveopora*-like forms, which are certainly neither *low* nor *embryonic* types ! And even in Mesozoic times the Astræans appear in force quite as early as the Fungians or the Turbinolians. If there has ever been such a definite geological sequence of the groups of corals as Agassiz imagines, it must have taken place in the ante-Silurian ages, concerning the life of which we know nothing. In the Lower Silurian seas the order was already well developed and highly diversified.

* "On the Affinities of the Tabulate Corals," in Proceedings of the American Association for Advancement of Science, 1867, p. 148. Proceedings of the Essex Institute, vol. vi. p. 90, 1869. Transactions of the Connecticut Academy, vol. i. p. 518, 1870. American Journal, vol. i. p. 389, May 1871.

The animals of *Pocillopora* are exsert in expansion, with a regular circle of 12, nearly equal, stout, tapering tentacles surrounding the circular disk*; and 12 internal, radiating, fleshy lamellæ show through the disk. Thus they closely resemble the polyps of *Stylophora*, *Porites*, and *Madrepora*, which are among the most typical of true polyps. The existence of stellate cells, with 6 or even 12 well-developed radiating septa, in several species of *Pocillopora* (e. g. *P. elongata*, Dana, *P. plicata*, D., *P. stellata*, V.) should be sufficient evidence that such corals have no Acalephian affinities whatever, even without the conclusive evidence derived from a study of the living polyps.

The Silurian genus *Columnaria* appears to belong to a different family; and if not actually a member of the *Astræidæ*, it should at least be referred to a family very near that group. It has from 24 to 36 well-developed, imperforate, radiating septa, those of the first cycles wider and, in *C. stellata* (Hall, sp.), reaching the centre, while those of the last cycle are quite narrow. The larger septa have the upper edge finely serrate. The walls of the adjacent cells are united together as in *Cœlastræa* and *Goniastræa*; they are solid and apparently imperforate. The genus closely resembles *Cœlastræa*; but the budding is marginal or interstitial, while in the latter the cells divide across the middle.

Another well-known and important group of tabulate corals was abundantly represented in the Palæozoic seas by the genus *Favosites*, with its numerous species, and by several other allied genera, constituting the subfamily *Favositinæ* of Edwards and Haime. In these corals the walls are thin and perforated by more or less numerous pores or foramina, which are small in *Favosites*, but large and numerous in *Koninckia*. The cells are usually crowded and polygonal; and there is no cœnenchyma. The radiating septa are sometimes obsolete, but usually 12 or 24, which may be continuous or represented only by vertical rows of spine-like points, as in *Favosites* and the existing genus *Alveopora* (fig. 1, *b*). The transverse septa are variously developed, being often nearly flat but with the intervening spaces variable (as in *Favosites*), sometimes partly vesicular and incomplete (as in *Emmonsia*), not unfrequently convex and vesicular (as in *Michelinia*), rarely infundibuliform (as in *Rœmeria*). It is obvious that this group has no relationship with the *Milleporidæ*, and at best only a distant

* Trans. Conn. Academy, vol. i. p. 523 (*Pocillopora lacera*, V.). The polyps of *P. damicornis*, as figured by Quoy and Gaimard in the 'Voyage of the Astrolabe,' are quite similar.

one with the *Pocilloporidæ*, although Edwards and Haime placed it in the same family with the latter.

In the 'Report on the Zoophytes of the U.-S. Exploring Expedition,' 1846, p. 509, Professor Dana instituted the family *Favositidæ*, in which he included three subfamilies:—1st, *Alveoporinæ*, including the genus *Alveopora*; 2nd, *Favositinæ*, embracing *Stylophora*, *Pocillopora*, *Seriatipora*, with *Favosites* and other extinct genera; 3rd, *Helioporinæ*, for *Heliopora*, *Millepora*, *Heliolites*: this family was placed next to the *Poritidæ*. Although more recent discoveries have shown that this arrangement is incorrect in several points, it is nevertheless much nearer correct than the classifications of Edwards and Haime and Agassiz. In thus bringing *Alveopora* and *Favosites* near together, Prof. Dana made a very important step in advance, and one that has unfortunately been lost sight of, or overlooked, by recent writers, and most unfortunately by Edwards and Haime, by whom these genera are very widely separated. In describing the genus *Alveopora*, Professor Dana gives, as one of its characters, "transverse septa remote;" and on plate 48. fig. 3, *d*, of his 'Atlas,' from which the accompanying cut has been copied, he figured a vertical section of *Alveopora spongiosa*, in which the transverse septa are well shown (fig. 1, *a*). In this species the walls of the cells are exceedingly thin and pierced by numerous large openings, often leaving a mere skeleton of a wall. The transverse septa, although thin, are perfectly developed and imperforate, completely closing the cells at intervals of about ·05 to ·20 of an inch, varying even more than this in some parts of the coral, but not more than do many species of *Favosites*. Moreover the septa in many adjacent cells are situated at the same level, giving the coral the appearance of being divided into successive layers by broad, thin transverse plates. This appearance is due merely to the thinness and porosity of the walls and coincidence of the plates. The same arrangement of plates is found in the Silurian genus *Dania*, which, however, is said to have imperforate walls.

The structure of the walls in the tabulated genus *Koninckia*, from the Cretaceous, is very similar to that of *Alveopora*. Moreover the latter, like *Alveopora* (fig. 1, *b*), has vertical rows of spine-like points, representing the twelve radiating septa. In some, if not all, species of *Favosites* the septa were likewise represented by just such rows of slender points. And the same is true of other extinct genera belonging to the same group. Whether all the species of *Alveopora* have complete transverse septa is uncertain; for they appear to have been generally overlooked by the describers. Edwards and Haime make no allusion whatever to such septa in their descriptions of the genus and its species. In all the species which I have examined, however, these septa are to be found; but they are usually more remote and less evident than in *A. spongiosa*, while the walls in most of the other species are thicker and perforated by fewer and smaller openings, thus producing firmer corals. In *A. dædalea*, Dana*, the walls are much thicker and perforated by smaller rounded orifices, of which there are two or three vertical series on each side of a cell. The cells are very deep; and the transverse septa are complete though distant, and coincident in adjacent cells. The radiating septa are represented by twelve vertical rows of stouter spines, which often meet at the centre. Mr. W. S. Kent † has described and figured a recent coral, under the name of *Favositipora Deshayesii*, which has well-developed transverse septa, and agrees in all other respects, according to Mr. Kent, with *Alveopora*. But as the presence of such septa appears to be characteristic of *Alveopora*, the *Deshayesii* should be regarded as a species of *Alveopora* in which the transverse septa are, perhaps, unusually numerous. Mr. Kent also mentions a palæozoic fossil coral, supposed to be from North America, which he refers to the same genus (*F. palæozoica*). This may prove to be an ancient species of the genus *Alveopora*, and in any case cannot be more than generically separated, either from *Alveopora* or *Favosites*, as remarked by Mr. Kent. The genus *Koninckia* of the Cretaceous is, perhaps, not generically distinct from *Alveopora*, approaching *A. dædalea* very closely, and differing from *A. Verrilliana*, D., chiefly in having but six vertical rows of septal spines, instead of twelve. The genus *Goniopora* is closely related to *Alveopora*, differing chiefly in having about 24 radiating septa, which are more fully developed, but perforated by large irregular openings, and a distinct columella. The walls are usually rather firm and rough, as if composed of coarse irregular granules so united together as to leave many openings through the wall. The lateral and younger cells are often very shallow, with a large rough columella, and with six small paliform lobes arising from the inner part of the septa; while in some cases the walls are much thickened and roughly granulous at the surface, in these characters closely resembling *Porites*, to which it is also allied in the internal structure of the coral. In fact *Goniopora* combines many of the characters of *Alveopora* and

* This species, which proves to be distinct from the *dædalea* of Forskål &c., has been named *A. Verrilliana* by Prof. Dana in his recent work on Corals and Coral Islands.

† Ann. & Mag. Nat. Hist. vol. vi. p. 384, Nov. 1870.

Porites, and has some additional special characters. The transverse septa are usually quite numerous and thin, usually irregular, but with an evident tendency to coincide in height in all the chambers of the same polyp-cell, though much broken up and forced out of the transverse plane by the presence of the large irregular columella. In one species of *Goniopora* I have occasionally seen cells with a deeply infundibuliform septum completely closing the cavity below, thus recalling the septa of *Rœmeria*.

The three genera *Goniopora*, *Alveopora*, and *Porites* agree closely in the characters of their polyps; the first, however, has 24 tentacles, while the others usually have but 12, although there are often a few larger polyps with 24 tentacles, scattered among the smaller ones, in both the latter genera. It seems necessary, therefore, to place these genera and the others that are evidently closely allied to each of them in one family, *Poritidæ*. It will also be understood, from what has already been said, that it is impossible to assign any characters sufficient for separating the *Favositinæ*, even as a family, from the *Poritidæ*. It is very doubtful whether the group can be maintained even as a subfamily; for *Alveopora* and *Goniopora* combine the characters of both groups. The family PORITIDÆ*, thus extended, might, perhaps, be provisionally divided into three subfamilies:—PORITINÆ, for *Porites* and the closely allied genera; ALVEOPORINÆ, to include *Alveopora*, *Goniopora*, *Litharæa*, and, if considered distinct, *Koninckia* and *Favositipora*; FAVOSITINÆ, to embrace *Favosites*, *Emmonsia*, *Michelinia*, and the other closely allied genera. It is probable, however, that even such a slight separation of *Alveopora* and *Favosites* is greater than the differences actually observed will warrant.

Admitting these necessary changes in the classification†, it follows that the *Madreporaria perforata* or *Madreporacea*, which is generally regarded as the highest division, or suborder, of the true corals, was abundantly represented even in

* The genus *Montipora*, for which Edwards and Haime constituted their second subfamily of *Poritidæ* (*Montiporinæ*), belongs properly to the *Madreporidæ*, as explained elsewhere by the writer (Trans. Conn. Acad. vol. i. p. 501), and where it was also placed by Prof. Dana.

† The opinion that the *Favositinæ* belong to the Madreporacea was advanced by the writer in 1870 (Trans. Conn. Acad. i. p. 518). Mr. Kent, in the article referred to, published simultaneously with mine, expressed the same opinion and used independently nearly the same arguments. He also uses the argument with reference to the impossibility that a coral with radiating septa could be formed by hydroid polyps, as I had also done both in the paper referred to and in that of 1867. This coincidence of opinion, arrived at through studies pursued in different ways and approached from different directions, could not fail to be gratifying both to the writer and to Mr. Kent.

the Silurian seas. Moreover the family *Poritidæ*, which now includes many of the most important of reef-building corals, was also, even in palæozoic ages, a family rich in reef-forming species; for some of the species of *Favosites* grew into hemispherical masses eight or ten feet in diameter. It also seems probable that the genus *Alveopora* has existed through all periods from the palæozoic to the present time, which would seem the more remarkable considering the extreme delicacy and fragility of these corals, and also the fact that, so far as known, they are all shallow-water and reef species.

XXXVIII.—*On the Morphology and Affinities of Graptolites.* By Prof. Allman, F.R.S., F.L.S., &c.*

Among the extinct forms of life few possess more interest than these remarkable fossils, absolutely confined, as they are, to one great section of the palæozoic rocks, where their vast abundance, wide geographical distribution, and easy recognition render them of special value to the practical geologist.

The Graptolites are now by most palæontologists referred to the Hydroida: and their living representatives are sought for among the calyptoblastic genera of this order. While, however, I am unable to recognize their hydroid relations from the point of view from which palæontologists have generally agreed to regard them, I believe that their affinities with the Hydroida are too decided to justify their omission from any complete exposition of the palæontological history of this group of the animal kingdom.

The typical form of a graptolite is that of a narrow tube, straight or more or less curved, emitting from one side a series of hollow denticles, which are the free extremities of little cups or calicles, through which the cavity of the tube opens

* The following paper is mainly a portion of a chapter on the Distribution of the Hydroida in Time contained in the second part of the author's 'Monograph of the Gymnoblastic Hydroids' now nearly ready for delivery; and as it contains some new views of a question much agitated at this moment, it was thought that its regular publication might be here anticipated. The section of the work to which it properly belongs was printed off some time ago, and consequently before the appearance of Dr. Nicholson's 'Monograph of the British Graptolitidæ,' the first part of which, just published, will be welcomed by the palæontologist as a very valuable introduction to the systematic study of the graptolites. This difference of date will explain the absence of reference to Dr. Nicholson's work in the Monograph of the Gymnoblastea. Dr. Nicholson, however, does not seem to have essentially modified the views contained in his earlier publications and discussed in that Monograph.

externally, and having a solid slender rod ("virgula") imbedded in the walls of the opposite side. This type form ("monoprionidian") is represented by the genus *Graptolites* proper (fig. 1), where the calicles or tubular offsets from the common canal are in contact with one another at their bases and usually for a greater or less extent of their length, and by the genus *Rastrites*, where they are separated from one another by considerable intervals.

Fig. 1.

Longitudinal section of a fragment of *Graptolites priodon*, after Barrande.

But we may conceive of two such graptolites being united back to back; and the resulting form will then present two series of tubular offsets, one on one side of the main tube and the other on the side diametrically opposite, while the solid rod will now occupy the axis, holding just such a position as it would do if it had been formed by the union of the two rods of the component halves.

This form ("diprionidian") is represented by such genera as *Diplograptus*, where the tubular offsets stand out more or less free from the sides of the main tube, and by *Climacograptus*, where they are adnate to one another, so as to appear entirely immersed in its walls.

Some other forms also exist, such as *Dicranograptus*, in which the graptolite with a double row of denticles, after continuing its course for a time, divides into its component halves, which then diverge from the basal portion as two branches, constructed each on the single-rowed type. Branched single-rowed forms (*Cladograptus*, *Dichograptus*) also occur. In *Dichograptus* primary branches radiate from a common point at the proximal end, where they are connected by a web-like disk, apparently composed of a double membrane of the same nature as that which forms the walls of the branches*.

There are also some anomalous forms (*Retiolites*, *Phyllograptus*), whose structure has not yet been determined with sufficient certainty to admit of a satisfactory association with the true graptolites; but the essential features in the morphology of the graptolites, as well as their more important modifications, are expressed in the genera already cited.

There is sufficient evidence to show that the graptolites

* See Hall, 'Graptolites of the Quebec Group.'

were flexible, and that the solid parts, which are all that have come down to us, were of a horny or chitinous consistence. There is also evidence to show that, though some obscure forms (*Dendrograptus*), associated on insufficient grounds with the graptolites, were apparently rooted, the true graptolites were never directly attached to any other bodies—thus differing from the hydroid trophosomes and most of the corals and Polyzoa of the present day.

We are absolutely ignorant of the original contents of the main tube and of its lateral offsets, and we know just as little of other soft parts which may have accompanied the chitinous skeleton; so that in attempting to assign to the graptolites their position in the system of nature we are driven to analogy, by no means close, as our sole guide.

The resemblance of the forms just described to the trophosome of a calyptoblastic hydroid (sertularian or plumularian), after the disappearance of all the soft parts, is sufficiently obvious. And it is this resemblance between the fossil graptolite and the recent chitinous skeletons of the sertularian and plumularian hydroids which has induced modern palæontologists to refer the fossil to the order Hydroida, regarding the lateral offsets as hydrothecæ and the main tube as the chitinous perisarc of the hydrocaulus*.

We shall presently consider whether the exact points of contact between the graptolites and hydroids have been indicated in this comparison.

The fact which most obviously opposes itself to an accept-

* The sertularian affinities of the graptolites have been strongly insisted on by Hall, who has greatly advanced our knowledge of these fossils in his classical work, 'Graptolites of the Quebec Group,' which forms one of the memoirs of the Geological Survey of Canada. On the structure and principal modifications of graptolites, the works of Barrande ('Graptolites de Bohême') and of Geinitz ('Versteinerungen der Grauwacken. Die Graptolithen') should also be consulted. The sertularian affinities of graptolites have also been defended by Mr. W. Carruthers, of the Botanical Department, British Museum; aud I know of no one who has worked out this question with so much care and completeness: see especially his "Revision of the British Graptolites" in the 'Geological Magazine,' vol. v. The hydroid relations of the graptolites are also maintained from the same point of view by Dr. Nicholson in various publications, in which he has largely contributed to our knowledge of these bodies, and more especially in his 'Mouograph of the British Graptolitidæ,' part 1, just published.

I must here express my thanks to Mr. Carruthers for the liberal way in which he has placed at my disposal his large collection of graptolites, and for the aid which I have derived from his extensive acquaintance with the literature of the subject; and to Mr. Woodward, of the Palæontological Department, British Museum, for the readiness with which he placed in my hands for examination the fine collection of graptolites in the Museum.

ance of the hydroid affinities of graptolites is found in the presence of a virgula, the rod or "solid axis," which constitutes an essential feature in the structure of the graptolite. This rod was apparently of the same chitinous material as that which formed the rest of the firm skeleton of the graptolite. It is frequently continued for some distance beyond the distal or growing end, while its opposite or proximal end usually terminates in a minute spine ("radicle" of Hall), often continued into a long slender filament, like that of the distal end. It grows with the growth of the graptolite, as can be easily proved by following the progress of the graptolite from its younger stages; and it is difficult to explain its increase of length and thickness without regarding it, like the proper perisarc, as an excretion from the cœnosarc; and though, in the adult graptolite, it appears to have been separated by a chitinous film from immediate contact with the soft contents of the common tube, it was probably in direct relation with these in the younger stages, and would thus owe its existence to a special activity and peculiar modification of the chitine-excreting function of the cœnosarc at this part. It is sometimes found in the single-rowed graptolites to have become detached from the test or chitinous perisarc, leaving behind it a furrow in which it had lain, this furrow being, in the more perfect state of the fossil, converted into a tube by a thin extension over it of the test.

Though the virgula would thus form an extremely exceptional structure, its presence can hardly be regarded as offering an insurmountable obstacle to the admission of the graptolites into immediate relation with the Hydroida. Until lately a similar structure would have quite as justly excluded from the Polyzoa any animal which possessed it. The discovery, however, of the living polyzoal genus *Rhabdopleura* shows that a rod quite like that of the graptolite in all points, except in its not being continued beyond the cell-bearing portion, might be developed in an animal possessing in all other respects a typical polyzoal structure*.

It is true that the extension of the rod in the fossil beyond the limits of the common tube appears to increase the difficulty of reconciling its presence with the hydroid affinities of the graptolite. I believe, however, that this is, after all, not so anomalous a fact as at first sight it may appear, and that there is reason to believe that the cœnosarc invested by a proper perisarc was originally continued along what now ap-

* Allman, "On *Rhabdopleura*," in 'Quarterly Journal of Microscopic Science,' Jan. 1869, p. 57, pl. 8.

pears as a free extension of the rod. Its distal extension would then correspond to what had been the young growing portion of the graptolite, as yet destitute of denticles and with its perisarc so delicate as to be incapable of preservation in the fossil, so that the thin perisarc has perished along with the soft cœnosarc it included, its thicker rod-like portion being the only part preserved.

This view is borne out by the fact that in the very young stage of the graptolite a distal extension of the body along the rudimental rod, and beyond the incipient denticles, may be noticed; while it is further confirmed by an observation by Dr. Nicholson*, who tells us that in some specimens of *Diplograptus pristis* he has seen the common canal without denticles continued on each side of the prolonged rod.

The continuation of the rod beyond the denticle-bearing portion at the proximal end of the graptolite may also have been accompanied by an extension of the cœnosarc and its enveloping perisarc in this direction, the rod alone remaining in the fossil. To this view an observation of Mr. Carruthers† gives support; for he has noticed the prolongation of the rod at the proximal end of *Climacograptus scalaris* frequently invested for a short distance by a sheath.

If this explanation be accepted, the continuation of the rod as a naked filament beyond the denticle-bearing portion of the graptolite need no longer surprise us. A comparison of the rod with the chitinous spines which bristle over the surface of *Hydractinia* may also here suggest itself; but these spines are not only invested by a cœnosarcal layer, but are permeated by canals which are lined by cœnosarc, while in other respects the approximation of the graptolites to *Hydractinia* offers too many difficulties to allow of its being attempted.

The lateral spines often present at the proximal end of the graptolite seem to be of a different nature from that of the rod, and would rather appear to be referable to the same group of structures as the chitinous spines and variously formed processes by which the hydrothecæ and other parts of the perisarc of living hydroids are not unfrequently ornamented.

It has been already said that the advocates of the hydroid nature of graptolites regard their calicles or hollow lateral offsets as hydrothecæ. If this be really the nature of these parts, the mode in which their cavity opens into that of the main tube is exceptional; for in the living hydroids the point of communication between the hydrotheca and tube of the

* Geological Magazine, vol. iv. 1867, p. 261, note.

† In the 'Intellectual Observer' for June, 1867, p. 370.

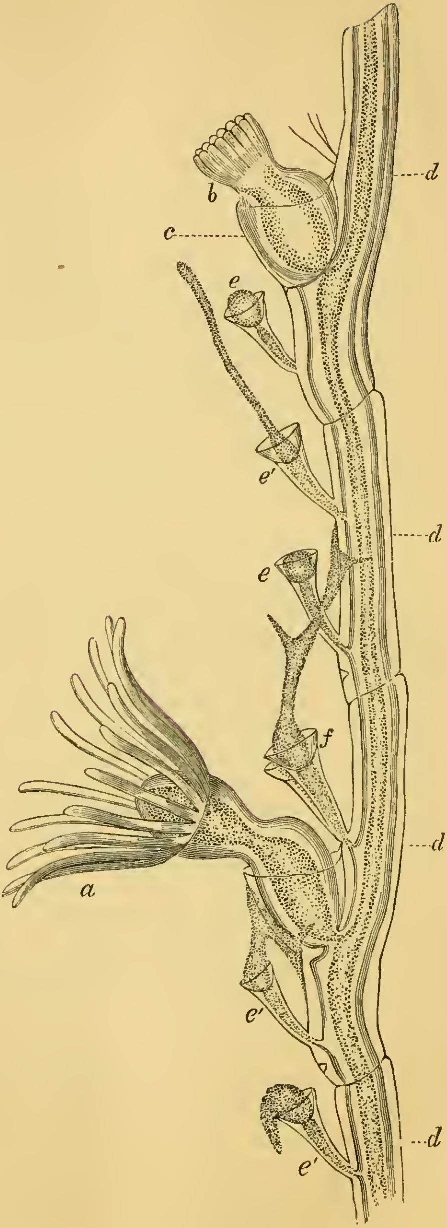
hydrocaulus is more or less constricted, or even provided with an imperfect diaphragm, so that the hydrothecæ become proper chambers, completely differentiated from the common perisarcal tube (figs. 2 & 3). Now the calicles of the graptolite have their cavity uninterruptedly continuous with that of the main tube, there being no diaphragm or constriction of any kind at the point where the one passes into the other (fig. 1)*.

There is, however, another view of the calicles which will meet this difficulty, a view suggested by the remarkable bodies known as nematophores, and which are characteristic of the Plumularidæ. These bodies constitute cup-like appendages formed of chitine and filled with protoplasm, which has the power of emitting pseudopodia or amœboid prolongations of its substance, and having their cavity in communication with that of the common tube of the hydrocaulus. They present two principal modifications, the movable and the fixed. In the movable forms (fig. 2) the nematophore always springs from a narrow point of attachment, whence it rapidly widens towards the distal end, while its cavity is divided transversely by an imperfect septum into two chambers. The nematophores of this form are more or less movable on the narrow point of attachment and are frequently caducous. They are characteristic of the genera *Plumularia* proper, *Antennularia*, &c. The fixed forms (fig. 3) commence with a wide basis of attachment by which they are immovably fixed to the hydrocaulus; and they are usually, though not always, destitute of an internal septum. They are never caducous. These are characteristic of such genera as *Aglaophenia*, where (as is also the case with the movable nematophores of other genera) they are situated, some upon the median line, when they are necessarily azygous, and some laterally, when they are in pairs. It is more directly with these fixed forms that I would compare the calicles of a graptolite; and such a comparison will show how exact is the resemblance. I have elsewhere shown that the tooth-like processes which project from the edges of the hollow leaflets which form the walls of the corbula in *Aglaophenia* (fig. 5, F, *c*) are bodies of an entirely similar kind; and the resemblance between these and the tooth-like processes of many graptolites is complete.

Now it is not alone in general form that the nematophores of *Aglaophenia* resemble the calicles of a graptolite. The mode in which their chitinous sheaths are seen to open into the common

* M'Coy ('Brit. Pal. Foss.') speaks of a septum at the base of the calicles in certain graptolites; but subsequent observations have not tended to confirm this statement.

Fig. 2.



Portion of a ramulus of *Antennularia antennina,* with hydranths and movable nematophores, showing the protoplasmic contents of the nematophores and the emission of pseudopodia.

a, hydranth extended; *b,* hydranth retracted; *c,* hydrotheca; *d, d, d,* consecutive segments of the ramulus; *e, e,* azygous or mesial nematophores with their protoplasmic contents quiescent; *e′, e′, e′,* azygous nematophores with their protoplasmic contents emitting pseudopodial prolongations; *f,* a pair of geminate or lateral nematophores, from one of which a thick branching pseudopodial process of protoplasm has been emitted.

canal of the perisarc (see fig. 3) after the destruction of all the soft parts is entirely similar to the mode of communication between the calicles and the common canal in the fossil (in those cases, at least, in which the graptolite has afforded facilities for examination such as to leave no doubt as to the structure of the parts in question), and quite different from that in which the proximal extremity of the hydrotheca is connected with the common tube of the chitinous perisarc in the existing hydroid*.

I cannot help believing that this is the true view to take of the morphology of graptolites. If so, the graptolites would admit of an approximation through an unexpected channel with the Plumularidæ. They would then be morphologically plumularians in which the development of hydrothecæ had been suppressed by the great development of the nematophores, probably the mesial ones†; while, on the other hand, the existing plumularian with well-developed hydrothecæ would present in its nematophores the last traces of the structure of its ancient representative, the graptolite.

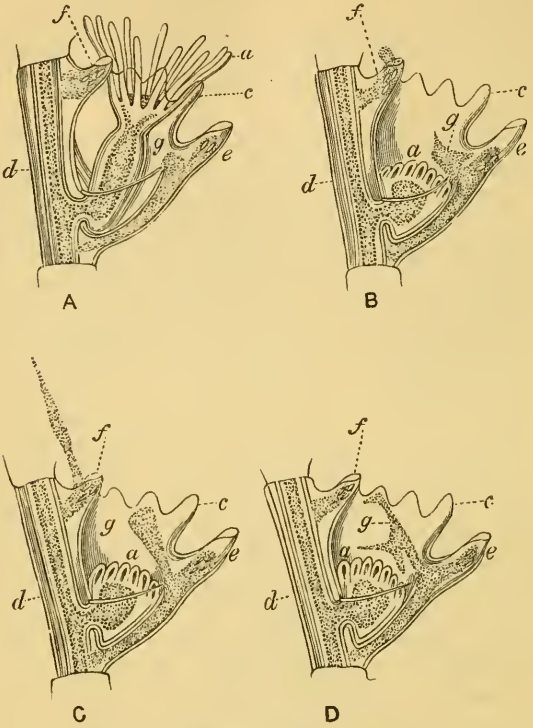
That the complete suppression of the hydrothecæ simultaneously with the retention of the nematophores is no overstrained supposition, will be admitted from what may be seen in certain plumularian hydroids which carry peculiar branches destined for the support of the gonangia or generative capsules. Now these branches are always destitute of hydrothecæ; but they are richly supplied with nematophores, which are distributed along the length of the branch, sometimes in a single row like the denticles of the monoprionidian graptolites, and sometimes in two opposite rows, like those of the diprionidian forms. In one undescribed species, from the deep-sea dredgings of the 'Porcupine,' I have found quite similar branches sent off from parts where they can have no connexion with the generative functions of the colony. The resemblance

* In the older parts of the hydroid stem the chitinous walls may become much thickened by successive layers of chitine, and the communication between the common canal and the cavity of the nematophore may thereby become contracted—a condition, however, which must not be confounded with the nature of the communication between the hydrotheca and its supporting stem.

† It may be here suggested that while the calicles of the monoprionidian graptolites have their representatives in the azygous or mesial nematophores of the plumularian, those of the diprionidian graptolites are represented by the paired or lateral nematophores. I should not hesitate to maintain this view, were it not that the comparison of a pair of opposite calicles in a diprionidian graptolite with a pair of lateral nematophores in a plumularian could hardly be reconciled with the view which would (apparently with reason) regard the diprionidian forms as morphologically representing two monoprionidian forms united back to back.

of these branches with their rows of nematophores to certain graptolites with their rows of calicles is too obvious to be overlooked.

Fig. 3.



Hydrothecæ of *Aglaophenia pluma*, with hydranths and fixed nematophores.

A. Hydrotheca with the hydranth extended and with the protoplasmic contents of the nematophores quiescent: *a*, hydranth; *c*, serrated margin of hydrotheca; *d*, segment of the ramulus, carrying the hydrotheca; *e*, mesial or azygous nematophore; *f*, lateral nematophore; *g*, lateral aperture through which the cavity of the nematophore communicates with that of the hydrotheca.

B. Hydrotheca with retracted hydranth and with the protoplasmic contents of the nematophores emitting pseudopodial prolongations: *a*, hydranth; *c*, margin of hydrotheca; *d*, segment of the ramulus carrying the hydrotheca; *e*, mesial nematophore with its protoplasm projected in an irregular pseudopodial mass, *g*, through its lateral aperture into the cavity of the hydrotheca; *f*, lateral nematophore with the commencement of a pseudopodium.

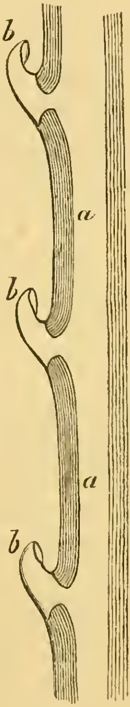
C. Same parts, with pseudopodial processes more advanced.

D. Same parts, showing different states of extension of the pseudopodia.

To the views here maintained further support is given by certain undescribed hydroids in the collections of the United-States Coast Survey placed in my hands for determination. Among these are some plumularians in which that part of the stem which lies at the proximal side of the pinna-bearing portion (and is accordingly destitute of hydrothecæ) carries along its length a single row of fixed nematophores separated from one another by regular intervals, and appearing to take the place of hydrothecæ (fig. 4). This part of the hydroid, if detached from the pinnate portion, might (except from the much greater slenderness of both common tube and calicles in the fossil than in the living form) almost be taken for a recent *Rastrites*.

Still further, the very important aid afforded in such questions as the present by the history of development may be here adduced; for in the plumularian genus *Antennularia* the embryonic stem is provided with well-developed nematophores before any hydrothecæ have made their appearance.

Fig. 4.



Portion of the stem from the proximal side of the pinnæ in an undescribed plumularian from the Gulf-stream, showing the distribution of nematophores along its length.

a a, part of the common canal, with the walls thickened by successive layers of chitine; *b*, *b*, *b*, nematophores.

Whether the calicles of the graptolites gave lodgment to true hydranths, or were filled with simple protoplasm, as I have already shown to be the case with the nematophores of the living Plumularidæ, it is, of course, impossible to assert with confidence. If, however, we give analogy its full weight, and extend the resemblance between the calicles of the graptolites and the nematophores of the plumularians to the nature of their contents, we should then have lodged in the graptolite-calicles, not hydranths, but simple masses of protoplasm, capable of emitting pseudopodial prolongations, on which would devolve the duties of conveying nutriment to the colony. The graptolites would thus not merely manifest relations to the Hydroida, but would exhibit others at least as strong to the Rhizopoda. Indeed but a step would be needed to convert such an organism into a true rhizopod; for if the common canal as well as the calicles were occupied by protoplasm, the whole might then be compared to an association of such rhizopodal forms as *Gromia*, united into a composite colony by a common tube filled with a common mass of protoplasm.

A very general feature in the mode of growth of graptolites is found in the fact that while the entire graptolite continues to increase in length, the denticles which are situated towards the proximal end remain of smaller size than those which succeed them, while, after thus increasing in size towards the middle, they again often diminish towards the distal end, the broadest part of the graptolite being consequently in this case near the middle. It may also be noticed that the denticles towards the base of the graptolite occasionally differ from those which succeed them, not only in size but in form.

Now, setting aside the undeveloped condition of the hydrothecæ near the growing or distal point of the stem, I know of nothing like this among the living Hydroida; while, on the other hand, the nematophores of the Hydroida vary in form in one and the same colony, and are sometimes found more or less arrested or otherwise modified towards the proximal end of the branch.

In support of the hydroid nature of graptolites, the occurrence of generative capsules in these fossils has been recently adduced; and as this is a matter of great importance in the present question, we shall here consider the evidence on which it rests.

Hall has described and figured in one of the double-rowed graptolites (*Diplograptus*) certain appendages of an irregularly triangular shape, having one angle continued into a narrow band, by which they become attached to the body of the graptolite. They are arranged with considerable regularity in two opposite rows, which extend for some length along the sides of the graptolite. These appendages are compared by Hall to the gonangia of a calyptoblastic hydroid*.

I am indebted to Mr. Etheridge for an opportunity of examining a British specimen of a *Diplograptus* which carries bodies of undoubtedly the same nature as those of Hall, and to Mr. J. Hopkinson, who had previously examined this specimen and determined its nature, for the inspection of an excellent enlarged drawing of it, which has since formed the subject of

* Hall, 'Graptolites of the Quebec Group,' p. 32, pl. B. figs. 6–11.

a woodcut accompanying Mr. Hopkinson's description of the specimen lately published in the present Journal*. Now, after a full consideration of Hall's and Hopkinson's descriptions and a careful examination of Mr. Etheridge's specimen, while I admit the probability of the appendages in question belonging to the generative system, I am unable to satisfy myself that they are the remains of gonangia. Indeed they do not appear to me to be capsular bodies at all, but rather double laminæ, though the way in which they are occasionally folded over on themselves, as seen in Mr. Etheridge's specimen, may give them the deceptive appearance of having been capsules, while in reality this condition would be inconsistent with their alleged capsular form.

The regularity of their disposition, and the close resemblance between those of the American specimens and those of the British, will not allow us to regard them as mere parasitical or accidental growths; and I believe that their connexion with the generative system of the graptolite may be considered probable. If so, then it remains for us to determine the parts which represent them in the living hydroid; and these I believe will be found in the leaflets which compose the corbulæ, or basket-shaped receptacles of the generative capsules, in *Aglaophenia* (fig. 5).

The two rows, then, of appendages in the graptolite would, according to this view, represent a corbula; and the gonangia or generative capsules, if such had existed, would have been borne upon the front of the graptolite along the bases of the appendages. We should hardly, however, expect to find any remains of gonangia in the fossil; for in all living hydroids which have their gonangia protected by corbulæ these gonangia are as delicate and perishable as the naked generative sacs in the *Gymnoblastea*.

The corbulæ of the graptolites, if such really had existed, were probably open ones, like those of the living *Aglaophenia myriophyllum*, and of several species from extra-European seas—a condition which indicates a low stage of differentiation, and represents a form through which the closed corbula of *Aglaophenia pluma* &c. passes in the course of its development (fig. 5, A, B, C, & D).

The view here adopted of the nature of these supposed generative capsules in the graptolite receives support from the fact that in every case where they have been satisfactorily observed the denticles of the graptolite become suppressed

* See 'Ann. Nat. Hist.' for May 1871.

in that part of the fossil which carries the appendages*, a fact quite in accordance with what we know of the corbulæ in the living hydroids; for in these the hydrothecæ with their accompanying nematophores are replaced by the leaflets of the corbula, while the naked gonangia of other hydroids are never accompanied by an atrophy or other alteration of the hydrothecæ or neighbouring parts.

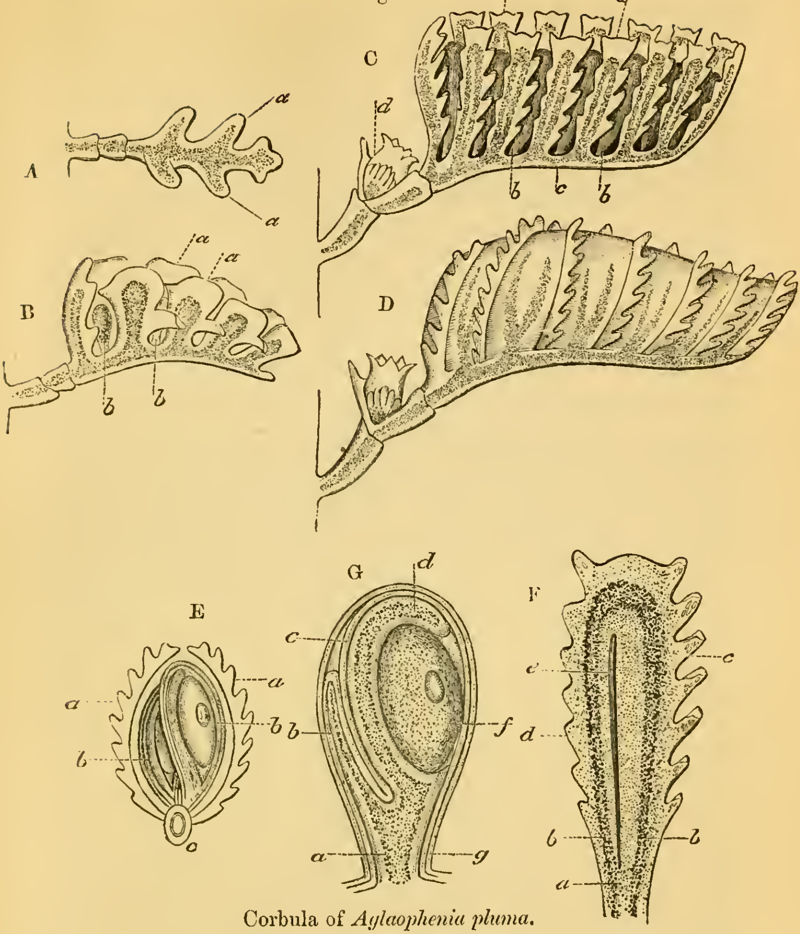
In both the American and British specimens the appendages in question seem to have been supported by a framework of branched chitinous filaments which remain behind after the destruction of the intervening membrane. The existence of these filaments probably depends on the same morphological conditions as those which determine the presence of the chitinous axial rod; and it must be admitted that we have no known analogy for them in any living hydroid, unless the internal narrow chitinous lamina which passes like a midrib through the corbula-leaflet (fig. 5, F, *e*) admits of being compared with them.

This comparison of the appendages of Hall to the corbula-leaflets of an *Aglaophenia* is in harmony with the view here advocated as to the nature of the calicles of the graptolite, which we have compared to the nematophores of an *Aglaophenia*. I believe the corbulæ of the living *Aglaopheniæ* to consist essentially of a special and excessive development of the nematophores; so that the graptolite, not only in its trophosome, but also in its gonosome, would thus present us with an instance of the great development of the nematophoral system at the expense of the hydranthal.

This view of the morphology of the corbulæ, in some cases at least, seems placed beyond doubt by their formation in an undescribed *Aglaophenia* from the deep-sea dredgings of the United-States Coast Survey. The leaflets which form the walls of the large and beautiful open corbulæ of this hydroid are mainly composed of the greatly enlarged and transformed nematophores which in the unaltered ramulus lie in front of the hydrothecæ. The hydrothecæ of the parts which become transformed into cor-

* Hall notices a case (*loc. cit.* p. 33, pl. B. fig. 9) which he regards as one in which the appendages are present in a graptolite which still retains its denticles. This, however, is by no means a well-marked instance, and one might be permitted to doubt the identity of the structures here figured with the appendages previously described by him. In Mr. Hopkinson's woodcut also, the denticles are represented as well developed for some distance on that part of the graptolite which carries the appendages; I cannot satisfy myself as to the reality of this in the actual specimen; indeed the woodcut does not do justice to the excellent original drawing kindly sent to me for inspection by Mr. Hopkinson.

Fig. 5.



Corbula of *Aglaophenia pluma*.

A. Very young corbula; B. Corbula more advanced; C. Corbula in a still more advanced stage; D. The mature corbula; E. Transverse section of mature corbula, showing two of its contained gonangia, each with a single gonophore: *a, a,* leaflets of corbula; *b, b,* gonangia; *c,* ramulus which supports the leaflets; *d,* a hydrotheca.

F. Separate leaflet from mature corbula: *a,* continuation of the cavity of the supporting ramulus into the leaflet, where it divides into two branches, *b, b*; *c,* nematophores, forming tooth-like processes on the distal edge of the leaflet; *d,* imperfectly developed tooth-like processes on the proximal edge; *e,* imperfect septum partially dividing the cavity of the leaflet.

G. Gonangium from mature corbula: *a,* continuation of somatic cavity into gonangium; *b,* blastostyle partially suppressed by the enlarging gonophore; *c,* gonophore; *d,* spadix; *f,* ovum; *g,* chitinous wall of gonangium.

bulæ are not here actually suppressed, but remain of somewhat smaller size, affording the clue to the morphology of the entire organ; and it can be plainly seen that it is the mesial nematophore of each of these arrested hydrothecæ which has become enormously developed and flattened out so as to form the leaflet of the corbula-walls, while at the same time it becomes complicated by carrying along one edge a row of small tooth-like nematophores, as in the corbula-leaflet of *Aglaophenia pluma* &c. The hydrothecæ, with their nematophores, which in the untransformed ramulus constitute a single series along the front of the ramulus, are, in order to form the walls of the corbula, thrown alternately from side to side.

If these views be accepted, we shall have nearly the entire graptolite in those instances in which the appendages of Hall have been noticed converted into a corbula, a state of things which naturally follows from the simple unbranched form of the fossil. The graptolite has, in fact, become greatly changed in form, and modified for a special reproductive function in a way which reminds us of the so-called fertile fronds of certain ferns as distinguished from the so-called sterile fronds.

It is true that the great rarity of these peculiarly modified graptolites is opposed to what we know of living hydroids; for among these we are not acquainted with a single trophosome which we are not justified in believing destined at some period of its life to develope a gonosome. A case, however, bearing some analogy to that of the graptolites would be afforded by fossil ferns; for we know how rare a thing it is to find, among the vast multitudes of individuals with which the coal-measures abound, specimens bearing fructification.

While the graptolites would thus seem to contrast with living hydroids in their rarely developing a gonosome, it is interesting to see them contrasting also in another respect—namely, in their free if not floating habit. And here we are reminded of the gulf-weed of the Sargasso sea; for, throughout the thousands of square miles over which the floating meadows of this remarkable plant extend, no one has yet succeeded in finding a single specimen in fructification, though the fructification of closely allied species, which grow attached to rocks like ordinary seaweeds and like the rooted trophosomes of the hydroids, is well known.

Certain bodies found associated with graptolites in the Silurian shales of Dumfriesshire have been described by Dr. Nicholson, who regards them as the "ovarian vesicles" of the graptolites, and as proving the hydroid nature of these fossils*.

* Nicholson, in 'Geological Magazine,' vol. iv. 1867, p. 259, pl. 2.

He describes them as "oval, bell-shaped, pyriform, or rounded, provided with a mucro at one extremity, and surrounded entirely by a filiform border, resembling in texture the axis of a graptolite." They attain a length of nearly half an inch.

He has found them not only free, but in many cases attached to the graptolite, not, however, to any constant point; for some spring "from the common canal, others from the apex of a cellule, and others from the under surface of a cellule, the last two modes being the most frequent."

The largest of these capsules which he has seen attached did not measure more than a tenth of an inch in diameter; and Dr. Nicholson believes that at this stage they become detached, and then attain the large size he has observed in the specimens found free in the shale; for he has there found them in all stages of growth, from small rounded bodies, not larger than a pin's head, to bodies nearly half an inch in length.

Whatever these bodies may be, it is plain that Dr. Nicholson's account of them is irreconcilable with the supposition that they represent either the gonangia or the gonophores of a hydroid; for, apart from their supposed development after detachment from the colony, their origin from the walls of the denticle is alone decisive on this point. Indeed their connexion with the graptolite appears to be purely accidental.

Hall has called attention to the occurrence, in the same beds which contain the graptolites, of minute free bodies which he regards as the young or "germs" of the graptolites*. In their earliest form they would appear to consist of a little chitinous oblong sac traversed longitudinally by a slender chitinous filament, which is continued for a little way at both ends beyond the sac, while at one end it is accompanied by two minute lateral spine-like processes.

This early form has been traced through more advanced stages, in which it has been seen to become more and more elongated, to develope denticles along its length, and finally to attain a form in all essential points identical with that of an adult graptolite.

Others, slightly differing in shape from those described by Hall, have been also obtained. Indeed these young graptolites (for there is little doubt that Hall is right in so regarding them) are now well known. They are by no means uncommon in graptolitic shales, in some examples of which I have seen them abounding in countless multitudes.

Hall believes that he finds evidence of their having been contained within the so-called reproductive vesicles of the

* Hall, *op. cit.* p. 33, pl. B. figs. 12–19.

graptolite. From his account of their relation to these, however, I can recognize nothing but accidental proximity; while if we admit that he has grounds for this belief, we should then have, in the advancement of the embryo to a stage in which it has become covered by a chitinous perisarc previously to liberation, a state of things quite at variance with all we know of the reproductive phenomena of living hydroids.

It is not improbable, however, that these graptolite "germs" of Hall are free zooids rather than true embryos, and that they had been originally thrown off by a process of non-sexual reproduction from some part of the living graptolite in a manner which reminds us of somewhat analogous bodies which I have elsewhere described as becoming detached from true hydroids in the case of *Schizocladium* and of *Corymorpha*. As we descend through the great biological groups it is no uncommon thing to find the faculty of agamic reproduction becoming intensified, until in the lowest members of the group we see it (as in the case of the gulf-weed already referred to) taking more or less the place of true sexual generation.

But little requires to be said regarding other views which have been from time to time advanced as to the affinities of graptolites.

Their alleged polyzoal affinities, however, have some claim on our acceptance. Indeed, were it not for the discovery of the probable graptolite gonosome (corbulæ?), we should have nearly as much to say for this view as for that which would refer them to the Hydroida, more especially as the discovery of *Rhabdopleura* renders us acquainted with a polyzöon in whose test is developed a chitinous rod in almost all respects like that of the graptolites*.

On the whole, then, it would seem that the graptolites constitute a very aberrant hydrozoal group having manifest affinity with the Hydroida, to which they are connected by the nematophore-bearing genera of the latter, while they have also important points of connexion with the Rhizopoda. The undoubted members of this group are further characterized in an eminent way by the possession of a solid supporting rod; and it is this feature which has suggested to me the name of Rhabdophora, by which I have proposed to designate them.

* The comparison of the rod of *Rhabdopleura* with that of a graptolite has already been made by Dr. Nicholson ('Manual of Zoology'), though he adopts the more generally accepted view which finds hydrozoal rather than polyzoal affinities in the graptolites.

XXXIX.—*Description of three new Species of* Eremias. By Dr. A. Günther.

Eremias nitida.

Snout not much produced or depressed, not much longer than the cleft of the orbit. *Eyelid scaly.* The labial margin of the suborbital shield is not longer than the preceding upper labial. Ventral scutes in six longitudinal and twenty-six transverse series. A brown longitudinal band along the back, separated by a brownish-red line from the black lateral band. Sides from behind the eye deep black, with two parallel white lines proceeding from the eye, the upper above the tympanum, the lower passing through its lower part. Tail and limbs uniform brownish. Lower parts white.

West Africa. Two specimens; the body of the larger is 40 millims. long, its tail being 90 millims.

Eremias Spekii.

Snout rather produced and pointed. *Eyelid scaly. All the shields on the upper surface of the head ornamented by deep grooves.* Supraorbitals with a few small scales in front and behind. The labial margin of the suborbital shield not longer than the preceding upper labial. Vertical narrowest and truncated posteriorly. Ventral scutes in six longitudinal and thirty transverse series. Dorsal scales very small, but each with an oblique keel. Brownish, with three white longitudinal lines on the back, and sometimes with another rather irregular one along the side. Short black cross bars between the white lines.

Two specimens were obtained by the late Capt. Speke in 5° 7′ S. lat., between the coast and Unyamuezi. The body of the larger is 53 millims. long (without tail).

Eremias Fordii.

Allied to *E. Knoxii.*

Snout pointed, moderately produced. *Eyelid scaly.* Anterior frontal not in contact with the rostral; generally an azygos shield between the posterior frontals. Vertical narrow and truncated behind; a series of granules between the supraciliaries and supraorbitals. *The infraorbital does not enter the labial margin, and is situated above the fifth, sixth, and seventh supralabials.* Dorsal scales very small, each with an oblique keel. Ventral scutes in twelve longitudinal and twenty-nine transverse series. Præanal scales rather large. Toes distinctly serrated behind. Brownish, with black spots, which are arranged in longitudinal bands, one on each side of the back being the broadest, and including round whitish ocelli. A narrow black median band is generally limited to the nuchal region, rarely extending to the end of the trunk.

Cape Colony. Several specimens from Sir A. Smith's collection. The body of the largest is 63 millims. long.

XL.—*Note on* Trionyx gangeticus, *Cuvier, and* Trionyx hurum, *B. Hamilton.* By John Anderson, M.D., Calcutta.

Having examined forty-five living specimens of a *Trionyx* the young and adolescent individuals of which agree in their form and coloration with the figure given in Hardwicke and Gray's 'Illustrations of Indian Zoology' as *Trionyx javanicus*, Schw., and having removed the skulls and compared them with Cuvier's figure of *T. gangeticus*, I do not hesitate to refer them to one and the same species, i. e. *T. gangeticus*, Cuvier; the adult skulls in form and size agree with the skull figured by Dr. Gray as *T. gangeticus*, Cuvier; whereas, on the other hand, the *Trionyx hurum* and *T. ocellatus* of Dr. Gray (that is, specimens corresponding exactly with these drawings, which Dr. Gray afterwards referred to the *T. gangeticus* of Cuvier) yield skulls quite distinct from Cuvier's figure of the skull which he regarded as the *Trionyx du Gange*! The true *Trionyx gangeticus*, Cuv., is therefore the species which has hitherto gone under the name of *T. javanicus*, Schw., if by the latter were meant *Trionyches* agreeing with the figure so named in the 'Illustrations of Indian Zoology.' The skulls, however, of such forms, as they answer in every detail to Cuvier's figure, could not well be referred to any other species; so we have here another instance of a Chelonian animal as a whole having a specific geographical name allocated to it, while its dismembered skull has awarded to it another but kindred term. The cause of this unfortunate jumble of names as applied to the *Trionyx* of the Ganges, and each of which implies a distinct theory as to its distribution, is not difficult to explain, so long as animals are described, as in this case, from drawings, without any practical knowledge of the structural characters of the animal itself.

One hundred and twenty examples, living specimens, shells, and sterna, of the common *Trionyx* of the Ganges have passed through my hands; but in collecting them I succeeded in obtaining only two individuals agreeing with Dr. Gray's figures of *T. hurum* and *T. ocellatus*. The abundance, therefore, of the former indicates the propriety that, in one sense, exists in the name given to it by Cuvier. Specimens agreeing with the last-mentioned figures yield skulls in no way resembling the skull figured by Cuvier as *T. gangeticus*. The head-coloration of the specimens yielding skulls identical with the skull figured by Cuvier is very characteristic and uniform, except in very old individuals. The upper surface of the head is uniformly greenish olive, and there is a black line running from between the eyes to the nape, with three pairs of divergent stripes on either side of it directed downwards and backwards. There is no yellowish temporal spot, nor any band across the nose. Young individuals with these characters have greenish-olive shells vermiculated with fine black lines; and of the large series of specimens that have come under my observation, not one has presented any trace of ocelli. The only change that occurs in the coloration of the adult is that the lines on the head become more or less broken up, and the vermiculations on the shell all but disappear. On the other hand, about twenty specimens of *Trionyx* with the yellow spot on the temporal region, and another at the angle of the mouth, with a yellow band across the snout, and with the surface of the head marbled with reticulated black lines over a ground-colour varying in the intensity of its yellow hue, and with the upper shell marked usually with four ocelli, which disappear with age, but of which generally faint traces can be detected in the form of dark spots, have, as I have already stated, skulls quite distinct from Cuvier's *T. gangeticus*. I propose therefore to retain provisionally for this last-mentioned form Dr. Buchanan Hamilton's name of *T. hurum*, and for the former *T. gangeticus*, Cuvier.

Dr. Günther*, in writing of the *T. javanicus*, Schweigger, as identified by Gray, observes, "that the characteristic markings of the head of the continental specimens are not mentioned in descriptions of Javan individuals, so that both may be specifically different." Now, however, that *T. javanicus* of Gray seems unquestionably to be *T. gangeticus* of Cuvier, may it not be that the "*T. gangeticus*, Cuvier" of Gray may prove to be *T. javanicus*, Schweigger. I have never seen *T. javanicus* in the flesh, nor am I acquainted with its skull; so that I only throw this out as a suggestion.

The skull of *T. gangeticus*, Cuv., as I have now indicated the species, differs from the form I provisionally designate *T. hurum* in its broader and shorter snout—two characters which also distinguish the heads in life. But I shall elsewhere illustrate and describe the two skulls in detail, the sterna, and sexual characters.

The foregoing identification is an important one, as it opens the way to a more satisfactory understanding of a group by clearing away a load of synonyms.

* Reptiles of British India, p. 48.

XLI.—*Investigations upon the Structure and Natural History of the* Vorticellæ. By Dr. Richard Greef.

[Continued from p. 211.]

Body-cavity and Digestive Organs of the Vorticellæ.

We are indebted to Ehrenberg for the first correct notion of the nutritive apparatus of the Vorticellæ. Whilst, before his time, as has already been remarked, it was supposed that the body of these animals constituted a hollow bell open anteriorly, he showed that the anterior opening of the bell was closed by a ciliated disk, and that it was only behind this disk that a lateral orifice led into the interior of the body. He likewise correctly determined the position of the anus as an orifice separate from the mouth but lying in the same pit, which, as we have already remarked, must be regarded as an essential systematic character of the Vorticellan family. The mouth and anus were said to be united by a curved intestine hanging down to the bottom of the body; and to this, in accordance with his conception of the polygastric nutritive system of the Infusoria, the stomachal vesicles were supposed to be appended by small lateral cæca.

After the refutation of the polygastric nutritive system, especially by the striking observation of the constant circulation of the whole contents of the body in *Paramecium* (Focke), the knowledge of the digestive apparatus of the Vorticellæ made an important advance by means of the researches of C. F. J. Lachmann (of whose labours science was unfortunately so early deprived), whose beautiful and careful investigations form to a certain extent a new starting-point in the examination of the entire structure and natural history of these animalcules.

Lachmann showed that the cilia upon the ciliated disk are not placed in circles, as Stein stated, but run in a spiral line to the mouth, which, indeed, Ehrenberg had already distinctly seen, as appears from many figures in his great work on the Infusoria (*e. g.* Taf. xxv. fig. ii., Taf. xxviii. fig. iii. 3, 2 &c.). But to Lachmann's observations we are indebted for the exact determination of the course of the series of cilia, which commences on the right from the external aperture of the nutritive tube, previously called the buccal orifice, runs round the ciliated disk once or several times, and then descends in a curve intc the above-mentioned orifice and traverses the first part of the nutritive tube. This commencing portion he called the *vestibulum*, after the example of Johannes Müller. The vestibulum consequently forms a part of the ciliary spiral, and cannot well be regarded as the œsophagus or as a part of the food-tube, seeing that the anus also opens into it. The mouth therefore only commences at the end of the vestibulum, near the anus, which is situated in the same cavity. From the mouth, a short tube (the œsophagus) leads to the somewhat spindle-shaped terminal part of the nutritive tube, which is characterized as the *pharynx.* The nutritive particles attracted and carried into the above-described canal by the ciliary current collect in the first place in the pharynx into a morsel, which, when it has attained a certain size, is forced into the interior of the body, and here driven about with the soft gelatinous contents until it is either entirely digested or removed again to the exterior through the anus.

Lachmann made a particularly careful investigation of the question whether the pharynx is really the terminal part of the nutritive tube, or whether there issues from it a wider canal which receives the morsels from the pharynx, carries them forward for a certain distance in a curved direction (as appearances would seem to indicate), and only then passes them into the interior of the body; but he finally decides in favour of the entire absence of any further canaliform structure.

Lachmann, then, regards the whole inner space enclosed by the cuticula and the cortical layer as a *great digestive cavity* or stomach, and the mass of contents rotating in it as *chyme.* This is of great importance for the view which we have hereafter to expound.

With regard to the behaviour of the ciliary spiral above described and its relation to the vestibulum, as also with regard to the further course and mode of termination of the nutritive canal, Stein has completely accepted Lachmann's views. On the other hand, however, he, and with him many others, has expressed himself most decidedly in opposition to the conception of the interior space of the body as a digestive cavity and of its contents as chyme, inasmuch as he denies the existence of both the body-cavity and of the chyme filling it. He endeavours rather to reestablish the opinion that the whole contents are to be regarded as contractile sarcode, supporting himself chiefly upon the supposition that the limits of the body-cavity are not determinable, as the outer (cortical) parenchyma passes quite gradually into the interior parenchyma, and is intimately united with it at all points.

If we first of all take up what is certainly the most important question, namely that of the existence of a digestive body-cavity, which has been answered so differently by the two investigators, I will declare at once that my investigations have led me quite unavoidably to Lachmann's opinion, and that I cannot admit the arguments brought against it by Stein.

In the preceding section we have endeavoured to prove that the external coverings of the body which enclose the interior space consist of three different parts, namely the *external cuticula*, the *muscles* lying beneath this, and the *cortical layer* following upon these. Although with respect to what in the Vorticellæ and the Infusoria in general is to be regarded as cuticula or as muscles, and with respect to the relations of these two parts, we have been compelled to express opinions in some points at variance with those of Stein, we are nevertheless in general in agreement with him in regard to the actual existence of the cuticula and muscular fibres as separate parts. We have here therefore to do chiefly with the existence and interpretation of the *cortical layer*, especially in its relations to the interior space and its contents.

If we examine a living Vorticellan carefully and for a long time (for which purpose, of course, the species of *Epistylis* are best adapted, as with them we are not disturbed in observation, as with the contractile-stalked Vorticellans, by constantly repeated and sudden contractions causing the continual disappearance of the object), one of the most remarkable of phenomena very soon strikes us—namely, that apparently the whole mass of the contents of the body *is engaged in constant rotatory movement*. This is the rotation-current first observed by Focke and then by others in *Paramecium* and other Infusoria, and also by Lachmann in the Vorticellæ, which must so far be regarded as a discovery of importance, that it furnishes us with the clearest evidence against the nutritive apparatus ascribed by Ehrenberg to the Infusoria. The actuality of this rotation-current itself cannot be doubted; it is one of the constant and normal vital manifestations of the Infusoria in question. It is by no means, as Ehrenberg endeavours to establish for the further support of his system, a pathological phenomenon produced by pressure, displacement of the contents, &c. It is observed under all circumstances in the living animal, even when not the smallest altering influence, such as pressure &c., exists; and it may be most easily and distinctly recognized when the contents of the body are coloured, or when for this purpose a colour-diet (carmine) has been administered to the animals.

Epistylis flavicans, which has already repeatedly been referred to, is one of those species of *Epistylis* which are generally more or less intensely coloured yellow or yellowish brown by nature, and also one of the larger species; and in it, for other reasons also, the phenomenon now under discussion may be very well followed in all its details, for which reason, in what follows, we shall chiefly take it as the foundation of our observations. If we carefully examine the movement of rotation in *E. flavicans*, we find that this movement does not occur, as at first sight appeared, in all parts of the interior of the body. *The entire conical hinder part of the body, from the attachment of the peduncle nearly to the point where the bellied curve of the bell commences, takes no part in the movement* (Pl. XVI. fig. 1). This part also is not coloured, but hyaline, and only occupied by a few dimly shining granules; hence it is strikingly differentiated from the coloured contents of the bellied part of the bell (Pl. XV. figs. 1 & 18). One sees most clearly how the circulating mass of contents *flows past the inner wall of this conical hinder part without any portions of the latter being carried away by the current.* Evidently there is here a fixed boundary between the constantly mobile fluid contents and a firmer wall-parenchyma, which in the first place fills the whole conical base of the Vorticellan body, but from this rises like a cup on the lateral walls and lines the inner surface of the cutaneous covering above described, presenting everywhere a sharp boundary to the fluid contents of the body.

Of this also we may convince ourselves by observation, by carefully tracing the movement of rotation from the base through the cavity of the bell. It is clear from this that there can no longer be any question of a gradual transition of the fluid body-contents into the firm parenchyma of the walls, of an amalgamation of the whole into a common sarcode or protoplasm filling the body as a parenchyma; for the *rotation becomes brisker and more regular the further out it is*, and passes everywhere *with a sharp boundary by the inner walls of the circumference of the body.* If the contents gradually acquired more consistence and tenacity outwards, and became amalgamated here with the firmer cortical layer, which also, although reluctantly, would be drawn into the rotation, the movement must gradually diminish exteriorly. But precisely the reverse takes place, as already remarked. Moreover, if the cortical layer really rotated with the rest, how should we explain the fact that the contractile vesicle, the nucleus, the first part of the nutritive tube (vestibulum and œsophagus), the muscles, &c. are nevertheless still maintained in their definite position? Must not they also be carried away and thus continually change their position? Or we must assume that these organs are not situated in the cortical layer, but within the cuticula. But they lie, as may be most easily ascertained, beneath the cuticula and in the cortical layer, and are probably not at all in contact with the former. In Rhizopoda, which Stein adduces as objects of comparison and in support of his view, and especially in *Amœbæ*, such a differentiation into a firm, limited cortical layer and an inner space has not yet been evolved, nay in many cases even an outer skin cannot be demonstrated; in these, however, the organs of the body have not yet found any definite position, but they are driven about in the interior with the mass of contents. Nevertheless I am far from supposing the whole Amœban body, especially in the large, independent, infusorium-like *Amœbæ*, to consist of a simple homogeneous protoplasm; but no doubt, as I hope to demonstrate more completely on another occasion, we have here to distinguish various substances and structures differing from each other in form and vital manifestation. Far less can we declare that an animal body comparatively so highly organized as that we have before us in the Vorticellæ, consists of mere protoplasm. Might we not, with almost equal justice, refer a great part of the Cœlenterata, Vermes, &c. to the rank of protoplasmic creatures?

It is sufficient that the observations cited determine me to accept for the Vorticellan body a *cortical layer* situated under the cuticula and not rotating with the rest of the contents, embracing within, with a firm boundary, a space, the *body-cavity*, which therefore, as, according to what has been stated, the wedge-shaped hinder part of the Vorticellan body is filled with the firm cortical parenchyma, has a shape like that of a cup or finger-stall.

The contents of the body-cavity consist of a thinly fluid paste of incepted or more or less dissolved nutriment, *i. e.* of *chyme*, which, by the constant accession of fresh nourishment and water from without through the mouth, and by giving off exhausted material through the anus, is engaged in continual change. In the interior of the body-cavity this nutritive paste circulates constantly, as has been already fully described; and by this means the fine division and chymification (in other words, *the digestion* of the nutritive substances on the one hand, and on the other their diffusion through the whole body) are assisted. In the body-cavity of the Vorticellæ we consequently see a *gastrovascular space*, in the full sense of the words—a body-cavity in which digestion and circulation, *i. e.* nutrition, is effected in precisely the same way as in the Cœlenterata.

By no means can this paste be regarded as "consisting throughout of mere sarcode," as Stein mantains very decidedly in favour of the protoplasm-theory. Leaving out of consideration that such a universalization of protoplasm would lead us to remote and obscure paths, as was the case formerly by Dujardin's means, unprejudiced and careful observation is in this point also strongly opposed to any such conception. And according to this, the chyme when already elaborated into a homogeneous granular substance (or, to anticipate no opinions, the fundamental substance of the circulating paste) is not at all sarcode or protoplasm in the sense applied to the term by authors. For the movement of rotation, as careful examination shows, is not that of a tenacious, contractile substance; it does not manifest itself after the fashion of the amœboid, slowly creeping protoplasmic streams with which we are elsewhere aquainted, but it progresses everywhere easily and briskly, sometimes even with a *slightly tremulous* current, through the inner space. But how is this to be brought into agreement with the phenomena of motion which we are always accustomed to witness in the tenacious contractile protoplasm, and which must be regarded as characteristic of the latter. Is not the vibrating movement rather a proof that it is performed by a readily flowing, non-contractile substance, *i. e.* precisely not by protoplasm? Moreover, we must here again call attention to the phenomenon already insisted on in the examination of the cortical layer surrounding the body-cavity, according to which the current is briskest at the outer walls.

Stein requires also, as evidence of a body-cavity, that this, when its contents are evacuated, must also appear as an empty cavity. If we could effect a transverse section through the body of a Vorticellan (which, however, does not seem possible, considering the minuteness and delicacy of the object), we should, I have no doubt, be able to bring the body-cavity under direct observation; but even the examination of the uninjured living animal satisfies this requirement. Thus, if we isolate for a time in clear water, upon a glass slide or in a watch-glass, a newly captured Vorticellan with its bell distended with food, we may see how the food-balls are ejected one after the other. The body gradually becomes paler and more elongated; the walls acquire folds; and after the lapse of a certain time the well-fed convex Vorticellan becomes a slim collapsed animalcule, the integuments of which sink here and there into the evacuated stomachal cavity in deep folds and sinuosities.

But, instead of food, water is now taken up through the nutritive tube; and according as the access of this is abundant or scanty, the body-cavity becomes filled out or not so completely collapsed as above indicated. At the same time, however, the remarkable phenomenon which is very characteristic in the question now before us makes its appearance—namely, that the movement of the contents is much brisker than before, and may generally be recognized in a distinct vibrating current of the form-constituents still mixed with the water.

These form-constituents, which remain after the removal of the larger food-balls, are, moreover, in some species, of very constant form and size: for example, in *Epistylis flavicans* they consist of shining, light-yellow spherules, of which usually three or four, but often several, are massed together into comparatively large balls (Pl. XV. fig. 5), so that one is induced to regard the whole of the fluid, now freed from the coarser, still undissolved or insoluble nutritive materials, as the blood or chyle mixed with water.

The preceding observations and indications may for the present suffice for the establishment of my assumption of a digestive body-cavity in the Vorticellæ; and we now come to the second of the questions raised above, namely the nature of the alimentary tube leading into this digestive cavity. As has been already remarked, the correct position of the external orifice of the nutritive tube described by him as the mouth, as also the position of the anus, was first recognized by Ehrenberg. According to him the rounded buccal aperture lies directly behind the ciliated disk, and the anus in a pit in the initial portion of the nutritive canal which enters the body. Stein showed further that this buccal opening is situated between the ciliated disk and the peristome, and that from this point the nutritive tube, distinguished by him into pharynx and œsophagus, hangs down into the body. The food-balls were supposed to be pushed through the œsophagus into the parenchyma of the body, and in most cases the exhausted food to be carried back again in the same way. The most accurate description of the nutritive apparatus of the Vorticellæ was given by Lachmann*. He found that the cilia upon the anterior disk of the body took a spiral course, and, indeed, that in *Carchesium polypinum*, for example, this ciliary spiral commenced to the right of the external nutritive aperture called the mouth by Ehrenberg and Stein, and then turned away to the left over the latter and ran round the margin of the circular disk, to sink again at last into the buccal aperture and into the first portion of the alimentary canal (see Pl. XIV. fig. 9). At the bottom of this first portion (as Ehrenberg had already discovered) the anus was situated, for which reason the mouth in reality could only commence here. The initial portion, situated before this point, and including Ehrenberg's buccal aperture, was therefore described, after the example of Johannes Müller, as the porch of the digestive apparatus, the *vestibulum*. The vestibulum was continued into a thinner, short tube, the *œsophagus*, and terminated in a somewhat wider, spindle-shaped part, which was called the *pharynx*, through which the par-

* Müller's Archiv, 1856, p. 340.

ticles of food fall directly in balls into the soft parenchyma of the body. Stein* afterwards confirmed Lachmann's observations, and also on the whole adopted the designations chosen by him for the different parts of the digestive apparatus, the only alteration being that he includes the two parts distinguished as œsophagus and pharynx under the latter name, as he cannot distinguish Lachmann's pharynx from the preceding tube, called the œsophagus, by any, even functional separation. Both authors agree that there is no further canaliform continuation of the alimentary tube from the posteriorly pointed end of the pharynx, but that the alimentary materials accumulate in the latter, and afterwards sink into the parenchyma of the body which divides in an arched form.

I must, in the first place, express my entire concordance with the observations of Stein and Lachmann as regards the ciliary spiral and the vestibulum in *Carchesium polypinum* and many others, especially of the smaller species of Vorticellæ (see Pl. XIV. fig. 9, in which the course of the ciliary spiral and its relation to the vestibulum &c. in *Carchesium polypinum* is shown). But in the larger species of *Epistylis* there is so far a deviation from this, that here the spiral is not confined to a single turn, but describes several turns upon the ciliated disk before sinking into the vestibulum ; to this, indeed, Lachmann has already called attention. A multiple circle of cilia of this kind occurs, for example, in our *Epistylis flavicans.* In this Vorticellan, moreover, the digestive apparatus appears with so distinct and in part peculiar an arrangement, that we will once more adhere to it in the investigation of this question also. In *Epistylis flavicans* the anterior ciliated disk bears four circles of cilia (Stein and Lachmann state three), which apparently lie concentrically around one another. Easy as it is in many species of Vorticellans (*Carchesium polypinum*, *Epistylis plicatilis* and *parasitica*, *Zoothamnium alternans*, &c.) to detect the spiral course and the final bending into the vestibulum of the series of cilia, it is just as difficult in *Epistylis flavicans*, probably chiefly because in this the so-called "peduncle" of the ciliary organ is deficient. The peristome seems rather to come directly against the ciliated disk as a thin border turned back when the bell is fully opened, without being separated from the disk, as in most Vorticellæ, by that deep furrow from within which the "cap-like" ciliary organ rises. The external aperture of the alimentary canal therefore, so far as I have as yet been able to see, is situated not merely behind the ciliated disk, but also, differently from the other Vorticellæ,

* Der Organismus der Infusionsthiere, ii. pp. 84 *et seqq.*

behind the peristome (Pl. XVI. fig. 1, and Pl. XV. fig. 5, *ff*). Fromt his aperture (Pl. XVI. figs. 1 & 2, *m ff*) a tolerably wide canal runs inwards directly behind the ciliated disk and parallel to its plane; it then makes a knee-like bend (Pl. XVI. fig. 1, *h*) and, gradually becoming narrower, runs again to the buccal (ventral) side and then backwards, describing in its course two or three more slight curves. As far as the knee-like bend, according to Lachmann, the initial part of the alimentary canal, the so-called vestibulum, extends. At the bottom of the cavity of this knee, behind a long bristle which traverses the whole initial portion of the alimentary canal and projects from the external aperture (Pl. XVI. fig. 2, *ff*) the *anus* is situated (fig. 2, *h*); and here, therefore, according to Lachmann, the mouth should begin.

This determination of the buccal and anal apertures and of the initial portion of the alimentary tube as the vestibulum, has certainly some justice on its side; but in my opinion it would render the whole conception of the alimentary canal simpler if we were to retain the designation mouth for the external aperture. That the anus opens into this initial portion of the alimentary canal, and that consequently the external aperture serves at once for the introduction of food and for the evacuation of exhausted materials, need not prevent our designating it as the buccal aperture. We find precisely similar conditions in all Cœlenterata and in many Echinoderms and worms, in which a special anus opening outwardly cannot be detected. Must we not in this case, for example, characterize the alimentary sac of the Anthozoa also as a vestibulum, and place the aperture of the mouth at its open posterior end, as here also the true orifice of ejection begins (that is to say, it opens into this initial part of the alimentary canal)? Moreover, if we admit in designation and conception that this vestibulum is to be regarded as the *initial part of the alimentary canal*, we need not hesitate to accept the beginning of this initial part, *i. e.* its external aperture, as the *buccal aperture*. At any rate by this means the whole conception of the alimentary canal, and especially its description and terminology, would be materially facilitated and simplified. Lachmann's *vestibulum* would then, as formerly, be designated the *pharynx*; and in this we are justified by a peculiar arrangement which exists in the kneed cavity of the end of this pharynx. Thus we see distinctly that the particles of food, driven into the mouth by the ciliary current, first of all reach this point, and are then carried either back again and out through the mouth or into the following section of the alimentary canal. To effect this there are, in *Epistylis flavi-*

cans, *two valve-like partitions* (Pl. XVI. fig. 2, *k* & *k'*), which occur in the posterior cavity of the œsophagus, the true pharynx, and which, aided by the corresponding ciliation, determine the direction of the two opposite currents.

From the œsophagus, or, if it be preferred, the vestibulum, the alimentary canal is continued as already described, making a curve and running, backwards and towards the ventral side, in a tube furnished with proper walls and gradually becoming narrower, which then finally, according to observations up to this time, passes into a portion which is a little widened anteriorly and pointed posteriorly, and here terminates. In this terminal portion the food driven by the ciliary current into the digestive apparatus, is collected into a ball, and then pushed directly into the parenchyma of the body. This part of the alimentary apparatus from the issue of the vestibulum (*i. e.* from the inner buccal opening) to the spindle-shaped terminal portion, was called by Lachmann the œsophagus, and only the terminal portion itself the pharynx; whilst Stein names the whole from the vestibulum, and therefore both the œsophagus and pharynx of Lachmann, the pharynx. According to the above statements with regard to the desirability of the denomination "vestibulum" for the initial portion, if we should give the name of pharynx to this latter, the above-described terminal portion must of course be regarded as the œsophagus.

But let this be as it may (as in it we have to do rather with a more or less desirable conception and terminology than with actual observation), the results of investigations up to this time all agree to show that behind this spindle-shaped dilatation of the pharynx or œsophagus there is no trace of special food-passages, but that the digestive canal here fully comes to an end.

Nevertheless, notwithstanding the careful investigations of Lachmann and Stein relating to this point, I must affirm, from my own observations, that, at least in *Epistylis flavicans*, this supposed terminal portion is really continued for a considerable distance further into the body-cavity as a closed canal with proper walls.

Of this we may convince ourselves in two ways:—first, by the direct observation of the canal in question within the body-cavity, nay, even by isolating it; and secondly, by subjecting the animal to a colour-diet, so as to trace the course taken by the coloured (*i. e.* the food) particles. Let us first of all take up the former as the direct and most certain course, and employ the second, which has been already so often tried and which so easily leads to delusions, only for the completion of our researches.

When a colony of *Epistylis flavicans* has been kept for a time isolated in clear water, the food-balls circulating in the body-cavity are all, as already stated, gradually expelled through the anus. By this means the animals, which are otherwise of a yellow or yellowish-brown colour, become paler and more transparent, and render it possible to get a better insight into the interior space of the body. When a Vorticellan thus prepared is examined under careful compression and in a suitable position, we see clearly in the first place the course of the whole of the above-described alimentary apparatus from the buccal aperture (Pl. XVI. figs. 1 & 2, *m*), through the vestibulum (pharynx) and the œsophagus (figs. 1 & 2, *o*), to the spindle-shaped terminal portion (*v*), and at the same time that the whole of this passage is clothed with briskly striking although comparatively few cilia. The end of this canal, however, the spindle-shaped dilatation which has been repeatedly mentioned, is, in *Epistylis flavicans*, not as represented by Lachmann and Stein and as appears to be the case in most other Vorticellæ, a simple continuation of the canal preceding it (the œsophagus), but it presents itself as a *bellied funnel distinctly marked off* from the latter (Pl. XVI. figs. 1 & 2, *v*), which embraces the end of the canal opening into it, and the posteriorly directed point of which, as may be most distinctly seen under favourable circumstances, passes into a *fine canal* (figs. 1 & 2, *d*), which describes a broad curve in the bottom of the body-cavity and suddenly breaks off, *i. e.* opens freely into the body-cavity, on the side opposite to the funnel and about at the level of its commencement. The whole canal, from the point of the funnel to its termination, when not dilated by nutritive material or water, is more or less collapsed, and consequently, in this state, appears as a clear curved line or fine streak. Sometimes by carefully and gradually compressing the body until it is crushed, at the same time keeping the clear curved line uninterruptedly in view, we may succeed in recognizing and tracing it for a certain distance in the effluent contents, which are quite out of their natural position. This phenomenon, however, which is therefore to a certain extent equivalent to an isolation of the part under consideration, is, I think, decisive, as it can only be explained by the presence of an actual canal.

After this direct observation, which may certainly often be attended with great difficulties and by frequent failure, with much loss of time caused by constant repetitions, we may confirm and complete the picture thus obtained in the most beautiful manner by administering a carmine diet to our animalcules, but at the same time meet with new difficulties in the way of this conception.

We see, in the first place, how the particles of carmine are carried by the circles of cilia of the ciliated disk towards the external aperture of the alimentary canal (buccal aperture) situated on the margin of the peristome (Pl. XVI. fig. 1, *m*), and here, for the most part, again thrown back in an eddy towards the opposite side, whilst only a comparatively small quantity passes into the vestibulum (pharynx). But even of these last most of the particles are again expelled from the deeply excavated bottom of the vestibulum, in which process the above-described valve-like partitions in the cavity of the vestibulum (pharynx) conduct the two opposite currents. (See Pl. XVI. fig. 2, in which the arrows indicate the different directions of the currents caused by the partitions (*k* & *k'*) and the ciliation.)

Those coloured particles which have freely passed the vestibulum are now generally rapidly forwarded through the canal which follows (figs. 1, 2, *o*), by means of the cilia which work briskly within it, fall into the funnel (*v*) and here stop, until this receptacle is gradually completely filled with coloured material. At the same time, however, water is of course carried in through the alimentary tube, so that the ball of coloured material appears to be surrounded by a hyaline vesicle. When the cavity of the funnel is more or less tightly filled, its point, which is directed backwards, opens sooner or later (sometimes when only a small quantity of coloured material has accumulated, and then perhaps by the pressure of the water); and then the whole of its contents, in the form of an elongated spindle-shaped morsel, glides at first backwards to the bottom of the body-cavity (Pl. XVI. fig. 1, *b*, *b*), to turn forward again in a curve about to the level of its point of issue. On its arrival here we see a small button suddenly make its appearance (fig. 1, *b'*) on the anterior pointed end of the little coloured body; and immediately afterwards the whole morsel coalesces into a spherical ball. During its whole course, the lumen of the canal, opening in front and closing up behind it, may be very distinctly traced. It is well worthy of notice, in connexion with the whole process, that the velocity with which the spindle-shaped corpuscles of coloured material glide over the course just described is quite different from that of the movement of the rotating nutritive jelly (*i.e.* it is much greater, and uniform throughout), and that this velocity ceases suddenly and indeed at the very moment when the morsel coalesces into a spherical ball in the manner described above. The coloured ball now lies evidently imbedded in the nutritive jelly of the body-cavity, at first still surrounded by a hyaline cyst (water), and is then slowly carried along with this nutritive jelly.

The change of form and movement of the coloured corpuscles is so remarkable and sudden that it cannot be explained except by the existence of a curved canal starting from the apex of the funnel. This is especially evident at the moment when the elongated, pointed, and rapidly gliding morsel suddenly stops, projects with a little knob from the narrow canal, and then apparently falls immediately from it and into the body-cavity. It is not to be imagined that the described phenomena could be produced by the balls of coloured material being pushed directly from the funnel without the intervention of any canal into the nutritive jelly of the body-cavity, especially as frequently one morsel after another traverses precisely the same curve in the same compressed spindle-shape, the whole course being often even beset with carmine particles arranged in a row, so that they shine forth from the interior like a red curved line. Thus the coloured particles often remain long within the canal marking its course, whilst all around the rotating movement of the nutritive jelly is maintained. It is clear that, if these coloured particles had simply fallen from the funnel into this nutritive jelly, they must have been carried along by the current of the latter, especially the small carmine granules, and that they could by no means have remained continuously arranged one after the other in a curved line.

When one has had the above-described pictures before one's eyes, both in the way of direct observation and of carmine feeding, one can hardly doubt that in reality a canal exists, running from the apex of the funnel in a curve in the bottom of the body-cavity and then opening freely into the latter.

But we must not overlook the fact that, besides these distinct and striking phenomena, others also come under observation, which, again, are of a kind to raise doubts as to the existence of a special canal, and which, indeed, have led Lachmann and Stein to deny the presence of such a canal. Amongst these there is, in the first place, the fact that the curves described by the balls of carmine, *i.e.* the nutritive material issuing from the funnel, are not always the same, but are sometimes wider and sometimes narrower. This, however, in my opinion, is to be explained in the following way:—The whole alimentary tube, from the external buccal aperture situated behind the ciliated disk, to the funnel, has a definite form and position not subject to change. It lies, as has already been remarked, within the comparatively firm *cortical layer* enclosing or forming the body-cavity, and is retained in its place by this. But the fine curved tube issuing from the funnel is *no longer fastened by the cortical layer, but hangs free in the body-cavity*, and may therefore undergo a change of position now and then by the movements of the nutritive jelly circulating around it. Moreover it is easy to understand that the loosely pendent tube may even be more or less curved, according to the size of the morsel &c. It is also to be borne in mind that under these circumstances mistakes may very easily occur, and that we may fancy that we perceive a change of curve, whilst it may be only that either by twistings of the animal itself or by displacement of the tube the direction of the curve has become different, especially by the fact that at one time the free end of the tube is turned to the side, and at another more or less towards the observer. This also explains why, when a Vorticellan is sufficiently compressed, the curves are usually most regular, as by the mere compression of the body the movements and changes of position of the tube are limited.

Another objection against the existence of a distinct canal is, that the morsel pushed in from the funnel does not always traverse the same course, but escapes at a greater or less distance from its original point of issue. But this appearance may also in many cases be produced by the above-mentioned changes of position of the movable tube. On the other hand, under certain circumstances, especially when the body-cavity is for the most part emptied of its solid constituents and filled with more or less fluid contents, and therefore with a diminished pressure, the delicate tube appears to possess a great extensibility, in consequence of which the morsels gliding through it may then become balled together and widened earlier than otherwise. This applies especially to water, which, when accumulated in the funnel and transferred into the curved tube, dilates the latter by forming a large drop, which only disappears gradually by mixture with the nutritive jelly.

The above-cited observations, as already remarked, apply especially to *Epistylis flavicans*. In the other Vorticellæ I have been unable to demonstrate the canal in question with the same certainty, although in many others also I have been able to ascertain by direct observation the fine linear continuation of the apex of the funnel into the body-cavity. It is possible, however, that in other Vorticellæ this tube is shorter than in *Epistylis flavicans*, or perhaps that it may occasionally be entirely wanting—for example, immediately after fission; upon these points further observation may decide. Moreover the *Epistylis* under notice also differs from the allied forms inasmuch as in it the bellied, pyriform funnel always seems to be distinctly marked off from the preceding œsophagus, and is consequently to be regarded as a special part. In consideration of this, we might perhaps see in this funnel the first attempt at the formation of a stomach with proper walls, and in the curved canal issuing from it a likewise very primitive intestine.

[To be continued.]

XLII.—*On some supposed new Species of Birds from Celebes and the Togian Islands.* By Arthur, Viscount Walden, P.Z.S., F.R.S.

The following five species of birds were obtained by Dr. Meyer, three on the mainland of Celebes and two in the small islands of the Togian or Schildpad group in the Gulf of Tomini or Gorontalo. That two distinct species should inhabit these small land-locked islands and yet not be known to occur on the neighbouring mainland of Celebes is another of those instances of the isolation of species and their restriction to small areas so numerous in the Indian archipelago. One of the two species belongs to a genus, *Criniger*, not as yet observed in Celebes although occurring in the Sula Islands. The other is a *Loriculus*, combining some of the characters of the Sula species, *L. Sclateri*, with those of the Celebean, *L. stigmatus*. It is, however, not improbable that these Togian species, although not found in North Celebes (Gorontalo, Minahasa), may yet be proved to inhabit the more southerly eastern limb (Bangaai and Ternate), a mountainous and as yet unexplored region.

Loriculus quadricolor, n. sp.

Adult male. Bright green; crown and edge of shoulder scarlet; rump, upper tail-coverts, chin, and throat deep blood-red; interscapulars and back bright golden; quills black, half the inner web of each quill verditer blue; entire under surface of rectrices verditer blue; bill black, feet yellow.

Male, immature. Faint indications of a few scarlet feathers on the forehead; a small red spot on the throat; edge of the shoulder scarlet mixed with yellow; upper tail-coverts and rump and remainder of plumage as in the adult. This stage closely resembles the adult plumage of *L. Wallacei*, G.R. Gray.

Male, still younger. Forehead, throat-spot, and edge of wing yellow, mixed with minute traces of scarlet; rump mixed red and green; upper tail-coverts as in adult; interscapulars golden; remainder of plumage of a less bright green than in adult.

Female. The only example sent and thus marked by Dr. Meyer is not quite adult. The head is entirely green, the chin and throat scarlet, the shoulder-edge yellow, interscapulars golden, back mixed green and golden, remainder of plumage as in adult male.

	Longitudo			
	Rostr. a nar.	Alæ.	Caudæ.	Tarsi.
♂ adult..	0·37	3·69	1·88	0·37
♀	0·31	3·50	1·63	0·37

This species is intermediate between *L. stigmatus* (Müller & Schlegel) and *L. Wallacei*, G. R. Gray. In dimensions the three are about equal. From *L. Wallacei* it differs by having a scarlet cap, by the golden of the back reaching to the nape, by the darker red of the uropygium and upper tail-coverts, and by the sexes differing; from *L. stigmatus* by the golden back, by the chin and throat-spot being much smaller, and the red of the uropygium not being quite so dark. All the examples sent are from the Togian Islands.

Myzomela chloroptera, n. sp.

Entire head, excepting the space in front of the eyes (which is black), back, upper tail-coverts, chin, throat, and breast scarlet; abdomen, ventral region, under tail-coverts, and flanks pale greenish fulvous, each feather dark centred with ashy; wing-coverts and quills dark brown, with bright yellowish-green outer edgings; scapulars dark brown, without any other colour; tail dark brown; under wing-coverts pure white; inner edging of the quills after the first two white; bill and feet black.

Longitudo			
Rostr. a nar.	Alæ.	Caudæ.	Tarsi.
0·37	2·18	1·75	0·62

Sent from Celebes by Dr. Meyer. The examples are in such bad order that it is not possible to discover whether the scarlet of the upper plumage is continuous or whether it is interrupted by brown on the nape.

This bird very nearly resembles the figure given by Audebert and Vieillot (Ois. Dorés, ii. p. 113, pl. 54), and drawn by Edwards, of Latham's *Scarlet Creeper* (Synop. i. p. 740), = *Certhia rubra*, Gm., and described from an example in the Leverian Museum said to have come from the South Seas. But Latham describes "the lower part of the belly and vent" as white, and the wings as black.

Hyloterpe sulfuriventer, n. sp.

Chin, cheeks, and throat silky white, changing into pale brown on the upper part of the breast; lower part of the breast pale sulphur-yellow; abdomen and under tail-coverts bright sulphur-yellow, most intense on the under-coverts; head dark olive-brown, back and wings a lighter shade; uropygium and upper tail-coverts with a ferruginous tinge; rectrices and outer webs of quills like the back; inner edges of the quills albescent; under carpal coverts yellowish white; axillaries white, with sulphur-coloured tips; shoulder-edge sulphur-yellow; 1st primary half the length of the 2nd, which is much shorter than the 3rd; the 3rd somewhat shorter than 4th, and shorter than the 6th; the 4th and 5th equal and longest.

Longitudo

Rostr. a nar.	Alæ.	Caudæ.	Tarsi.
0·32	3·25	3	0·75

Two examples of this species have been obtained in North Celebes by Dr. Meyer.

Criniger aureus, n. sp.

Under surface bright golden yellow; upper dark golden olive, darkest on the head, ear-coverts, and cheek; uropygium lighter in shade than the back, upper tail-coverts still more golden; upper surface of wings like the back; quills on their inner webs brown, outer webs edged with golden olive; under shoulder-coverts bright golden; inner webs of primaries, commencing with the second and increasing in extent on each succeeding quill, bordered with bright yellow; upper surface of rectrices dull golden rufous, each feather terminated by a pure golden narrow band; inner edges of all the rectrices, except the middle pair, pale yellow as seen from above, bright yellow below; the darker cheeks contrast strongly with the golden yellow of the chin and throat; lores yellow; bill and legs black.

Longitudo

Rostr. a nar.	Alæ.	Caudæ.	Tarsi.
0·63	4·88	4·63	0·75

Described from a male obtained by Dr. Meyer in the Togian Islands.

This species is nearly allied to *C. longirostris*, Wallace, but differs by being somewhat smaller, by having a much shorter bill, and by the bright golden colouring of its plumage.

Cisticola Grayi, n. sp.

Forehead, crown, nape, sides of neck, breast, abdomen, flanks, under and upper tail-coverts, and under carpal covers unspotted rufo-fulvous, most intense on the head; back and quills dark brown, edged with rufo-fulvous; rectrices dark brown, tipped with rufo-fulvous.

Longitudo

Rostr. a nar.	Alæ.	Caudæ.	Tarsi.
0·37	1·75	1·62	0·75

Obtained in Celebes by Dr. Meyer, and represented by a single example in such bad order that I am unable to describe it more minutely. Many of the abdominal feathers seem to be pure white, and the chin, throat, and ear-coverts to be pale fulvous.

XLIII.—*On a new Species of Thrush pertaining to the Genus* Oreocincla. By John Gould, F.R.S. &c.

Oreocincla iodura, Gould.

Crown of the head, back, and wing-coverts orange-brown, becoming of a paler and brighter tint on the rump and upper tail-coverts, each feather being margined with blackish brown; four middle tail-feathers of the same colour as the rump; the three next on each side dark brown, very slightly tipped with buffy white; the external feather light brown, with at least an inch of buffy white on the tip of the inner web; circle round the eye, lores, and a patch on the centre of the ear-coverts buffy white; throat and all the under surface white, each feather tipped with a lunate mark of black, which is broadest and blackest on the chest and flanks; across the breast a wash of buff; axillaries white at the base, black on their apical half; the last row of the lesser wing-coverts tipped with yellowish white; greater coverts orange-brown, tipped with yellowish; spurious wing and primaries dark brown, margined externally with orange-brown; secondaries dark brown on their internal and orange-brown on their external webs; vent and under tail-coverts buffy white, without lunations.

Total length $9\frac{1}{4}$ inches; bill $1\frac{1}{8}$, wing $5\frac{1}{8}$, tail $3\frac{3}{4}$, tarsi $1\frac{1}{8}$.

Habitat. Queensland and Northern Australia.

Remark. After carefully comparing this bird with examples of the genus from every other part of Australia, from Java, the Philippines, China, and India, I cannot come to any other conclusion than that it is distinct from the whole of them. In comparison with the Australian members of the genus, it is a smaller, much neater, and more compact bird, and has the rump and upper tail-coverts orange-brown instead of olive-brown; the bill also is smaller, narrower, and more delicately formed than that of the Tasmanian and New-South-Wales species.

PROCEEDINGS OF LEARNED SOCIETIES.

ROYAL SOCIETY.

January 11, 1872.—George Biddell Airy, C.B., President, in the Chair.

"The Myology of the Cheiroptera." By A. Macalister, A.B., M.B.T.C.D., Professor of Zoology, University of Dublin.

This paper is a record of the structural details of nineteen species of Bats; and for purposes of comparison the author has appended a description of the muscles of the Flying Squirrel (*Pteromys*) and of the Flying Lemur (*Galeopithecus*). The species of Bats examined were the following:—*Pteropus edulis, medius, Edwardsii, Macroglossus minimus, Cephalotes Pallasii, Cynonycteris amplexicaudalis, Eleutherura marginata, Rhinolophus ferrum-equinum, speoris,* and *diadema, Megaderma lyra, Arctibeus jamaicensis, Vampyrops vittatus, Vespertilio murinus, Vesperugo pipistrellus, Synotus barbastellus, Plecotus auritus, Noctulina altivolans,* and *Scotophilus hesperus.*

As the habits of the Bats are singularly different from those of the other mammals, the study of their myology becomes a matter of great interest. The special features displayed by their muscles are very numerous; but the principal of these may be tabulated as follows:—

1st. The singularly modified occipital trapezius.

2nd. The enormously developed and subdivided great pectoral.

3rd. The digastric being intersected by a linear inscription, forming a connecting link between the mammals with a single-bellied depressor of the mandible and those with a biventral muscle.

4th. The separate and displaced scapular deltoid.

5th. The palmaris longus acting as a superficial flexor.

6th. The displacements of the lower-extremity muscles consequent on the rotation of the lower limbs backward—such as the everted iliacus, the diminished glutei, and the weakness of the extensors of the knee.

7th. The increased size of the gracilis.

8th. The absence in general of the sartorius, tensor vaginæ femoris, biceps, plantaris, popliteus, and soleus.

It is interesting, in connexion with this last peculiarity, to notice the occurrence of a rudimental sartorius in one species and of a rudimental popliteus in another.

The cutaneous muscles are of very great interest; and this is increased by the comparison with those of the other flying mammals.

The author regards it as a point of very great importance that he has been able to apply the test of nerve-supply in the identification of some disputed muscles. Thus he has shown that the upper part at least of the occipito-pollicalis is of the nature of the trapezius, although its continuation is a cutaneous muscle; and this is interesting, as in the other flying mammals the entire of this muscle is cutaneous and springs from the upper part of the platysma: he has also been able to show that the abdominal pectoral is not part of the pectoralis minor.

By dissecting a large number of species, the author has been able to correct a number of errors in the hitherto published records of the myology of the Cheiroptera—such as the origin of the fourth pectoral, the insertion of the latissimus dorsi, the arrangement of the forearm-muscles, &c.

Although the general plan of the muscular system is the same in all the species, yet there are very many suggestive varieties; and, from a comparison of their muscles, it would seem that each of the four great groups of Bats is characterized by a slightly different arrangement of muscles.

The author has, for purposes of brevity, carefully abstained from adding any thing of theoretical deduction to this paper, which he has endeavoured to confine to a simple statement of anatomical facts.

"Notice of further Researches on the Fossil Plants of the Coal-measures." By Dr. W. C. Williamson, F.R.S. (in a Letter to Dr. Sharpey, Sec. R.S.)

Owens College, Manchester, Nov. 16, 1871.

My dear Dr. Sharpey,—Since I read my last communication to the Royal Society on the organization of the Fossil Plants of the Coal-measures I have done a large amount of work, having cut between two and three hundred new sections, and with most satisfactory results. I have obtained a series of specimens almost completing the life-history of one plant from Burntisland, beginning with the tips of the smallest twigs and ending with the large stems. The former are mere aggregations of parenchyma with a central bundle of barred vessels mixed with a small amount of primitive cell-tissue. As the twig grew the leaves assumed definite form, and the central vascular bundle opened out at its central part, so as to form a cylinder, the interior of which was occupied by parenchyma. This cylinder grew rapidly, the number of its vessels steadily increasing; but they were all equally arranged as in what I have termed the medullary vascular cylinder, i. e. *not* in radiating series. We thus obtain the origin of that remarkable cylinder, and see that it is the expanded homologue of the central vascular bundles of the living Lycopods. Whilst these processes were in progress the cortical portion became differentiated into layers, and the parenchymatous cells of the pith continued to multiply, so as to occupy the expanding interior of the vascular cylinder. After attaining a certain size through the above processes, a new element of growth appeared: an *exogenous* addition was made to the exterior of the cylinder, also consisting of barred vessels; but these are arranged in the radiating series described in my last memoir. This series continued to grow until it attained to considerable dimensions; but the entire vascular system always remains small, compared with the diameter of the stem, the chief bulk of which consists of an enormously thick bark. The structure just descibed is that of a true example of the genus *Diploxylon* of Corda. But I have got abundance of specimens with leaves on the exterior of the bark, demonstrating that the plant is a true *Lomatophloios*, thus indicating the correctness of my supposition, advanced in my last memoir, that sooner or later the genus *Diploxylon* would have to be abandoned.

As if to place beyond doubt the accuracy of these interpretations, I have now got magnificent specimens, apparently representative of a *cambium layer*, in which the half-grown vessels and the imperfectly formed medullary rays are exquisitely clear. In addition to these discoveries I have obtained a *Lepidostrobus*, which I have no doubt is the fruit of the above plant. It is provided with both microspores and macrospores, the exteriors of the latter being curiously furnished with numerous caudate prolongations, causing them to resemble some of the fossil *Xanthidia* of the chalk.

I have further obtained, both from Lancashire and Burntisland, beautiful stems of another type, and which I have no doubt belong to *Asterophyllites*. These began to grow, as before, with a central vascular bundle surrounded by a cylinder of parenchyma; but the transverse section of the bundle soon became *triquetrous* instead of circular. This, it may be remembered, is the characteristic of the corresponding bundle of the strobilus which I have just described in the 'Transactions of the Literary and Philosophical Society of Manchester,' under the name of *Volkmannia Dawsoni*, and which I referred to *Asterophyllites*. This central triangular axis does not expand or become converted into a hollow cylinder; but vessels are at once added to each of its three sides, exogenously, and in radiating series, until it becomes converted into a cylindrical woody axis. I have specimens showing the nodes and internodes, leaving little, if any, room to doubt the close affinity between the plant in question and the verticillate-leaved *Asterophyllites*.

The details of these discoveries, along with those respecting a most remarkable series of Lycopodiaceous plants, to which I have given the name of *Dictyoxylon* (but this will have to be abandoned for the late Mr. Gourlie's name of *Lyginodendron*), will be laid before the Royal Society with as little delay as possible. I may observe that the plants last referred to have developed, so far as type is concerned, in a way very similar to that of the *Lomatophloios*, allowance being made for generic and specific peculiarities.

I am, my dear Sir,

Very sincerely yours,

W. C. Williamson.

I ought not to close this letter without acknowledging the indefatigable energy of G. Grieve, Esq., of Burntisland, who has supplied me with a constant stream of specimens, upon which I have been able to operate, thus rendering an admirable service to the cause of palæophytology.

MISCELLANEOUS.

On the Genus Osteocella. By Dr. J. E. Gray, F.R.S. &c.

Mr. Clifton, many years ago, sent, through Dr. Bowerbank, to the British Museum the "backbone taken out of the marine animal in bottle marked 'No. 1.' I caught him or it swimming with great rapidity in shallow water." The bottle never reached the British Museum; but the backbone did; and I described it at the end of the 'Catalogue of Sea-Pens or Pennatulidæ in the British Museum,' published in 1870, under the name of "*Osteocella Cliftoni*," but considered very doubtful its belonging to the Pennatulidæ.

The British Museum has lately received a very long slender bone, 64½ inches long and $\frac{3}{16}$ inch broad in its broadest part, which was sent to the Zoological Society by the Hudson's Bay Company, and evidently came from the northern seas, probably from the west coast of America.

Mr. Carter has kindly examined the Australian specimen sent by Mr. Clifton and the one sent home by the Hudson's Bay Company to the Zoological Society, and finds them, under the microscope, "present the same horny structure, viz. a fibrous trama more or less charged with oval cells or spaces," quite unlike that of *Gorgonia* and *Pennatula*, which present a concentric mass of horny layers charged more or less with calcareous crystalline concretions. It is evidently a second species of the same genus, *Osteocella*; and it is more to be regretted that the animal sent home by Mr. Clifton to Dr. Bowerbank never reached its destination and was lost to science; but it is to be hoped that before long we shall receive from West Australia or from the Hudson's Bay Company the animal which produces the *Osteocella.*

Osteocella, Gray, Cat. of Pennatulidæ (1870), p. 40.

Style internal, elongate, calcareous, hard, smooth, with a slightly pearly surface, formed of concentric layers, subcylindrical, tapering at the ends; the apical (?) end shortest, more rapidly tapering, cartilaginous at the tip, the other end longer, more gradually attenuated, ending in a hard calcareous extremity like the rest of the style. Animal or colony of animals free, marine; otherwise unknown; most probably like the Pennatulidæ, but the style is harder, more calcareous and polished than any known style belonging to that group, which are generally square, sometimes cylindrical but rarely fusiform in the genus *Virgularia*; or it may be the long conical bone of a form of decapod cephalopod which has not yet occurred to naturalists, as Mr. Clifton spoke of its being a free marine animal, and it has a cartilaginous apex like the cuttlefish. It is much to be regretted that Dr. Bowerbank did not transmit the animal sent with it to the Museum.

It is evident that there are two species of animal yielding this kind of bony substance:—

1. *Osteocella Cliftoni.* Thick, about 11 inches long, tapering at each end. From Western Australia.

2. *Osteocella septentrionalis.* Long, slender, about 64 inches long, attenuated at the base, and very much attenuated and elongated at the other end. Northern Seas? Collected by the Hudson's Bay Company.

Mr. Carter informs me that subsequent examination of this axis with acid "shows that it is similarly composed to that of *Gorgonia*, viz. of kerataceous fibre or substance and calcareous crystalline matter like that of the stem of *Osteocella Cliftoni* and the other Pennatulidæ which it most nearly resembles;" so that my original view as to the nature of this organ seems to be thus confirmed. The elongated northern species was called by a zoologist a "fish's tail," by which was probably meant the tail of a ray.

Further Remarks on the Relationship of the Limulidæ (Xiphosura) *to the* Eurypteridæ *and to the* Trilobita. By HENRY WOODWARD, Esq., F.G.S.

In this paper the author described the recent investigations, made by Dr. A. S. Packard, Dr. Anton Dohrn, and the Rev. Samuel Lockwood, upon the developmental history of the North-American king crab (*Limulus Polyphemus*), and discussed the conclusions as to the alliances of the Xiphosura and Eurypteridæ, and to the general classification of the Arthropoda, to which the results of these investigations have led Dr. Dohrn and some other continental naturalists. According to this view, the Xiphosura and Eurypteridæ are more nearly related to certain Arachnida (the Scorpions, &c.) than to the Crustacea; and this opinion is further supported by the assertion of Dr. Dohrn, that in *Limulus* only one pair of organs (antennules) receives its nerves from the supraœsophageal ganglion, and that the nature of the under lip in *Limulus* differs from that prevailing among the Crustacea. Dr. Dohrn also recognizes the relationship of the Merostomata to the Trilobites, as shown especially by the development of *Limulus*, and considers that the three forms (*Limulidæ*, *Eurypteridæ*, and *Trilobita*) should be combined in one group under the name of *Gigantostraca*, proposed by Häckel, and placed beside the Crustacea. The author stated, on the authority of Prof. Owen, that *Limulus* really possesses two pairs of appendages which receive their nerves from the supraœsophageal ganglion, that, according to Dr. Packard, the young *Limulus* passes through a Nauplius-stage while in the egg, that no argument could be founded upon the lower lip, the condition of which varied extremely in the three groups proposed to be removed from the Crustacea; and he maintained that, even from the ultra-Darwinian point of view taken by Dr. Dohrn, the adoption of his proposal would be fatal to the application of the hypothesis of evolution to the class Crustacea. —*Proc. Geol. Soc.* Dec. 1871.

On some Pupipara *parasitic upon Chiroptera.*
By Dr. F. Rudow.

To the few animals of this kind described by Nitzsch, Frauenfeld, Westwood, Kolenati, and others, I am able to add some which have not yet been described, which live parasitically upon bats, chiefly of America, and the original specimens of which are probably preserved in the collection founded by H. Schilling in the Hamburg Museum.

1. *Strebla longipes.* Belonging to the group B of the convex forms of Kolenati. Ochreous, tolerably thick, very rough; the abdomen beset with dark-brown thick spines, standing singly among weaker ones. All the horny parts coriaceously wrinkled. Head elongate shield-shaped, nearly pointed in front, with long brown setæ. Proboscis strong, projecting acutely. Thorax cordiform, longer than broad, slightly convex, with long bristles.

Legs tolerably thick; femora and tibiæ clavate; tarsus thin; claws very strong, strongly bristled, with single, nearly black spines among the bristles. Wings tolerably transparent, pale ochreous, at least one third longer than the abdomen, nearly elliptical, with a rather thin, laterally margined basal piece; fringe of hairs on the sides tolerably long, but fine, as is also the hairy covering of the whole surface. The venation is different from that of Frauenfeld's *S. Kollari*; the two middle veins, which are not very prominent, are furcate almost at the base, the others simple. Halteres very small.

Abdomen elongate-ovate, with the segments indistinct, finely fringed at the sides; terminal segment with some long bristles and strong warts.

A female from *Phyllostoma hastatum*, 0·75 millim. A comparison with the only other known species admits of no confusion between them.

2. *Liptoptena dubia.* Ochreous, strongly bristled. Head broad, particularly thick in the region of the eyes. Antennæ very broad, especially the last joint, and provided with strong spines. Strongly bristly and spinous. Proboscis very long and acute. Thorax much broader, nearly quadrangular, with rounded sides. Ground-colour ochreous, with some curved, transverse, and angulated longitudinal furrows of a red colour. Legs moderately thick and long, strongly bristly, with clavate joints and sharp claws. Wing-rudiments scarcely one fourth the length of the abdomen, rounded elliptical, with long but fine setæ. Abdomen very thick, broadly ovate, with the segmentation indistinct, on the sides finely, on the back strongly bristled, and with isolated long spines; terminal segment small, with two thick obtuse tubercles, with very long setæ.

Length 0·5 millim. On *Noctilio dorsatus* from Venezuela.

In our specimen, besides the wing-rudiments, there are on the thorax very small rudiments of halteres, attached laterally, of a very narrow oval form, and only a little smaller than the wings themselves. The structure of *L. cervina*, from the roe, stag, and elk, presents nothing of this kind; so that the above-mentioned animal may be regarded, if not as a new genus, at least as a transition towards *Strebla*.

3. *Nycteribia elongata.* Belonging to Group I. of Kolenati, with no angular ridges on the thorax, and with the margin of the anterior part of the thorax entire. Colour dark ochreous; legs rather paler. Animal elongated; head small, concealed, with a long, extensible, acute proboscis, covered with long hairs. Thorax ovate, depressed at the lower margin, translucent at the portion near the head, furnished with a few transverse rows of stiff bristles, among which there are some longer spines. Upper surface convex, lower surface nearly flat. Lateral ctenidia of 17 teeth, almost reaching the margin. Legs with very long bristles; femora elliptical, tibiæ clavate, both spinous on the lower surface; tarsus long and slender; claws very thick and spinous.

Abdomen elongate, ovate, with a tuft of spines at the margin of each segment. Colour of the sutures pale yellow. Anterior ctenidium with 45 teeth. Anal segment of the male tolerably broad, with a short forceps and long thin outer horny covers, strongly hairy. Anal segment of the female at the sides with two truncated tubercles, and two rounded ones in the middle.

Length 0·5 millim. On *Nyctophilus Geoffroyi*.

4. *Nycteribia varipes.* Belonging to Group II., with angular ridges and thin tibiæ. Colour pale ochreous. Legs quite pale. Head elongated, thickly clothed with long setæ. Proboscis short, but sharp; vertex with two rows of very long spines standing outwards. Thorax with distinct reddish-brown angular ridges in front, which nearly touch one another. Lower surface finely and densely, upper surface densely clothed with hairs, with a tuft of long setæ. Ctenidia rather distant from the margin of the thorax, 25-toothed; teeth of nearly equal length, with the exception of the outermost.

Abdomen of the female 5-jointed; first segment narrow, second very long and broad, third nearly as broad, but only one quarter as long, the last two narrower; terminal segment with two warts directed outwards at the angles, and two approximated ones in the middle, all furnished with long setæ. Upper surface with isolated long setæ among dense hairs; sides with short fringes; angles of the segments furnished with dense tufts of hairs. Sutures dark-coloured. Ctenidium with 50 teeth, not distinct.

Legs very long; femora elliptical, tibiæ narrow, tarsi long, strong-clawed, finely but densely hairy, with long setæ at the joints; femora and tibiæ of the anterior legs almost truncated and tubercular at the joints, with very small articulations.

Length 0·4 millim. On *Miniopteris morio*.

Sufficiently distinguished from the rest by its broad abdomen. —*Zeitschr. für die Gesammten Naturwiss.*, neue Folge, Band iii. pp. 121–124.

THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[FOURTH SERIES.]

No. 54. JUNE 1872.

XLIV.—*On two new Sponges from the Antarctic Sea, and on a new Species of* Tethya *from Shetland; together with Observations on the Reproduction of Sponges commencing from Zygosis of the Sponge-animal.* By H. J. Carter, F.R.S. &c.

[Plates XX., XXI., & XXII.]

Among the sponges preserved in spirit at the British Museum which Dr. J. E. Gray wished me to examine with reference to any thing that might remain untold about them, as well as to their future arrangement there, are two glass jars partly filled with specimens, which, but for the presence of spicules, might very well pass for so much wet brown paper torn into pieces and soaked in sandy mud. Notwithstanding this uninviting aspect, however, they claim attention through bearing respectively the following labels, so far as the writing on them can be now made out, viz.:—

"Dredged from depth of 300 faths. Lat. 74½° S. . . . . . Antarctic Exp. Admiralty." And "Dredged in 206 faths. Lat. 77½° S. and long. 175° West. Antarctic Exp. Admiralty."

The fragments in both jars belong to the same species of sponge; and the "locality" being known, there is no doubt that they were dredged up by Captain Sir James Ross during his Antarctic Expedition, which is further proved by the following extracts from that illustrious navigator's book entitled 'A Voyage of Discovery and Research in the Southern and Antarctic Regions during the years 1839–43,' viz.:—

"Feb. 16th. The lat. at noon was 75° 6′ S., long. 189° 04′ W. In the afternoon we hove-to and sounded in 290 fathoms on a bottom of green mud, the temperature at that depth being 32°, while that of the surface was 30°. . . . . The dredge was put overboard for a short time, and many curious invertebrate animals and a small fish taken in it" (vol. ii. p. 195).

No doubt it was on this occasion that the fragments of sponge still preserved in the British Museum were obtained. Rolled over and over by the dredge, probably in a rough sea, and mixed up with the sandy mud of the bottom, it is not extraordinary that they should have passed into the state mentioned. The only part extraordinary is, that at such a time and under such circumstances as those recorded in the book to which I have alluded, the dredge should have been put overboard at all. No one but a cool and intrepid scientific investigator of the highest type could achieve such results as were obtained in this Antarctic Expedition. Well might England be proud of such men!

With this feeling, then, it will easily be conceived that, however uninviting the remnants of this sponge appeared, the fact of their having been obtained when most men would have been making their vessel snug and sailing away from such an inhospitable locality demanded the little exertion which their examination would entail on one sitting quietly at home by his fireside.

Hence they were examined ("overhauled," to use a nautical expression very appropriate here) bit by bit, and carefully scrutinized, with the most repaying results, as will presently be seen.

Among the fragments were observed pieces four inches long; there was evidently a porous surface on one side and a cavernous structure on the other, both like those of *Hyalonema* (*Carteria*, Gray) and *Holtenia*, Wy. Thomson (see figures of the latter in Phil. Trans. 1870, pl. 69 &c.). The spicules belonging to the fragments were of three kinds, viz. acerate, anchor-, and fork-headed. It was therefore evidently a deep-sea *Tethya*. Subsequently tufts of long anchor- and fork-headed spicules were found attached to some of the fragments; and these as evidently belonged to the base of the sponge, being the means by which it was fixed to the muddy bottom. Thus many points presented themselves which led to the conjecture that the sponge must have been in form of body something like *Carteria* and *Holtenia*, which in this respect are nearly identical, —not possessing podal beards of spicules eighteen inches long, like Mr. Kent's noble specimen of *Pheronema Grayi* in the British Museum, dredged up off the coast of Portugal, in the yacht 'Norna,' in 1870, but with short spiculous tufts not more than an inch in length.

Up to this point, then, inference was all that I had to depend on for the original form of this sponge, when, by good fortune, among the mass I found a fully developed ovum or, rather, young *Tethya*, about one-sixteenth of an inch in diameter, which, when magnified, turned out to be so perfect that it probably is as much a facsimile of the adult parent as a human infant is that of a grown-up man. I therefore wanted nothing further than to magnify this, and with the detail afforded by the "fragments," to give not only the figure and description of the latter, but that of the entire sponge, for which I now propose the name of *Tethya antarctica* (Pl. XX.).

While examining these fragments I also observed that they had acted in the dredge as a kind of "tangle," by having caught up several large foreign spicules, of two distinct kinds, but apparently belonging to the same sponge. There were only these two kinds, which were very numerous, and so long and large that they could be seen and easily extricated with unaided vision. One is, up to this time, a unique form, viz. an anchor-head with *four* arms, and sometimes a fifth—which being a continuation of the shaft, the spicule is hexactinellid. The other is a quaternate or quadrifid spicule, with a cruciform head, whose four arms spread out horizontally and somewhat sigmoidly from the end of a vertical shaft. It is evidently allied to the same form of large cruciform spicule which spreads its long arms over the surface of *Carteria* and *Holtenia*, but differs from these in being covered throughout with a layer of minute or micro-spines, which, in all but the shaft, are accompanied by a great number of large or macrospines.

Thus, these two forms of spicule being very numerous and unaccompanied by any other foreign forms in the fragments of *Tethya antarctica*, I have assumed that they are respectively the podal and surface spicules of a sponge allied to *Carteria* and *Holtenia*, for which I propose the name of *Rossella antarctica* (Pl. XXI.), in memory of the great antarctic navigator who dredged them up.

I have also found a branched Antarctic sponge belonging to the Suberites, which will be described, with other sponges of the kind, on a future occasion.

Lastly, in a jar labelled "Shetland. J. S. Bowerbank, 52. 3. 12. 70–73," to which is added, in Dr. Bowerbank's blue ink and handwriting, "*Tethya lyncurium*," I found six specimens, viz. two of *Tethya cranium* and four of another species of *Tethya* as yet undescribed; so that the conjecture of Dr. Bowerbank in writing *T. lyncurium* (*Donatia*, Nardo & Gray) was very wide of the mark, and excusable if it had not been for a public museum.

Having learnt by experience that appearances are more misleading among the Spongiadæ than in any other of the lower animals which I have been accustomed to study, from the great resemblance of one sponge to another, I never now am content to decide in this respect until I have actually examined microscopically a bit from the sponge itself presented to my notice. Thus, in examining all the six specimens mentioned, I came upon four, distinctly different from *Tethya cranium*, Johnston, which has been so aptly named and figured with its oviform bodies by this accurate naturalist (Hist. Brit. Spong. &c. 1842, p. 83, pl. 1. figs. 1–8).

From the label on the jar, it is therefore evident that both species inhabit the sea about Shetland, having probably come from the "Haaf Banks;" for Dr. Bowerbank states that he obtained "nearly three hundred specimens" that were dredged up there (B. S. vol. ii. p. 84).

For this new species, which will presently be described, I propose the name of *Tethya zetlandica* (Pl. XXII. fig. 1).

As all the specimens, viz. both *T. cranium* and *T. zetlandica*, are filled with ova in different stages of development, I took the opportunity of mounting some of the more advanced ones in Canada balsam, and found that they possessed the same distinguishing characters which point out the differences between the adult forms of both these species.

Moreover the presence of the ova in different stages of development from a very early period has enabled me to give descriptions and illustrations of a sequence of them, preceded by *zygosis* in the sponge-animals, taken from *Halichondria simulans*, Johnston, in the living state, which thus far seems to point out the mode of sexual reproduction and development in the Spongiadæ generally.

The *zygosis* takes place by apparent union of the "collars" of two sponge-animals, animalcules, or infusoria (whichever name pleases best), so that their "rostra" are brought into apposition just like that witnessed in the *Difflugiæ*, where the mouths of the two tests are brought together by an apparent union of the contained animals. Of course it will be necessary to give a detailed account of zygosis in the *Difflugiæ* to compare it with that of the sponge-animalcule.

For the terms "collar" and "rostrum," see my description and illustrations of the sponge-animal (Annals, 1871, vol. viii. p. 9, pl. 1. fig. 13, *b*).

I shall also at the same time be able to add a few more observations on the development of the spicule.

Tethya antarctica, n. sp. Pl. XX.

Body globular; colour tawny yellow. Surface smooth, interrupted frequently by papillæ, through which the spicules of the interior project in bundles, cactus-like (Pl. XX. figs. 1

& 2). Dermal sarcode cribriform, from the number of minute "pores" in it (fig. 4), with here and there a large circular vent (fig. 2, *c c c*). Summit presenting three or more large vents, which branch off internally into the excretory canal-system (3, *a a a*). Base furnished with tufts of long spicules, anchor- and fork-headed respectively, some of which have their heads in the sponge and their shafts free, and *vice versâ* (fig. 2, *e*). Internally cavernous, arising from a much dilated state of the excretory canal-system, whose extremities are peripheral, where the sponge-structure appears to be densest. Spicules of three kinds, viz.:—1, acerate, very slightly curved, and long-pointed (fig. 5); 2, anchor-headed, of two forms, viz. one with thick arms, hastiform (fig. 7), the other with the arms more expanded (fig. 8); 3, tri-fork-headed, one prong much longer than either of the other two, which are equal (fig. 6). *No* bi-hamates. The first or acerate spicule is chiefly confined to the body, and the two other kinds to the surface, being longest and most numerous at the base. Thus the spicules generally vary much in length. The largest acerate form averages 1-20th of an inch in the adult sponge (fig. 9); and the longest fragment of shaft found with anchor-head attached did not exceed 1¼ inch (fig. 10). Generally the longest of these spicules do not appear to have been more than 1½ inch in length. The hastate form of anchor-head appears to be chiefly confined to the body, and the expanded or grapnel form to the free extremities of the spicules of the tufts at the base of the sponge. Size of young *Tethya antarctica* figured 1-16th of an inch in diameter exclusive of the tufts at the base—inclusive of the tufts, 5-48ths, or about 1-10th of an inch long (fig. 1). Size of largest *fragment* of adult sponge 4 inches long.

Hab. Marine; deep sea, in 206 to 300 fathoms.

Loc. Antarctic Ocean, in lat. 74½° and 77½° S., and long. 175° W.

Obs. I have little to add to what has already been stated of this sponge. The description of the form is taken from that of the young one found in the parent, and the details of structure from the adult fragments; so that the whole is almost as complete as if we had had the adult entire. Generally the sponge corresponds to the *Tethyadæ* of which *T. cranium* is the type, modified more or less by a great dilatation of the excretory canal-system, in which it more particularly agrees with *Carteria* and *Holtenia*. It is also tufted at the base for fixture in the mud and sand; but in this it does not resemble these sponges any more than *Tethya dactyloidea*, which not only is similarly tufted at the base, but presents a large vent at the summit, through which the excretory system of canals empties itself (Annals, 1869, vol. iii. p. 17, and 1872, vol. ix. p. 82). Perhaps most of all it is like Schmidt's *Tetilla polyura*, which came from Desterro, on the coast of Brazil; but it contains no bihamates, which makes it differ, I think, from all the other species known but the one from Shetland, about to be described.

I am not able to state if, like the other *Tethyadæ*, its internal structure radiated from a nucleus; but if so, the fragments would lead me to infer that this must have been situated towards the base. Here, of course, our young one does not assist us, as to ascertain this point by its destruction would not compensate our loss of the only entire form of this sponge that we possess.

With reference to the nature of the grains of sand which pervade these fragments, I might here state that they have a lava-like aspect and structure, as if they originally came from the active volcanoes witnessed and measured by Sir James Ross on the adjoining continent.

Rossella antarctica, nov. gen. Pl. XXI.

Large peripheral spicule with quaternate or cruciform head, consisting of four arms radiating at more or less than right angles from the peripheral end of a vertical shaft (Pl. XXI. fig. 1); arms very long, spreading, somewhat sigmoid in their course (fig. 6), round, ending in attenuated extremities, covered throughout with a layer of microspines in close approximation, and here and there large or macrospines, all directed outwards (figs. 1, *a*, *b*, and 4, *c*, *d*), the latter failing towards each end of the arm; shaft also sharp-pointed, and covered with the layer of microspines, but not so distinct, and entirely without macrospines (fig. 1, *d*, *c*); so that, under a low power, the arms appear spined and the shaft smooth.

Podal spicule consisting of a long shaft with anchor-head composed of four recurved arms (fig. 7) and sometimes a fifth, which is in continuation with the shaft, and thus renders the spicule hexactinellid (fig. 8, *a*). Peripheral and podal spicules both visible to the unassisted eye, the largest of the former presenting a shaft about 4½-12ths and each of the arms about 3-12ths of an inch long (figs. 5 & 6). Head of podal spicule 1-20th of an inch broad, and longest fragment of shaft, with head attached, 1½ inch (fig. 10). From the latter having become attenuated towards the broken end, it is probable that, if entire, it would not have exceeded two inches. Length of podal spicule, generally, unknown.

Hab. Marine. Deep sea, in 206 to 300 fathoms.

Loc. Antarctic Ocean, in lat. 74½° to 77½° S., and long. 175° W.

Obs. All that I have to offer respecting this sponge is the description of these two forms of spicules. It might seem strange that I should endeavour to establish a new genus upon them, were it not considered that the *four*-armed anchor-head (fig. 7) is unique, so far as our acquaintance with the Spongiadæ at present goes; that is to say, with the exception of *Acarnus innominatus*, Gray, where there is a fourth arm, but in a totally different kind of spicule (Annals, 1871, vol. vii. p. 273, pl. 17), I know of no other instance. Secondly, the four-armed, spreading, or great peripheral spicule (fig. 1) is so far identical with that of *Carteria* and *Holtenia*, but totally differs from it in being spiniferous instead of smooth. Perhaps the minute cruciform-headed and spined spicules congregated in multitudes along the course of the smooth arms in *Carteria* and *Holtenia* may be represented by the spines on those of *Rossella*. The only question, therefore, is, whether the two spicules belong to the same sponge or to two different sponges; and this seems to be answered by the facts that the two forms are analogous to the anchor-head or anchoring spicule and the great cruciform one of *Holtenia* respectively, and also that both forms are equally and abundantly present about the fragments of *Tethya antarctica*, wherein they have become entangled, to the exclusion of every other kind, except those which belong to the *Tethya* itself. Thus we may fairly assume that they both belonged to some deep-sea sponge which, thus differing from all others yet known, merits a separate genus, with perhaps no more appropriate name than that of "*Rossella*," after the great navigator who dredged them up from the bottom of the Antarctic Ocean.

It is impossible to say how long the shafts of the anchor-headed spicules might have been, although the longest portion that I have found is attenuated at the fractured end; for, although this generally indicates an approaching termination, still the attenuation may or may not be much prolonged. But, judging from the average of specimens found, I should say, as before stated, that the shaft probably did not exceed two inches.

The occurrence of a fifth arm in the direction of the shaft, forming a kind of spike at the end (fig. 8), seems to be too common to be abnormal, and therefore allies this sponge still more to the Hexactinellidæ of Schmidt.

I also found one of these six-armed spicules in which there is an extension of one of the recurved arms to such a degree as to be almost equal in size and length to the shaft (fig. 9, *a*). This, I fancy, *must* be an abnormal form.

In no portions of *Tethya antarctica* that I mounted in Canada balsam, nor in any others examined, could I find the least trace of any of the minute kinds of spicules which characterize the Hexactinellidæ. Then it must be remembered that, although the large spicules of a sponge of this kind might be caught up and preserved by such a "tangle" as the *Tethya* afforded, the small spicules to which I allude would inevitably escape.

Fig. 3 is a more magnified view of the central portion of one of the great cruciform peripheral spicules, here introduced for comparison with the fossil fragment (Annals, 1871, vol. vii. p. 126, pl. ix. fig. 37). It is the only part of this spicule which in the hurly-burly of the waves and currents, would be likely to survive all the rest on its way to become fossilized; and the identity is so great that my conjecture, at the page mentioned, of their having belonged to a "quaternate or quadrifid system, whose parallel is only to be found in *Hyalonema* (*Carteria*) &c." is thus confirmed. That which I supposed to be an enlarged central canal in the fossil is the original shaft, and the external portion (*d*) an additional layer, as evidenced by the recent specimen—thus being only an instance of the common mode of strengthening and enlarging the structures of the Spongiadæ, viz. by the addition of layers to the external surface of the horny or silicified fibre.

Hence, having found fossilized fragments of this system in the Greensand, the Hexactinellidæ cannot be descended from the Ventriculitidæ of the Chalk, as Schmidt's pedigree-table (Atlant. Spong. Faun. 1870, p. 83) would have it, in support of the evolution-theory. But as a "theory" is but a "theory," it is only to correct the mistake and maintain the remaining part until another error is found out, and so on.

I take this opportunity of stating, in modification of what I have said in my "Fossil Sponge-spicules of the Greensand," p. 126 (*op. et loc. cit.*), viz. that I had not been able to find any *hex*radiate spicules in my mounted specimens of *Hyalonema*, that since then I have obtained and mounted other specimens from an undoubted *Hyalonema*, taken off with my own hands, in which *hex*radiate spicules, of *minute* size, are as plentiful as in any other sponge of the kind. Still I maintain that, if *Hyalonema* is to be considered one of the Hexactinellidæ, it must be based upon the presence of these *small* hexactinellid spicules; for the large ones of the periphery, and the minute feathered ones too, there, which appear to be the same in this respect as in *Holtenia*, bear no trace of the sixth ray, that I can see. Indeed the sixth ray, if on one of these large cruciform peripheral spicules, which appear to be intended to bind down the surface smoothly, would, by its projecting outwards, be evidently out of place; and if these spicules are to be considered hexradiate because a little projection of the central canal may be observed where the sixth ray would be if developed, to carry out this principle in the Spongiadæ will be found very inconvenient, if not wholly impracticable. In distinguishing species, which is a purely conventional arrangement, we should select, if possible, prominent features that are easily recognizable, both for practical purposes and to facilitate the study of natural history, there being, comparatively, no limit to minute distinctions, as there is no real line of demarcation in nature, if we do not limit the power to which the microscope should be used in this respect. The infinite mind of Nature does not require them; but the finite mind of man cannot get on without this aid, and still less the "finite purse;" when the more costly, *i. e.* the highest, powers of the microscope are required for their detection.

Tethya zetlandica, n. sp.

Pl. XXII. figs. 1–6 and 11–13 and 14–17.

Conical, globular, or slightly compressed (Pl. XXII. fig. 1). Colour bright grey in spirit. Surface smooth, interrupted by thick-set papillæ irregularly disposed, large and separate (fig. 2, *a*) or small and approximate (fig. 1, *a*). Pores and vents for the most part closed by contraction. Internal structure consisting of bundles of spicules (fig. 13, *b b b*) radiating from an excentric nucleus or point (*a*) to the circumference, where they end respectively in the papillæ of the surface (*f*), imbedded throughout their course in the sarcode of the body (*c c c*), which is charged, in the adult state, with minute ova (fig. 7), and presents, in dilated cavities connected with the excretory canal-system (fig. 14), a great number of pendent seed-like bodies —that is, the young *Tethyæ* (fig. 13, *d d d*); sarcode terminating peripherally in a condensed tough lamina (fig. 13, *e e e*), which forms a kind of cortex to the whole, and, extending upwards on the projecting bundles of the spicules respectively, also forms the papillary prolongations of the surface (*f f f*). Spicules of three kinds, viz.:—1, acerate slightly curved; 2, triforked, with the prongs of equal length; 3, anchor-headed. All these spicules vary in length with their position; the acerate, which are much the shortest, are chiefly confined to the body and internal parts, while the two others chiefly occupy the surface and base, being shortest on the upper part of the body and longest towards the base; all three kinds may be found projecting from the papillæ in variable plurality when the anchors and forks have not been broken off, which is generally the case. There are *no* bihamates. Average length of longest spicule, which is the anchor-headed shaft at the base of the *Tethya*, about 5-12ths of an inch. Size of specimen, viz. fig. 1, about 2 inches high by $1\frac{3}{4}$ inch broad.

Hab. Marine; deep water.

Loc. Sea about the Shetland Islands; Haaf Banks.

Obs. I have assumed that this species comes from the Haaf Banks, seeing that the label on the jar bears the words "Shetland. J. S. Bowerbank," with "*Tethya lyncurium*" written, as before stated, in Dr. Bowerbank's hand, who, in his 'British Sponges,' vol. ii. p. 84, as before stated, observes, with reference to *T. cranium*:—"I obtained nearly three hundred specimens of this sponge from the Shetland deep-sea fishermen, through their agent," part of which, viz. the two specimens of *T. cranium* and four of the species just described, in the jar at the British Museum, I further assume to have belonged to that collection. "*Tethya lyncurium*" (*Donatia*, Nardo & Gray) does not appear to have been yet found north of Connemara Bay, in Ireland, viz. lat. 53° 26′ (Johnston, *op. cit.* p. 85).

T. zetlandica is closely allied to *T. cranium* in most ways. It appears to inhabit the same locality, and sometimes, in like manner, to grow in the cavity or on the stem of *Halichondria ventilabrum*, Johnst. (see illustrations of both species, Pl. XXII.); but it markedly differs from *T. cranium* in two points, viz. in the disposition of the spicules on the surface, and in the absence of bihamates. This is at once seen in fig. 9, where the hoary, shining, asbestine appearance of the spicules of *T. cranium*, arranged in whorls like the hair of the human head, parting from the crown, from which Johnston has aptly named it (*op. cit.* pl. 1. fig. 1), contrasted with the irregular disposition of the same in *T. zetlandica* (fig. 2), at once points out the two species; while the entire absence of bihamates (fig. 9, *c*) in the sarcode (which is pregnant with them in *T. cranium*) is a not less distinguishing microscopic character, in which *T. zetlandica* agrees with *T. antarctica*. And not only, as before stated, are these differences to be seen in the adult forms, but they equally characterize the still unborn *Tethyæ* of the interior in each species (figs. 11 & 12). Thus the spiral twist of the spicules and the presence of bihamates, though all very minute, in the young *Tethyæ* of *T. cranium*, are as characteristic of it as the opposite is characteristic of *T. zetlandica*.

For the purpose of illustration, I have given figures of two specimens of *T. zetlandica*, in one of which the papillæ are large and separate (fig. 2) and in the other small and almost confluent (fig. 1); the latter, as will be observed, has grown on the stem of *Halichondria ventilabrum*: also a figure of *T. cranium* growing in the bottom of the cavity of a specimen of *Halichondria ventilabrum*, from another jar in the British Museum, labelled "*Halichondria ventilabrum.* J. S. Bowerbank, 52. 3. 12. 54."

The reader will at once observe that these are mere outlines of the objects they are intended to represent, and not finished drawings, as the latter would occupy more time than I feel disposed to give them, and are not absolutely necessary for the purpose, since, with the description and these diagrammatic sketches, the general appearance of both species, with their distinguishing characters, can at once be seen and applied.

In the illustration of *T. cranium* may be observed a distinct group of vents (fig. 9, *a*), to which attention is here directed because Dr. Bowerbank in his diagnosis inserts, "Oscula and pores inconspicuous" (*op. cit.* p. 83). But the distinctness of the whorls or spiral lines of spicules (fig. 9, *bb*) must be viewed as diagrammatic, since in the natural state they no more appear than in the hair of the human crown.

I have also added a group of the bihamates magnified (fig. 9, *c*), which are not to be found in *T. zetlandica.*

The word "bihamate," first applied by Dr. Bowerbank to this spicule, does not always meet the requirements of the case, although it is quite as good as any other that has been chosen. The name, however, does not matter, so long as we remember that it is a C- or S-shaped body, of a more or less spiral tendency, with the ends so turned in opposite directions that, if laid on a flat surface, they do not both rest on the same plane; so that, in whatever position the bihamate is, one end is always projecting, ready to catch any thing that may come into contact with it: hence Dr. Bowerbank has placed this form among his "retentive spicula" of the sarcode.

Nature, however, does not always require them for this purpose, as they are absent in *T. antarctica* and *T. zetlandica*, where the sarcode is held together apparently without any thing else of the kind. The habit of assigning a cause for every thing that Nature does more frequently meets with contempt than admiration.

Reproductive Process.

As with *Tethya cranium*, so with *T. zetlandica*; both species, in the adult condition, are richly charged with the small globular and compressed elliptical bodies (fig. 13, *d d d*) first described and figured by Johnston under the designation of "oviform" (*op. cit.* p. 84, pl. 1. fig. 8). Those in *T. cranium* are about 1-24th and those in *T. zetlandica* about 1-16th of an inch in diameter: they are therefore easily visible to the unassisted eye, and hence I have been able to give the outlines of a section of fig. 2 in fig. 13, which is pregnant with them, while, every part having been drawn of the natural size, the reader will, by reference to it, have nearly a facsimile of the object itself. Most of the oviform bodies and many in the *section* only just showing themselves above the level of the sarcode, while others are on their edges, their outlines, of course, are not all of the same size and shape. Whether the compression, which, as will hereafter be seen, is confined to the less-advanced forms, arises from the contracting effect of the spirit on a globular form when fresh, or whether it is natural to these bodies, I am ignorant, having never seen a *Tethya* under these circumstances while *living*.

In Dr. Bowerbank's 'British Sponges,' pl. 25. fig. 343, will be found a monstrous representation of one of these oviform bodies under the designation of "gemmule," which is only surpassed by his description (vol. ii. p. 87), where he applies the term "sexual" to them, and conjectures that one may be the "female or prolific gemmule;" but Dr. Bowerbank had never been able to discover any "spermatozoa" in either!

As this is a kind of physiology which I do not understand, let us go back to the term "oviform" first applied to these bodies by their original discoverer, and see if we can trace them from their earliest appearance up to the complete development of the full-formed young *Tethya*. But before entering upon this subject, it is desirable to premise a description of the sponge-animal from which the ova are first produced, and then the mode of sexual union by which impregnation is accomplished.

Last year I confirmed Prof. James-Clark's discovery of a "collar" round the cilium of the sponge-animal (Annals, vol. iv. p. 1, pls. 1 & 2), and at the same time gave a full figure of this body, which must now be regarded as the animal of the sponge just as much as the polype is regarded as the animal of the coral.

Since then most of my observations on the "ultimate structure of *Spongilla*," in which the animal was first pointed out (Annals, 1857, vol. xx. p. 21, pl. 1), have also been confirmed by Prof. James-Clark in his description and illustration of the American *Spongilla* (American Journ. Sc. and Arts, Dec. 1871, vol. ii.; republished in the Annals, 1872, vol. ix. p. 71, pl. 11, and in the Monthly Microscop. Journ. for March, No. xxxix. p. 104).

Shortly describing the animal, animalcule, or infusorium of the Spongiadæ, whichever appellation may be thought most appropriate, it is, in its passive form, a minute globular cell, apparently filled with granuliferous plasma, bearing a nucleus and two contracting vesicles, provided with a rostrum or projecting cylindrical portion supporting a delicate fimbriated collar, in the midst of which is a single cilium, and, in its active state, will take into its body crude material (that is, particles of indigo) if they be presented to it. The collar and rostrum possess the power of polymorphism; and, when necessary, the whole body can be thus transformed. The latter is about 1-3000th of an inch in diameter in the calcareous sponges, and only half that size in those of the siliceous ones that I have examined; and they are arranged in countless groups on the lining sarcode of the areolar cavities of the sponge.

Of all other animalcules or Infusoria with which I am acquainted, the sponge-animal seems to me to come nearest to *Difflugia*, or to that kind of *Amœba* which throws out its pseudopodia from one part of its globular form in particular (see an illustration of this in 'Annals,' 1856, vol. xviii. pl. 5. fig. 17). Hence it may be inferred that, if among the sponge-animals we find instances of two in apparent union similar to that which is termed "zygosis" among the *Difflugiæ*, we have strong reason for believing that in both instances this kind of union is for the same purpose.

In zygosis of the *Difflugiæ* the mouths of the two tests are brought together by an apparent union of the two contained animals; and if this be watched, the two animals thus united will be observed to flow backwards and forwards into each other's tests, as if their incorporation was as complete as the union of two drops of water; after which they separate, and each betakes itself to its own test.

Of this process Mr. W. Archer, of Dublin, who is probably the highest authority living, from his extensive and actual observation of the nature and habits of these animals, states respecting zygosis:—" Whatever may be the significance of the phenomenon, it is at least one which I have noticed myself in nearly every form of all the genera [of the freshwater Rhizopoda], each individual species always *conjugating* only with its *own* fellow" (Quart. Journ. Microscop. Sc. April 1871, No. xlii. p. 111). I can confirm what Mr. Archer has stated; and in one instance I found *five Difflugiæ* of the same form and species, which is one of the largest, viz. *D. urceolata*, Cart. (Annals, 1864, vol. xiii. pl. 1. fig. 7), all united together by their mouths, after the manner of zygosis. But, whether they be found united in pairs, which is the usual way, or in greater number, they are always, as Mr. Archer has stated, of the *same* species. Neither of us has ever seen two different species of *Difflugiæ* in zygosis, which is not less significant of the act being for sexual reproduction than that the individuals engaged in it are not mere varieties of one species, as some would have it.

I have also long since tried to find out the whole bearing of this phenomenon in connexion with the oviform bodies found in both the *Difflugiæ* and *Amœbæ*, and from time to time have recorded what I have observed, by illustration as well as description, which those who wish to consult my contributions in this respect may find in different numbers of the 'Annals,' viz. in vol. xviii. p. 115 (1856), vol. xii. pp. 30 & 261 (1863), vol. xiii. p. 23 (1864), and vol. xv. p. 171 (1865), since which time I have not returned to the subject. I had hoped to publish a figure, now in my journal, of zygosis in *D. urceolata*, in which every detail was measured and drawn upon the same scale, that the relative sizes of all might at once be seen; but, thinking that this might be indefinitely postponed, on account of my studies having taken another direction, I published the description of it in my last paper on the conjugation of certain species of Diatomaceæ, viz. that in the 'Annals,' vol. xv. above mentioned.

Finding that I could obtain no more knowledge of the process by mere observation of it externally, I tried what the effect of crushing and tearing to pieces a pair of *D. urceolata* (for this is the largest and thus best adapted species that I have found for the purpose) under the microscope, with the following results, which, as a kind of *ultimatum* on the subject, was thus published in the paper last mentioned:—

"Returning, then, to the question of impregnative generation in the Diatomeæ, it seems to me that, being so closely allied to the Rhizopoda in their organization, they might be inferred, by analogy, to follow the same mode of producing an impregnated generation as *Difflugia*. That this mode has been demonstrated, I by no means wish to assert; but observations on the subject, made subsequently to those published in my last communications to the 'Annals,' still further support me in the views therein announced, viz. that the nucleus furnishes the *sperm-*, and some other part of the body of the *Difflugia* the *germ-cells*, which produce the new generation. For in that large species which I have designated *urceolata* in my last communication, and which I have since ascertained to be one of the most persistent and plentiful forms about this neighbourhood, I, last summer, almost invariably found the nucleus (instead of undergoing the change as a whole) to become divided into several spherical cells of equal size, each of which presented bodies in its interior similar to a brood of cells, which, on other occasions and under similar appearances, I have found to issue in the form of ciliated, monadic, polymorphic Rhizopods. With these also were present a number of much larger round and subround refractive cells, in which a nucleus was present, but very difficult to be seen, owing to the extreme fineness and apparent homogeneity of the material they contained. There were also several starch-grains present; and on many occasions, but on one in particular, a pair of these *Difflugiæ* in zygosis, when crushed in water under the cover of the slide, presented in their interior, besides a great number of the three kinds of cells mentioned, a still greater number of ciliated, monadic Rhizopods, of the sizes of the bodies in the nuclear cells, and a number of small unciliated *Amœbæ*, about the size of the 'refractive cells.' So far, then, only, do I feel justified in stating that this appears to me to be the mode in which the impregnated generation of *Difflugia* is produced; and if it be so, then all that remains to prove it is the evidence afforded by witnessing the actual union of the 'ciliated monadic Rhizopods' with the 'unciliated refractive cells'—an act which, probably taking place within the body of *D. urceolata* in an undisturbed condition, is not likely to be soon seen among its contents when forced out of the test into water by crushing and the pressure of a glass cover" (Annals, 1865, vol. xv. p. 171 *et seq.*).

I have quoted this paragraph at length, not only to show the results of my last observations on zygosis, but to point out what may take place in the sponge-animalcules under similar circumstances, if we can satisfy ourselves that they also enter into this kind of union. But before commencing this part of our subject, it is also desirable to add briefly what I have observed in the oviform bodies of the *Difflugiæ*, which we may assume to be the result of their zygosis.

One thing is always obvious, viz. that the nucleus disappears, leaving the nuclear utricle empty; and the changes which take place in the oviform bodies in *Euglypha* are recorded in the following extract, viz.:—"I have seen the ovule of *Euglypha* in every stage, from its first appearance in the test to the time when it has acquired the power of putting forth rhizopodous prolongations (fig. 31), after which the tests of very small *Euglyphæ* presented themselves in the same basin, which did not appear before the parents had died off and left their ovules to shift for themselves" (Annals, 1856, vol. xviii. p. 230, pl. 5). All this was described and figured in the place just mentioned, more than fifteen years ago.

We are now in possession of the form of the sponge-animalcule as well as that of the *Difflugiæ* and *Amœbæ*. We know that they all possess the power of polymorphism, and take in crude material for nourishment, but that the former differ from the latter in being infinitely smaller, in possessing a cilium, and in living in communities. However, if we view the sponge-animalcules as but an inferior grade of *Amœbæ*, as we view the compound Tunicata as inferior grades of the great separate Ascidians, then the presence of the cilium in the sponge-cell finds its explanation in the fact, according to my observations, that the young *Amœbæ* begin life with a cilium, which is afterwards retracted. (Annals, 1863, vol. xii. p. 48, and 1864, vol. xiii. p. 21, pl. 2. fig. 19.

We have also become acquainted with the phenomenon called zygosis in the *Difflugiæ*, and its probable consequences, including the formation and development of the oviform bodies into forms like the parent. Let us now see how far any thing in the sponges may present itself to us like the latter.

In Dec. 1869, long before I knew any thing, from actual observation, of the form of the sponge-animal, as described by Prof. James-Clark, I had a very small *Halichondria simulans*, Johnston (*i. e.* not more than a quarter of an inch in diameter), under microscopic observation, in a watch-glass with sea-water, for several days; and during this time I repeatedly assured myself of the form and measurement of all its elementary parts, which, with the position of the spicules, were carefully drawn in my journal, upon the scale of 1-6th to 1-6000th of an inch. I have therefore now the most reliable information on this subject, particularly as these observations and drawings were again repeated with similar results on another specimen of the same species in January 1870.

Among these elementary parts there are figures of the conjugation of cells somewhat larger than the sponge-animals of the "groups," but bearing such a strong resemblance at once to the form of the sponge-animalcule among the sponges, and to zygosis among the *Difflugiæ*, that little doubt can be entertained of the latter being identical.

I have therefore selected for publication that figure (8) which best illustrates the facts, as the others, although equally convincing, are more or less complicated with pseudopodial prolongations.

In this figure we observe distinctly the bodies (*a a*) of the two sponge-animalcules in conjugation or zygosis, united by their rostra (*b b*), drawn upon the scale, as just stated, of 1-6th to 1-6000th of an inch. This would give the ordinary size of the sponge-animalcule of the calcareous sponges, which appears to be about double the size of that of the siliceous ones—measurements which at all times, of course, with such small objects, of such a polymorphic nature, and viewed under such circumstances, should only be regarded as approximative.

I have already stated (Annals, *l. c.*) that, among the marine *siliceous* sponges, *Halichondria simulans*, from its hardiness and the apparently larger size of its sponge-animalcules, together with its plentifulness, affords one of the best species for observations of this kind.

Besides the figure of zygosis above described and given in the plate, there are others where the sponge-animalcules are united linearly, like the individual Diatomeæ in the filament of *Melosira*, with here and there a conjugation like that of our illustration. Schmidt has also figured something of this kind in an allied species, viz. *Reniera aqueductus* (Adriat. Spong. 1st Supp. pl. 1. fig. 12). But, with the polymorphic nature of the sponge-animalcule, such diversities of form being unlimited, our present object has been to select that which is most like zygosis in every respect, an almost facsimile of which I figured long ago in *Amœba radiosa* (?) (Annals, 1856, vol. xviii. pl. 5. fig. 17).

Not knowing until last year the form of the sponge-animalcule by actual observation, I only viewed this conjugation as *very like* zygosis in the *Difflugiæ*; but now that I am familiar with the figure and habits of this animalcule, the identity of the process seems to me complete.

Thus having obtained a starting-point for our history of the reproductive process of the Spongiadæ by impregnation, let us revert to the seed-like bodies in the *Tethyæ*, for the purpose of following it up to the fully developed young animal of the Shetland species, with which we are now most immediately concerned.

And taking a portion of the sarcode of *T. zetlandica* (i. e. from fig. 13), it will be found, when torn to pieces in water under the microscope, to be thickly charged with granuliferous cells about 15-6000ths or 1-400th of an inch in diameter (fig. 7). There is, of course, a wide difference between this size and even that of the body of the sponge-animalcule, which may be set down roughly about the 3000th of an inch. But I can recognize with certainty in these spirit-preserved specimens *no* stages between the two sizes; so I must be content to assume that this is an advanced state of the sponge-ovule, whatever its original size might have been.

When further examined, this cell is observed to be filled with nucleated cellules (*c*), each of which is again filled with minute granules (*d*), and in the midst of all an effete (?) nuclear cell (*b*), like that seen in the *Difflugiæ* and *Amœbæ* (see also

Annals, 1863, vol. xii. pl. 3, on *Amœba princeps*)—that is, *without the nucleus.* This cell, again, is exactly like that which I have described and figured as existing so abundantly in *Dercitus niger* and *Stelletta aspera* (Annals, 1871, vol. vii. p. 13, pl. 4), and which therefore now must be regarded as ova.

From the condition of the ovule imbedded in the sarcode, as just described, we go to the seed-like bodies *outside* it, viz. in the dilated cavities of the excretory canal-system, where they are still pendent to the sarcode by a little pedicle which is analogous to the umbilical cord in higher animals (fig. 14), and which, as the young *Tethya* becomes fitted for an independent existence, gradually atrophies until the separation is complete.

Here, although there is every stage to be observed between the least and most advanced ovule in this part of their development, we shall find it convenient to divide them into two groups, viz. that in which the ovule is elliptical, compressed, pear-shaped, and circumscribed by a kind of capsular covering (figs. 14, *b b b*, and 6 & 12), and that in which it assumes a globular form, with undefined spiculiferous border and areolar sarcode (figs. 14, *a a*, and 4 & 11).

In the first instance (figs. 6 & 12) the cellules of the ovule appear to have become broken down into a granuliferous homogeneous sarcode (*c*) charged with minute refractive silicified spheres, which may be the germs of the spicules that are subsequently to appear in the centre of the mass. Those that are now present are all acerate (that is, without heads), and do not reach the confines of the ovule (fig. 5)—which presents a defined margin (*a*) with the shape above mentioned, and in this form is attached to the dilated cavity of the excretory canal-system by the little pedicle mentioned.

In the second instance (figs. 4 & 11) the "granuliferous homogeneous sarcode" has become areolar (*a*); the spicules have greatly increased in number (*b*); heads of different shapes have been and are being added to them; they have burst through the defined margin of the foregoing development, and carried out with them the areolar sarcode into a papillated globular form, in miniature, like that of the parent. Young sponge-animals have in all probability begun to grow in the areolar cavities; and the pedicle of attachment perishing, the little sponge falls loose into the excretory canal-system, through which it is rapidly ejected into its new element, there to find a place of attachment (perhaps again the stem of a *Halichondria ventilabrum*) and finally attain its adult size.

These two descriptions apply to the ovules of *Tethya cranium* as well as to those of *T. zetlandica*; only the spicules in the former are arranged in a whorl from the commencement, and accompanied by the bihamate spicule (figs. 11 & 12), which points of distinction are, of course, absent in the latter.

It might also be observed that, although the one-armed anchor-headed spicules project beyond the rest in the young *Tethyæ* of both species, they do so to such an extent in *T. cranium* as to form a kind of fringe (fig. 11, *c*).

I am not prepared to make any lengthened comparison between these young *Tethyæ* and the so-called "seed-like bodies" of *Spongilla*. At first it would appear that there is not any very great difference between their sizes respectively, the fully developed young *Tethyadæ* of *T. cranium* and *T. zetlandica* being respectively 1-24th and 1-16th of an inch in diameter, while the seed-like bodies of the five species of *Spongilla* at Bombay, viz. *cinerea*, *Carteri*, *alba*, *Meyeni*, and *plumosa*, average respectively 1-63rd, 1-29th, 1-30th, 1-47th, and 1-22nd of an inch in diameter, the last measurement being the long diameter of the elliptical form (Annals, 1849, vol. iv. p. 81). But when it is considered that these measurements include the thick crust which surrounds each seed-like body, and that the globule of soft contents is still smaller, that no spicules are yet developed in it, and that it cannot be considered the "fully developed" young *Spongilla* until it has left the capsule, it becomes evident that we are not comparing like with like. In short, the state of the contents of the seed-like body much more resembles the ovule of the *Tethyæ* while "imbedded in the sarcode" (fig. 7) than any other stage of the latter above described. At a very early period the seed-like body of *Spongilla* very much resembles in all particulars the globular body of the sponge-animalcule itself, somewhat enlarged; and when fully formed, its contents consist of a globular cell containing a number of spherical cellules filled respectively with granular matters, among which are many still smaller cells or germs. Thus it closely resembles in this respect the ovule of the *Tethyæ* before it leaves the sarcode to become pendent in the dilated cavity of the excretory canal-system. Hence it now seems to me that we should regard the so-called seed-like bodies of *Spongilla* as true ova, which, like the seeds of plants, are wrapt up in a shell for preservation until such time and circumstances occur as are favourable to their development. As the contents of the seed-like body issue from the capsule, the globular cells and *their* contents respectively appear to pass directly into the globular groups of sponge-animalcules, and the excretory canal-system to be hollowed out, and the horny skeleton and spicules formed, in the intercellular plasma which exists between the globular cells (Annals, 1857, vol. xx. p. 26).

The presence of a capsular covering to the ovum in *Spongilla*, and its absence in the *Tethyæ* and the marine sponges generally, is explained by the drought to which the former may be exposed during subsidence of the fresh water in which it is growing. Thus the masses of *Spongilla* in the tanks of Bombay become uncovered and perfectly dry for several months in the year—a contingency to which the marine sponges can never be exposed; and hence the capsule, instead of being a protection to them, would be in the way of the full development of the ovum, which goes on uninterruptedly from the beginning to the end, when it is ejected into the water in a state of comparative maturity. The contents of the ovum of *Spongilla*, on the other hand, do not reach this state until they have emerged from the capsule and become developed into the young *Spongilla*.

Of course, in a new field like this, to which I have now and then turned my attention for the last twenty years, my views progressively have been somewhat modified—and yet not much, as will be seen by my "Description of the Fresh-water Sponges of Bombay," first published in the 'Journal of the Asiatic Society of Bombay,' in 1849, and subsequently reprinted in the 'Annals' of the same year (*l. c.*).

In describing the development of the young *Spongilla* from the seed-like body in the paper just mentioned, it may be observed, at p. 87, that I mention an "intercellular substance," or "semitransparent mucilage," which forms the "bond of union between the cells" of *Spongilla*, that it possesses a power of polymorphism "independently of the sponge-cells, and presents contracting vesicles." All this, too, is figured in the illustrations (pl. 4. fig. 2). Finally, at p. 95 is the following sentence:—"My impression, however, is, that both the horny skeleton and its spicules are formed in the intercellular substance, and not within the cells." This is Häckel's view in 1870; and for this "intercellular substance" he proposes the name of "sarcodine" or "syncytium" (Annals, 1870, vol. v. pp. 112 & 113, "On the Organization of Sponges &c.," translated). No allusion whatever is made to my notice of the same substance &c. in 1849, which probably would have been the case had this naturalist read all that had been written on the subject previously to writing himself. How unlike the old Salmasiuses and Bocharts, &c., who read every thing on their subject and acknowledged it! Has not the age for these master minds passed away amidst the growing desire to avoid every thing that gives extra trouble, even though it may entail inferior work?

The same kind of bodies which Dr. Th. Eimer found in the siliceous and calcareous sponges at Capri, from March to July 1871, and figured, with description, as spermatozoa of these sponges, in the following December (Schultze's Archiv für Mikroscop. Anat. vol. viii. pt. 2, p. 281), I found in *Microciona atrosanguinea*, at Budleigh-Salterton, Devon, in July 1870, and fully described them as such in the following October (Annals, vol. vi. pp. 339,340)—conjecturally, it is true, because I do not know that any one has yet seen them pass into the ovum of the sponge, which is thus still wanting to confirm the otherwise well-assumed fact. My description is unaccompanied by illustrations; but the figures in my journal, from which it was taken, are identical with those of Eimer, and therefore the description too.

The "thread-cells" which Eimer figures from the Renieridæ &c., at p. 283, *ib.*, I have not yet seen.

I could have wished that Eimer had alluded to my description of October 1870 instead of quoting Häckel's account of mine and Prof. Huxley's figures respectively (published in the 'Annals,' in 1854 and 1851) of spermatozoa in the sponges, as explained by Lieberkühn, whose identification of the latter with a flagellated infusorium is now shown by Eimer's figures to have been most unfortunate—and as regards my own, doubtfully given from the first (in 1854, and contradicted in 1858) as spermatozoa, equally unjust; for although probably not the spermatozoa of *Spongilla*, there can be no doubt that they really belonged to it, and, by their habits, could not have been the infusorium mentioned by Lieberkühn. In short, had Lieberkühn read my description as well as seen the figures, he would not have suggested this explanation.

Eimer states, in his "Addendum," that Häckel has also now seen spermatozoa in both the siliceous and calcareous sponges (Jenaisch. Zeitschrift, vol. vi. pt. 2).

Development of the Spicule.

While the opportunity was afforded of tracing the development of the ovule generally in the two *Tethyæ* mentioned, it will not seem unlikely that I should have endeavoured to find out something more of the development of the spicule than is stated in my "Ultimate Structure of *Spongilla*" (Annals, 1857, vol. xx. p. 23); but I could not, so far as its earliest and primary form is concerned (that is, the simple acerate one), although I have been able to do so as regards its arms or appendages. It should be understood, however, that I am not going into the whole of the development of the spicule now, as I am accumulating material for a separate paper on this subject.

In the development of the young *Spongilla*, I, of course, had nothing to deal with but the acerate or primary form of the spicule, as this is the only large form in this sponge; but in the young *Tethyæ*, as will have been seen, there are arms to many of the spicules, resulting in the development of several different forms, the chief of which, and that which is peculiar to the young *Tethya*, is the one-armed anchor-headed spicule.

To resume shortly what I have already stated in this respect:—the development of the ovule commences with the cell of cellules &c. *in* the sarcode; then follows the breaking down of all these cellules into a granular mass of plasma, of an ovoid shape, appended by a pedicle to the *outside* of the sarcode, in a dilated cavity of the excretory canal-system; then a few acerate spicules appear in the centre of this, together with many minute spherical refractive granules, apparently of a siliceous nature; lastly, the granular plasma becomes areolar, the spicules greatly increase, and heads of various forms develope upon their peripheral ends, among which the one-armed anchor-headed one mentioned is not only the most numerous, but, as before stated, extends somewhat beyond the circumference of the young *Tethya*, now become globular. It is to this form, which appears in all stages of development, that my attention has been chiefly directed; and from it I am able to add a little more to the development of the spicule than I have already given.

The four representations under fig. 16, Pl. XXII. are intended to furnish a series of forms illustrative of the development of this one-armed anchor-headed spicule, which, of course, will apply to all other developments of the same kind of form: that of *a* is, of course, assumed, since, before the end of the shaft begins to be inflated, there is no indication of what it is to be, beyond a linear acerate form. I have drawn it as *open* at the ends, though I am not certain if this state always precedes the inflation, as it is frequently seen in the simple acerate spicule. In *b* we have the inflation of the head, which undoubtedly precedes the formation of the arm, together with a terminal expansion of the central canal in a compressed cellular form. Our figure *c* shows the first budding of the arm and the extension of the central canal which leads to it branching off *below* the terminal compressed expansion; while *d* not only shows the full formation of the arm, but that of the one-armed anchor-headed spicule generally, attended by a frequent occurrence, viz. the budding of another arm, *e*. All these figures are drawn to the same scale, viz. 1-24th to 1-600th of an inch, whereby they furnish facsimiles equally magnified of the objects they are intended to represent. Fig. 3 is the head of an average anchor-spicule taken from the base of the *adult* form (fig. 1) and magnified to the same scale. It not only also shows an extension of the central canal beyond the branches given off for the arms, but points out the relative sizes of the adult and fœtal spicules of this kind, when compared with *d* of the following figure.

There are other spicules in the young *Tethya*, especially fork-heads having one, two, or three arms; and these are represented under fig. 17: *a* is one-armed, analogous to the one-armed anchor-head just described; *c* has two arms, and is the most numerous form in the young *Tethya* after the one-armed anchor; *b* is the three-armed form, which is scantily present, like the three-armed anchor-head, *d*; while *e* is the acerate form. I need hardly add that the other ends of all these spicules are single-pointed.

Thus the development of *the* arm is always accompanied by an extension of the central canal of the shaft. But there are other additions to the spicule, viz. spines &c., which are not always so accompanied, as may be seen by reference to fig. 4, Pl. XXII., where they may be observed to have been added to the outside of the shaft after the latter had been formed. Hence, in this instance, it is not the extension of the central canal which determines the ultimate form of the spicule, but some external agency, which adds to and modifies the external form of both the horny and silicified fibre, as well as the spicules. That this should be easily effected on all sides in the midst of the sponge, where these parts are enveloped in the intercellular sarcode, may be easily conceived; but it is not easy to conceive how this takes place in the long spicules of *Hyalonema* and *Holtenia*, unless they grow, like hairs, by additions to their proximal extremities, or the sarcode creeps out over them to their ultimate terminations.

Still, we are dealing here with the developments of the spicule *after* the shaft has been formed, and not with its earliest appearance, to which I can add nothing more than I stated in 1849, *l. c.*, viz. "My impression still is, that both the horny skeleton and its spicules are formed in the intercellular substance, and not in the cells." But how they come into being I know not, any more than the "Preacher," who, 3000 years ago, wrote:—

"As thou knowest not what is the way of the spirit, nor how the bones do grow in the womb of her that is with child;

even so thou knowest not the works of God who maketh all" (Ecclesiastes, xi. 5).

Undoubtedly the power which developes the ovum, and causes it to pass into the new being, acts without brain and organs of sense. It is a power which pervades all nature, and is infinite. Hence, as our brain and organs of sense are secondary products with a finite power, we can never comprehend the infinite one. So that all idea of ever finding out how things come into existence or grow may as well be abandoned. We can see a crystal as soon as it is formed, but the highest magnifying-power does not enable us to see it come into existence or increase in size. As familiar instances of this power, we might perhaps mention the return of the messenger-pigeon direct to its home, the bee to its hive, the young cuckoos to the land of their parents, &c. But the instances are infinite, as the power is unknown; like that of the mind itself, we only recognize it by its manifestations. It is called "instinct," and is regarded by most as a kind of inferior intelligence; but it can see without eyes and reason without a brain, better than we can do with either. In short, it is nature unbounded, of which man is but a finite imitator.

So also in investigations with the microscope, it seems to me highly unphilosophic to speak without modification of the "structureless jelly," to wit, of an *Amœba*, or of the absence of a cell or layer round this animalcule or any body of the kind, because it is not demonstrable to our senses. The leg of a *Euplotes* is probably as complicated in its muscular apparatus as that of a crab-claw, yet it is as transparent and apparently structureless as glass. The texture of a cell- or surface-layer may be infinitely delicate or infinitely dense. There is no difficulty in calling it such under the latter; and it would be unphilosophic to deny its existence in the former. There are, no doubt, textures in the Spongiadæ that loom, as it were in the misty distance of development, which in higher animals can be recognized by the coarsest sense; but in the former condition we should only speak of them as such, and not with that certainty that we would of the latter. The atoms which make up the complicated and beautifully formed body of a *Euplotes* rush about before us, under the microscope, as a whole, with the appearance of being as tough and compact almost as a crab. But let death occur, and the phenomenon called "diffluence" will immediately succeed, in which the atoms fall asunder like a bunch of iron-filings held together by magnetism, when the latter is suddenly withdrawn. Lastly, both motion and change of form may be infinitely slow or infinitely rapid. We could not see either in the *Amœba* were it not for the magnifying-power of the microscope, nor in the heavenly bodies, were it not for their great size and great distance. Hence we cannot comprehend this infinity, and should only speak of these phenomena as they appear to our finite organs of sense, modifying our assertions by our equally finite reason, in all philosophic humbleness. I have been induced to make these remarks because I have lately observed a tendency to speak more decidedly in microscopic inquiries than our powers justify.

EXPLANATION OF THE PLATES.

Plate XX.

Fig. 1. *Tethya antarctica*, n. sp.; fully developed young one, natural size.

Fig. 2. The same, lateral view, magnified to the scale of 1-48th to 1-1800th of an inch: *a*, summit; *b*, base; *c c c*, vents; *d d d*, papillæ of surface supporting spicules; *e*, tufts of spicules projecting from the base; *f*, two very long anchor-headed spicules projecting from the side.

N.B. The greater part of the anchor-heads have been broken off.

Fig. 3. The same, end view of summit, magnified to the same scale, showing three large vents, which branch off internally into the excretory canals: *a a a*, vents; *b b b*, papillæ of the surface supporting spicules.

Fig. 4. The same, full-grown specimen; portion of dermal sarcode, showing the pores and spicules of the surface: *a a*, pores; *b*, spicules. Scale 1-48th to 1-1800th of an inch.

Fig. 5. The same, form of acerate spicule.

Fig. 6. The same, form of triforked spicule; one prong much larger than the other two, which are equal.

Fig. 7. The same, form of anchor-headed spicule of the body.

Fig. 8. The same, form of anchor-headed spicule of the tufts at the base.

N.B. All these are adult forms, drawn to the scale of 1-24th to 1-1800th of an inch.

Fig. 9. The same, real average length of largest acerate spicule.

Fig. 10. The same, real length of longest portion of shaft, to which the anchor-head remained attached.

Plate XXI.

Fig. 1. *Rossella antarctica*, nov. gen.; large cruciform peripheral spicule, showing:—*a a a a*, the four arms, covered respectively with a layer of large and small (macro- and micro-) spines; *b*, continuation of adjoining arm; *c*, shaft or vertical arm, covered with a layer of microspines only; *d*, continuation of same, to show form of free extremity. Scale 1-48th to 1-1800th of an inch.

N.B. In this figure the arms are truncated, to meet the size of the plate, and drawn straight instead of sigmoid, for convenience. See the natural form in figs. 5 & 6.

Fig. 2. The same, lateral view, to show the position of the arms relatively to that of the shaft. All truncated to make the figure smaller.

Fig. 3. The same, central portion, drawn to a larger scale, viz. 1-24th to 1-1800th of an inch, to compare with the fossil one, fig. 37. pl. 9, vol. vii. p. 126, Annals, 1871: *a*, shaft or vertical arm; *b b b b*, horizontal arms; *c*, central canal; *d*, subsequent layer added to the original shaft.

Fig. 4. The same, portion of a horizontal arm much more magnified, showing the original shaft, the spiniferous layer, and the relative size of the macro- and microspines: *a*, original shaft; *b*, additional or spiniferous layer; *c*, macrospines; *d*, microspines.

Fig. 5. The same, lateral view, nat. size.

Fig. 6. The same, to show sigmoid curve of horizontal arms and straight shaft, nat. size.

Fig. 7. The same, podal (?) spicule, showing portion of shaft and anchor-or, rather, grapnel-head, consisting of four recurved arms.

Fig. 8. The same, hexactinellid form, in which the shaft is continued on into a fifth arm (*a*) or straight spike.

Fig. 9. The same, hexactinellid form, where one of the recurved arms (*a*) is prolonged after the manner and length of a shaft. Abnormal form?

N.B. These three figures are all drawn to the scale of 1-48th to 1-1800 of an inch.

Fig. 10. The same, longest portion of shaft found with anchor-head attached, nat. size.

Plate XXII.

Fig. 1. *Tethya zetlandica*, n. sp., attached to the stem of *Halichondria ventilabrum*, Johnston, nat. size: *a*, papillæ, small and closely approximated; *b*, stem of *H. ventilabrum.*

Fig. 2. The same, nat. size, half the specimen: *a*, papillæ, here large and separate.

Fig. 3. The same, anchor-headed spicule of the base of fig. 1, to show, *a*, the continuation forwards of the central canal towards the point. Scale 1-24th to 1-6000th of an inch.

Fig. 4. The same, fully-developed young one, nat. size, viz. 1-16th of an inch in diameter.

Fig. 5. The same, magnified about 16 diameters, showing:—*a*, areolated sarcode; *b*, spicules, chiefly one-armed anchor-headed, of the form given in fig. 16, *d*.

N.B. This must be viewed merely as a diagram. It would be almost impossible to give a facsimile of this beautiful object with all its detail on this scale.

Fig. 6. The same, earlier stage: *a*, defined margin of the ovule; *b*, granular plasma; *c*, spicules, now few and all acerate or without heads, showing that the acerate is the fundamental form of the spicule.

N.B. The same remark applies to this figure: it must be regarded as a diagram. To have introduced a shade for the "granular plasma" would have confused the whole.

Fig. 7. The same, still earlier stage of the ovule, viz. while it is imbedded in the sarcode, now about 1-400th of an inch in diameter: *a*, cell-wall; *b*, nuclear cavity (?); *c*, nucleated cellules; *d*, nucleated cellule, more magnified, showing contained granules.

Fig. 8. *Halichondria simulans*, Johnston; two sponge-animalcules in zygosis?: *a a*, bodies of sponge-animalcules respectively; *b b*, their necks or rostra in conjugation.

Fig. 9. *Tethya cranium,* Johnston, attached to the stem of *Halichondria ventilabrum,* Johnston, nat. size: *a,* group of vents at the apex; *b b,* lines indicating the disposition of the projecting spicules of the surface winding round the summit, like the crown of the human head; *c,* form of bihamate spicules with which the sarcode is charged; *d,* stem of *H. ventilabrum*; *e e,* part of cup of same.

Fig. 10. The same, fully developed young one, nat. size, viz. 1-24th of an inch in diameter.

Fig. 11. The same, magnified about 16 diameters, showing:—*a,* areolated sarcode; *b,* spicules, chiefly one-armed anchor-headed, disposed in a whorl; *c,* extension of anchor-headed spicules beyond the periphery of the young *Tethya*; *d,* minute bihamates.

N.B. The same remarks apply to this and the following figure as to figs. 5 & 6. Note the disposition of the spicules in a whorl, and the presence of the bihamates as distinguishing this species from *T. zetlandica.*

Fig. 12. The same, earlier stage: *a,* defined margin of ovule; *b,* granular plasma; *c,* spicules, few in number, and all acerate or without heads, already disposed in a whorl; *d,* bihamate spicules.

Fig. 13. *Tethya zetlandica,* vertical section of fig. 2, about two-thirds of nat. size: *a,* nucleus; *b b b,* bundles of spicules radiating from the centre of the nucleus to the circumference of the *Tethya,* where they end in the papillary projections of the surface; *c c c,* sarcode filling up the intervals between the bundles of spicules, charged with the ovules, fig. 7; *d d d,* young *Tethyæ* (magnified in figs. 5 & 6) in dilated cavities of the sarcode connected with the excretory canal-system, fig. 14; *e e,* condensed layer of sarcode forming the cortical layer of the *Tethya*; *f f,* papillary prolongations of the same extended up upon the projecting ends of the spicule-bundles.

N.B. All parts of this figure are of their natural size.

Fig. 14. The same, diagram of dilated cavity of sarcode connected with excretory canals, showing pendent position and forms respectively of the young *Tethyæ,* figs. 5 & 6; also openings of the excretory canals: *a a,* fig. 5; *b b b,* fig. 6; *c c c,* openings of excretory canals.

Fig. 15. The same, three young *Tethyæ* attached to one pedicle.

Fig. 16. The same, four figures showing the development of the one-armed anchor-headed spicule, viz.:—*a,* simple shaft; *b,* the same with end inflated; *c,* showing the budding of the "one arm;" *d,* the arm fully formed; and *e,* the bud of a second arm. Scale 1-24th to 1-6000th of an inch.

Fig. 17. The same, other spicules of the fully developed young *Tethya,* fig. 5: *a,* one-armed forked spicule analogous to the one-armed anchor; *c,* two-armed forked spicule; *b,* three-armed forked spicule; *d,* three-armed anchor-headed spicule; *e,* acerate spicule.

Of course, the ends of all these spicules, which are not represented, are single-pointed.

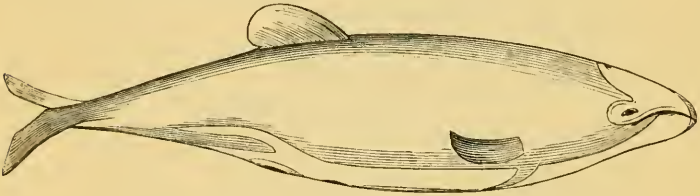
Budleigh-Salterton, Devon.
25th March, 1872.

XLV.—*On the New-Zealand Bottlenose* (Lagenorhynchus clanculus, *Gray*). By Dr. James Hector, F.R.S.

Several lower jaws, a skull, and one complete skeleton of a Bottlenose Dolphin referable to this species are in the Colonial Museum, the skeleton having been described by me in the 'Transactions of the New-Zealand Institute,' vol. ii. p. 27.

It was not till December last, however, that I had an opportunity of examining this dolphin in the flesh, although it appears to be common in Cook's Straits, at least during the summer months; and as the species appears only to have been founded on a skull obtained in the Pacific Ocean, and now in the British Museum, the notes I made may have some interest.

The specimen I have to describe was shot from the deck of the Colonial Government S. S. 'Luna,' at Cape Campbell. The vessel was at anchor under shelter of the Cape during an official inspection of the lighthouse; and a large schul of these "porpoises," as they are commonly called, kept tempting fate till two were shot. Only one was secured; and the preparation of the skeleton has left no doubt that, although a smaller individual, it belongs to the same species as the one already in the Museum.



The colouring, which, as far as I have been able to judge by casual inspection, is very uniform in all the individuals, has very marked characters. The nose and forehead are pure white, bounded by a black crescent behind the blow-hole, sharply defined in front, but shading off behind to light grey, which is the uniform colour of the upper surface of the body. The fins are all blacker than the trunk; and there is also pure black round the blow-hole, cloaca, and vent. The white of the snout extends behind the eye; but the dusky colour extends forward beneath the angle of the mouth. The inferior surface for about one third of the girth is white as far back as the vent, but crowned by an oblique V-shaped isthmus of dark grey beneath the pectorals. The white band is also continued behind by two lateral stripes that ascend on the flanks, but does not extend far beyond the vertical over the vent.

Form. Head convex; snout conical; lower jaw longest. Body fusiform; greatest height one fifth the total length. Pectoral extremity narrow, falcate, equal in length to base of dorsal; dorsal low, rounded, commences at middle of the back and over the umbilicus. *No second fin-like ridge near the tail.* Tail-lobes narrow, falcate, each one third longer than the pectoral.

Total length 51 inches; girth 32 inches; weight 78 lbs.

	inches.
Snout to anterior margin of pectoral	12
,, angle of mouth	6
,, blow-hole	8
,, commencement of dorsal............	24
,, umbilicus	24
,, vent	36
Length of base of dorsal	8
Spread of tail..........................	15
Length of anterior margin of tail-flipper......	12

This species thus differs in external characters from the genus *Lagenorhynchus* as described in Dr. Gray's 'Catalogue of Seals and Whales,' p. 267, in the forward position of the dorsal and the absence of a second fin-lobe on the back.

The dentition of the specimen in the Museum is as follows, and shows that this character is a reliable one for the distinction of species:—

	Length of lower jaw. inches.	Teeth.
1. Complete skeleton	11	$\frac{32}{31} \cdot \frac{31}{31}$.
2. ,, ,, ...	9	$\frac{31}{31} \cdot \frac{31}{31}$.
3. Skull	10	$\frac{32}{31} \cdot \frac{31}{31}$.
4. Lower jaw only	12·5	$\frac{}{31} \cdot \frac{}{32}$.
5. ,, ,, ...	12	$\frac{}{31} \cdot \frac{}{31}$.
6. ,, ,, ...	12	$\frac{}{31} \cdot \frac{}{31}$.
7. ,, ,, ...	11	$\frac{}{31} \cdot \frac{}{32}$.

In every case the three or four front teeth are feeble and irregularly developed, being difficult to observe, the variation in the numbers observed depending on the condition of this part of the jaw. The other teeth are cylindrical and acutely incurved, the middle ones being the best-developed.

There is also in the museum a skull prepared from a specimen cast ashore in Porirua Harbour, in December 1870, which appears to agree with *Delphinus novæ-zealandiæ*, Gray. The characters of the animal were not obtained; but those of the skull are as follows:—

	inches.
Total length	20·5
Beak	11·5
Greatest width	9·0
Width at notch	4·5
„ at orbits	8·0
„ of intermaxillaries at blow-hole	3·4
„ of intermaxillaries at middle of beak	1·3
Height at occiput	6·5
Width of foramen magnum	1·5
„ of condyles	3·8

Has a marked occipital crest and transverse ridge. Also a smaller specimen with beak imperfect, the width at notch being 3·7. Teeth small, irregular in shape, pointed, $\frac{49}{47}\cdot\frac{49}{47}$.

Another recent addition is an imperfect skull of much larger dimensions than the foregoing, the width being 14 inches and the height of the occiput 9 inches. At the same time the bones of the cranial arch are thin, convex, and without prominent crests. It was picked up on the beach outside the harbour of Wellington. The beak with the teeth are wanting; so that the group to which the skull belongs cannot be stated, but it is probably allied to *Beluga*.

Colonial Museum, Wellington, N.Z.
Feb. 19, 1872.

XLVI.—*Notice of two new Fishes from Celebes.* By Dr. Albert Günther.

Symphorus.

Allied to *Dentex*, but with the præoperculum finely serrated. Form of the body oblong, compressed; eye moderate; cleft of the mouth of moderate width, rather oblique, with the jaws nearly equal. One continuous dorsal fin, with the numbers $\frac{10}{12+x}$; anal $\frac{3}{9}$. Caudal fin emarginate. Canine teeth in both jaws. Præorbital entire, broad, the distance between the eye and angle of the mouth being great; præoperculum finely serrated, with more than three series of scales. Seven branchiostegals. Scales of moderate size, ctenoid. Pseudobranchiæ well developed.

Celebes.

Symphorus tæniolatus.

D. $\frac{10}{16}$. A. $\frac{3}{9}$. L. lat. 55. L. transv. 9/20.

The height of the body is a little more than the length of the head, and one third of the total (without caudal). Eye situated immediately below the upper profile of the head, rather nearer to the extremity of the snout than to the end of the operculum, one fifth of the length of the head. The maxillary extends somewhat beyond the vertical from the front margin of the eye. The width of the interorbital space is not much more than the diameter of the eye. Scales on the cheek small, forming about ten series. Dorsal spines rather feeble and short, the third to ninth not much differing in length, about one fourth of the length of the head; the tenth is conspicuously longer, and attached to the first ray. The soft dorsal fin elevated, the third to sixth rays being produced into long filaments. Anal spines feeble, the third nearly thrice as long as the second; anal rays long, especially the third, which is produced into a filament. Caudal fin emarginate. Pectoral reaching to the vent, the fifth upper ray being the longest. Ventrals not produced into filaments.

Olive, fins with a reddish tinge. Body with seven narrow, slightly oblique and undulating, bluish bands, edged with darker; a narrower parallel stripe of the same colour between every pair of the bands. The bands and stripes are continued along the side of the head, but more irregular and broken up in their course. The interradial membrane of the soft vertical fins with round violet spots as large as the pupil of the eye.

One example, 12 inches long, was found by Dr. A. B. Meyer at Macassar.

Batrachus grunniens.

It is worthy of remark that in two specimens from Celebes the vomerine and anterior palatine teeth are not uniserial, but form rather a narrow band.

Mugil Meyeri.

Very similar to *Mugil nepalensis.*

D. 4 | $\frac{1}{8}$. A. $\frac{3}{9}$. L. lat. 27. L. transv. 11.

The height of the body is contained five times in the total length, the length of the head five times and a half; the latter equals the length of the caudal fin. An adipose membrane covers a portion of the iris anteriorly and posteriorly. The upper profile, from the dorsal to forehead, is nearly straight.

The interorbital space is flat, and its width is two fifths or one third of the length of the head. The upper lip is moderately thick, and forms the front margin of the snout. The anterior margins of the two mandibular bones form an obtuse angle; and the cleft of the mouth is very much broader than deep. The præorbital is angularly bent, and has its extremity truncated and distinctly denticulated. The extremity of the maxillary is conspicuous behind and below the mouth. There are nineteen series of scales between the spinous dorsal and the snout. The pectoral extends to the seventh scale of the lateral line, and is as long as the head, the length of the snout not included; it has no elongate scale in its axil. The anterior dorsal commences above the ninth scale of the lateral line, midway between the snout and the base of the caudal fin; its anterior spines are stout, the first the longest, two thirds of the length of the head; there is an elongate pointed scale at its base. The soft dorsal and the anal are enveloped in scales, and lower than the spinous dorsal; the former commences above the eighteenth scale, or above the middle of the anal fin. Caudal distinctly emarginate.

Two specimens, 7½ inches long, were sent by Dr. Meyer from Macassar.

XLVII.—*On a Subfossil Whale* (Eschrichtius robustus) *discovered in Cornwall.* By William Henry Flower, F.R.S.

In the Museum of the Royal Geological Society of Cornwall at Penzance are preserved some bones of a whale, which were discovered more than forty years ago at Pentuan, in the parish of St. Austell. The circumstances under which they were found are of considerable geological interest, and are fully described in a paper communicated to the Society by the late Mr. J. W. Colenso, entitled "A Description of Happy Union Tin Stream-Work at Pentuan" (read October 1829), and published in the fourth volume of the Society's Transactions. It appears that they were found about half a mile from the present sea-shore, and at a depth of rather more than twenty feet from the surface, imbedded in a stratum of sea-sand, above which was a bed of rough river-sand and gravel, and which overlay a remarkable deposit of sand containing timber trees (chiefly oaks), remains of various land-animals, red deer, oxen and boar, human skulls, and, at a still lower level, stumps of trees *in situ*, moss, leaves, hazel-nuts, &c. Beneath these was the tin-ground, on account of which the excavations were made, lying on hard rock composed of blue killas, at a depth altogether of about 60 feet from the surface, the greater part of which is below the present sea-level. These conditions appear to indicate that at one period the spot was occupied by dry land, and was the site of a forest—that it subsequently became submerged to a considerable depth below the sea, at which period the whale would be stranded—and that it has since been restored to the land, either by elevation or by accumulation of sand driven up by the sea, together with gravel washed down from the neighbouring hills. As to the date of the whale's stranding, I will not venture to offer a conjecture; but the evidence is conclusive as to its having been subsequent to the occupation of the country by man and recent animals, as the red deer.

The bones mentioned by Mr. Colenso are all now in the museum at Penzance, and are (1) the right ramus of the mandible or lower jaw, (2) a lumbar vertebra, (3) a humerus, (4) a radius, (5 & 6) two metacarpals. There is every reason to suppose that they have belonged to the same individual, and to an animal which had probably attained its full size, though the disk-like terminal epiphyses of the vertebra had not yet coalesced with the body. At the time of their discovery, they were rightly identified as having belonged to "a large whale;" but they have never been fully described, nor has the species to which they belong been ascertained. During a recent visit to Penzance, I had the opportunity, through the kindness of the officers of the Society, of making an examination of them; and I propose to present the results in a complete form to the next meeting of the Society, that the full description of the bones may appear in the same series of publications which contains the account of the geological features of the spot in which they were found; but in the mean time I think it desirable that an abstract of these results should be placed on record.

It is perfectly evident that these bones belong to no species of whale known to inhabit the British seas; indeed the peculiar form of the mandible and the relative proportions of the different bones to each other exclude not only all these, but all known existing whales. On turning to the published descriptions of skeletons of whales supposed to be extinct, it was with much interest that I was able to identify them with those of a specimen found under remarkable and somewhat similar circumstances in the Swedish island of Gräsö, in the Baltic. In this case, fortunately, the skeleton was far more complete than in the Pentuan specimen; and as all the bones have been excellently described and figured by Professor Lilljeborg, of Upsala*, there is no difficulty in making a satisfactory comparison. This specimen was first named by Lilljeborg *Balænoptera robusta*; but it constitutes the type of the genus *Eschrichtius* of Gray—a designation which has been adopted by its discoverer in his subsequent and more detailed description above referred to. It was found in a field, imbedded partly in sand and partly in clay, at a depth of from 2 to 4 feet from the surface, 10 or 15 feet above the present sea-level, and 840 feet from the shore, in conjunction with shells of *Mytilus edulis* and *Tellina balthica* of precisely the same appearance as those now met with in the Baltic—indicating a period when the general physical features of the sea were as at present, though anterior to the elevation of the island to its present level.

In size the Cornish specimen was slightly inferior to the Swedish, the length of the mandible of the one being 7 feet 6 inches, of the other 7 feet 11½ inches (English); the remaining bones bear a corresponding proportion. The entire length of the Swedish skeleton was estimated at between 45 and 50 feet.

A single cervical vertebra, in a mutilated condition, cast ashore in Babbicombe Bay, Devonshire, in 1861, has been referred by Dr. Gray† to the same species; and Mr. Cope considers that a jaw-bone preserved at Rutger's College, New Brunswick, N.J., may belong to it‡.

These are the only known instances of the occurrence of this whale, which, if extinct, must have become so at a comparatively recent period. Its systematic position is of much interest, as it certainly cannot be placed in either of the three principal genera into which the existing whalebone-whales arrange themselves, viz. *Balæna*, *Megaptera*, and *Balænoptera*, but is in some respects an annectent form, though with certain peculiarities of its own.

XLVIII.—*Notes on the Classification of the Sponges.* By Dr. J. E. Gray, F.R.S. &c.

In the 'Proceedings of the Zoological Society' for May 9, 1867, I published some notes on the arrangement of sponges, and descriptions of some new genera—in which I divided the genera into sections, orders, and families.

In the present paper I propose to make an alteration in the

* "On two Subfossil Whales discovered in Sweden," Nova Acta of the Royal Society of Sciences at Upsala, ser. 3. vol. vi. 1867; also Recent Memoirs on Cetacea (Ray Society), 1866, p. 278.

† Catalogue of Seals and Whales in the British Museum, 1866, p. 133.

‡ Proc. Acad. Nat. Sc. Philadelphia, 1868, p. 194.

general arrangement of the families, which is the result of a continued study of the sponges and of the various books and essays that have been written upon them.

I have thought it well to propose this arrangement, leaving the details of the genera for naturalists who are younger and have better eyes than I have or am likely to have at my advanced age.

In the 'Annals and Magazine of Natural History' for 1868, vol. i. p. 165, I did propose a revision of the arrangement of the families; but more experience in the study of these bodies has induced me to suggest a further modification, retaining the families suggested in the first paper, but abolishing the division of *Malacosporæ* and *Chlamydosporæ* (as it is nearly certain that what Dr. Bowerbank calls spores or ova in *Geodia* have nothing to do with generation), though retaining the section for the freshwater sponges, which have ova of very different structure from that found in marine sponges.

I believe the system I proposed in 1867 and 1868 may be much simplified by leaving out some of the larger divisions, though the groups separated by them are evidently natural. Thus, for example, misled by the confidence I placed in Dr. Bowerbank's observations, I called the spherical mass of spicules in *Geodia* ovisacs, which he says become converted into these balls; but my friend Mr. Carter states, in the 'Annals and Magazine of Natural History' for 1869, vol. iv. p. 17, that "on no occasion have I been able to discover any central cavity in any stage of their development;" and he calls them "globular crystalloids," considering them the same as the large stellate bodies in *Tethya*, called by Dr. Bowerbank "stellate spicules," while he describes the seed-like bodies of *Spongilla* as commencing in a simple spherical soft cell, looking like a white speck imbedded in the sponge, and finally becoming coated with its horny and siliceous spicular cortical coat.

This being the case, I propose to abandon the sections *Malacosporæ* and *Chlamydosporæ*, and to retain the orders *Sphærospongia* and *Potamospongia*, only rendering their characters more consistent with our present knowledge of the subject. This systematic distribution is considered only a first attempt at arranging the genera of sponges in a systematic order, according to an analytical method. It is doubtless very incomplete, but it has the advantage of being capable of any extension that may be required; and I shall consider it a step in advance if it allows naturalists to be able to say at once to what group a majority of the sponges they examine will belong. I am aware that there do occur sponges which are intermediate between the orders—as, for example, Mr. Carter has described a Tethyoid sponge which has the defensive spicules of the *Hamispongia*, and there are some sponges which it is difficult to say if they belong to the *Astrospongia* or *Sphærospongia*; but such annectent or intermediate genera are found in all methods of arranging animals and plants. Dr. Bowerbank and Prof. Oscar Schmidt form genera for single species or for small groups of species, and at the same time place beside them genera of a most polymorphal character, containing an abundance of species, which would break up into natural groups having characters quite as marked as those which distinguish the limited genera which they admit. But all this must be left to younger eyes.

Some sponges have the habit of collecting and imbedding in their skeleton or sarcode spicules which are the remains of other sponges that have died and decayed in the sand on the sea-coast on which they live. Some species are so particular that they select one or more special kinds of spicules for this purpose; therefore it is necessary to determine with care the real spicules that naturally belong to the organization of the sponge and those that have been added to it.

It has been repeatedly stated that the external form of sponges does not afford any character for their distinction, and that they can only be distinguished by their microscopic structure. It is quite true that the microscopic structure and the form and arrangement of the spicules do afford most important characters for the distinction of the sponges, as they do in all other natural and artificial bodies; but the external character is quite as important, and the two together must be studied before a natural method of classifying these animals can be arrived at. This fallacy has arisen from the sponges having of late been chiefly studied by microscopists: since they found that the spicules form very pretty slides, of course they considered their method of study was the only one to be followed. I think no one can look at an extensive collection of sponges without being struck by the persistence of the forms which the species assume, and how the species naturally fall into groups according to their external form; and it is curious to see that the microscopists who write most strongly against any attention being paid to the external form, are themselves influenced by it in the formation of their genera. It is very true that some species are very polymorphous, as, for example, the *Voluspa polymorpha* of Miklucho-Maclay, from the North Pacific Ocean; but there are polymorphous species of Algæ and zoophytes, and yet the general forms of these animals and plants are used in their arrangement, and the polymorphism, as in this case, is the exception and not the rule; if the example cited is confirmed by future research, then polymorphism will be one of the characters of the group.

Amateur naturalists and microscopists often complain of the brevity of the characters that I have given to the genera, forgetting that it is only necessary to give a character which separates it from the genera of the same family or section of the family to which it is referred. To make this analytic, the character often requires a considerable knowledge of the subject and of the structure of the group, while almost any body with a slight knowledge of the terms can easily make a long description of a sponge, which will probably contain the characters of the class, order, and family to which it belongs, but very likely not contain the essential character of the special sponge; or if it does contain it, it can only be discovered by repeated reading of the description, and comparison of it with equally prolix descriptions; so there can be no doubt of the advantage of the analytic method and of the great improvement that the Linnean system introduced. But to form them, and, perhaps, properly use them, requires preliminary and systematic study.

Ellis, in his 'Zoophytes,' mentions the existence of glassy spicules in sponges; but, I believe, the first person who figured them, and showed their structure in the different sponges, was Jules César Savigny, who figured several Egyptian species which had spicules, in the large and expensive work, published by order of Napoleon, to illustrate the history and antiquities of Egypt. I do not think that Savigny ever published the descriptions of his plates, the work being too large to be finished, and Savigny having unfortunately become blind in after life. It was one of the saddest of the many sad sights I saw in Paris, when I visited the two great naturalists, viz. Savigny and Lamarck, both stone-blind and suffering most abject poverty. I believe Savigny's only means of support was the small allowance he had from the Academy of Sciences; and he had to wander to the meetings of that body, led by a boy, that he might obtain the larger allowance given each time that he made his appearance in person. The last decade of Lamarck's life was even still more sad and tragic; but I believe that I have already recorded the greater part of this in another place. Indeed the end of the purely scientific man in France, uninfluenced by any thing but the love of nature, is most distressing. Fortunately I have never known men even with far lower scientific pretensions in such distress in this country. As soon as it was known that Ralfs was in difficulties, his wants were most amply provided for by public subscription among scientific men; and I could refer to several cases where such were hardly known before they received similar sympathy, whatever might have been the cause of their distress respectively.

Section A. *THALASSOSPONGIA.* (Marine Sponges.)

Sponge marine, brown, red, or purple. Ova membranous, unarmed.

Subsection 1. *Leiospongia*, Gray, P. Z. S. 1867.

Sponge horny, without any spicules, or, when spicules are present, they are of the most simple kind, being either fusiform, needle-shaped, or pin-shaped, often varying in size in the same species, and sometimes strengthened with sand and other extraneous bodies.

Order I. KERATOSPONGIA.

Sponge consisting of horny fibres, often anastomosing and more or less elastic; sometimes purely horny, at others strengthened with grains of sand, broken spicules, or siliceous spicules, either enclosed in the centre of the fibres or scattered on the surface. The thickness and solidity of the horny coat vary in different families; sometimes it is very thick and hard, and at others it scarcely covers the spicules with a very thin coat.

A. *The skeleton of the sponge horny or only strengthened by grains of sand or foreign spicules borrowed from the sand.*

Fam. 1. **Spongiadæ**, Gray, P. Z. S. 1867, p. 508.

Skeleton formed of reticulated horny fibres.

a. The fibres of the skeleton homogeneous. *Spongia*, *Spongionella*, *Cacospongia*, *Phyllospongia* (Ehlers).

b. The fibres of the skeleton surrounded by a soft cortical substance. *Aplysina.*

c. The fibres with a central tube. *Verongia*, *Ianthella* (Gray).

Fam. 2. **Ceratelladæ**, Gray, P. Z. S. 1868, p. 575.

Sponge irregularly dichotomously branched; stem hard, solid, dilated at the base, with abundance of very minute, cylindrical, tortuous tubes; branches and branchlets tapering, formed of very tortuous cylindrical fibres forming loops, which produce a spicular surface.

Ceratella and *Dehitella*, Gray, P. Z. S. 1868, p. 579, figs. 1, 2.

Auliskia appears to be a sponge-fibre on which a horny zoophyte has grown. Dr. O. Schmidt says it is a parasitic Alga, but I know no Alga of a horny texture!

Fam. 3. **Hirciniadæ**, Gray, P. Z. S. 1867, p. 510.

Skeleton formed of two kinds of horny fibres:—the one thick, and with a central line of broken spicules or grains of sand within, reticulated, forming the base of the skeleton; the other very slender, forming radiating spicular tufts, which do not anastomose.

Hircinia, *Sarcotragus*, *Stematumenia*.

Fam. 4. **Dysideidæ**, Gray, P. Z. S. 1867, p. 511.

Skeleton formed of reticulated horny fibres, with sand or broken spicules of other sponges imbedded in the centre, and covered with a more or less thick coat of horny matter; brittle when dry.

Dysidea.

B. *Skeleton formed of anatomosing filaments having one or more series of spicules in the central line.*

Fam. 5. **Chalinidæ**, *l. c.* pp. 503 & 511.

Fam. 6. **Phakelliadæ**, *l. c.* pp. 503 & 516.

Fam. 7. **Halichondriadæ**, *l. c.* pp. 503 & 518.

Fam. 8. **Polymastiadæ**, *l. c.* pp. 503 & 527.

Add:—*Quasillina* (*brevis*), Bowerbank. Very like *Euplectella*, but without hexaradiate and other spines.

C. *Skeleton formed of anastomosing filaments or expanded fin-like lobes covered with diverging spicules on the outer surface.*

Fam. 9. **Ophistospongiadæ**, *l. c.* pp. 503 & 514.

* Spicules smooth. *Ophistospongia*.

** Spicules verticillately spined. *Ectyon*.

Order II. SUBERISPONGIA.

Skeleton massive, composed of sarcode densely charged with simple or pin-like spicules; without branched excretory system, which is replaced for the most part by areolar cavities inosculating and finally terminating in vents on the surface.

Fam. 1. **Suberitidæ**.

Suberita, *Spiculina*.

Fam. 2. **Raphiophoridæ**.

Raphiophora, *l. c.* p. 524; *Raphyrus*, *l. c.* p. 516; *Osculina*, but the figure appears much embellished, and the papillæ are the excurrent canals.

Fam. 3. **Clioniadæ**, *l. c.* pp. 504 & 524.

Generally living in shells or rocks.

Ciocalypta probably belongs to this order, but is quite unknown to me.

Order III. ARENOSPONGIA.

Skeleton consisting of agglutinations of grains of sand, forming a subcircular disk, with spicules on the circumference and at the mouth of the oscules.

Fam. 1. **Xenospongiadæ**, *l. c.* pp. 504 & 547.

Sponge consisting of a subcircular disk of agglutinated siliceous spicules and sand, with a series of diverging filiform spicules on the circumference and around the oscules.

Halichondria patera, from Mr. Barlee, in the British Museum, and the type of *Halicnemia patera*, Bowerbank, seems to be allied to *Xenospongia* (1868).

Subsection 2. *Acanthospongia.*

Sponge armed with peculiar-shaped spicules, as well as the usual formed ones found in the other sections. Often several kinds in the same sponge.

Order IV. HAMISPONGIA.

Sponge horny or fleshy, strengthened with fusiform or needle-like spicules, interspersed with anchorate or bihamate spicules.

Esperiadæ, Gray, P. Z. S. 1867, pp. 504 & 531.
Desmacidon, O. Schmidt, Spong. Faun.

The fusiform spicules are generally imbedded in more or less abundant horny matter; but in some this horny matter is so small that the spicules appear to form fascicles in the sarcode.

Fam. 1. **Esperiadæ.**

Anchorate spicules with a large and a small or rudimentary fluke, attached to the keratose skeleton; bihamate and polyhamate spicules are often immersed in the sarcode.

Esperiadæ, sect. 1 & 2, P. Z. S. 1867, p. 532.
Esperia, *Mycale*, *Ægogropila*, *Menyllus*, *Alebion*, *Iophon*, *Carmia*, *Grapelia*.

Fam. 2. **Desmacidonidæ.**

Retentive spicules with a similar well-defined expanded unilateral fluke at each end (æquibianchorate), free in the sarcode, which also contains simple or bihamate spicules.

Esperiadæ, sect. 3, Gray, *l. c.* pp. 532 & 534.

The flukes of the bianchorate spicules are of very different shapes, as described in the paper above referred to; and the sponges are of very different forms, sometimes probably containing more than one family.

a. Ends of spicules divided into two or three spines. *Isodictya*, *Emplocus*, *Anchinoë*, *Microciona*, *Dendoryx*, *Pronax*, *Euthymus*, *Desmacidon*, *Hamigera*, *Hymedesmia*, *Tereus*, *Homœodictya*, Ehlers.

b. End of spicules concave, with a single central apical tubercle. *Corybas.*

c. End of spicules cup-shaped. *Ingallia.*

d. Spicule oblong, boat-shaped, concave on the sides. *Naviculina.*

Fam. 3. **Hamacanthidæ.**

Retentive spicules with a definite compressed sharp-edged fluke at each end, free in the sarcode. Sponge thin, coating.

Esperiadæ, sect. 4, Gray, *l. c.* pp. 532 & 538.

Hamacantha = *Desmacella.*

Fam. 4. **Gelliadæ.**

Defensive spicules simple or contorted, without any bianchorate spicules intermixed, free in the sarcode.

Esperiadæ, sect. 5, Gray, *l. c.* pp. 532 & 538.

a. Defensive spicules filiform. *Gellius*, *Biemna*, *Asychis*, *Oceanopia* (Norman).

b. Defensive spicules clavate at the end. *Dymnus* (*Damo*).

Order V. CORALLIOSPONGIA.

Skeleton with hexaradiate spicules covering the surface or imbedded in the sarcode, and very often simple or forked tricurvate spicules imbedded in the sarcode. The sarcode of this family is very fluid or very slight, and scarcely visible in the dried sponge.

The hexaradiate stellate spicules, which are the essential character of this order in the perfect state of development, consist of an elongate needle-shaped spicule, which has four diverging rays springing from about the centre of its length.

The primary spicules and rays are generally smooth and tapering to a point; but one or both ends of the primary spicule, and sometimes of the rays, are armed with spines which are recurved from the centre; sometimes these spines are so numerous and crowded that they imbricate one over the other. Very commonly when the transverse rays of the spicule form the outer surface of the sponge, or are attached to the internal skeleton of the sponge, one end of the central axis is reduced to a small tubercle in the centre of the rays. Sometimes one or even all of the lateral rays may be very small and so abortive as to be only represented by a small tubercle or swelling in the needle-shaped primary spicule; but when this is the case, there is always to be observed a tube crossing the central tube of the primary ray where the diverging rays would have been situated. The variations of the spicules are well figured in Schultze's work on *Hyalonema*, tab. iii. & iv.

The sponges of the genus *Axos* have the primary spicules and rays very short, and of equal thickness and length; they look like seven cubes, one of which is placed on each side of the central one.

The study of the variation which one kind of spicule may undergo, even in a single species, is most important; and it is to be regretted that Dr. Bowerbank, in his paper on the organization of sponges, has not paid more attention to this part of the subject, rather than giving his long and composite names to all the varieties of spicules that had occurred to him. This is a subject that must be studied in detail before we can hope to understand the organization of the sponges.

Sect. 1. *The hexaradiate spicules on the outer surface of the sponge.*

Fam. 1. **Pteronemadæ.**

Sponge oblong; outer surface formed of hexaradiate spicules; lower surface with elongate filiform spicules ending in three recurved lobes.

a. Anchoring filaments arising in a circle of tufts around the base of the sponge. *Pteronema*, Leidy, Kent, Microsc. Journ. 1870, =*Holtenia*, Thompson, P. Z. S. 1869, p. 32.

b. Anchoring spicules arising from all parts of the sponge. *Caliptera* = *Pheronema Grayi*, Kent, Microsc. Journ. 1870. *Vasella* = *Holtenia*, Smit.

Fam. 2. **Lanuginellidæ.**

Sponge cup-shaped, attached; surface of the sponge formed of abundant irregularly placed hexaradiate spicules, with very long subulate ends, and with scattered spheres of very long radiating spicules with dilated ends.

Lanuginella, Kent, Microsc. Journ. 1870, tab. lxv.

Sect. 2. *Hexaradiate spines in the sarcode.*

A. *Sponge free, attached to the mud by numerous elongated filamentous spicules surrounding its base and having small recurved spines at the end. Skeleton formed of elongated cylindrical spicules more or less united by siliceous secretion.*

Fam. 3. **Euplectelladæ.**

Sponge tubular, free, formed of bundles of elongated thread-like spicules placed in horizontal transverse and oblique directions, often crossing each other, forming more or less irregular network, and often closed at the top by a netted lid formed of shorter spicules; the base with elongated free spicules terminating in three or four short spines, by which it is fixed to the mud. The sarcode mucilaginous, studded with differently shaped spines, some of which are many-rayed, stellate, with clavate arms.

Euplectelladæ, sect. A, Gray, P. Z. S. 1867, p. 528.

Euplectella.

Fam. 4. **Hyalothaumadæ.**

Sponge elongate, free, wider above, with anchoring fibres at the base. The filiform spicules united into bundles, which anastomose freely with each other, forming a solid framework.

Hyalothauma, Herklots and Marshall; ?*Semperella*, Gray, Ann. & Mag. N. H. 1868, xi. p. 373; *Eureta*, Semper.

B. *Sponge fixed; spicules united together by siliceous matter, forming a netted mass covered with sarcode, in which are scattered other differently shaped spicules. Spicules of skeleton forming a coral-like mass.*

Coralliospongia, Gray, P. Z. S. 1867, p. 505; Ann. & Mag. Nat. Hist. 1868, i. p. 165.

These sponges are hard and coral-like, the skeleton being formed of siliceous spicules anchylosed together, forming a hard siliceous mass, covered with sarcode. They contain a number of very curiously shaped spicules, which are generally free, of very different forms in the different genera: some have regular spines with three-spined ends, like *Tethya* and *Geodia*, which are sometimes bifid and forked at the end, and others are trifid. In other genera the spine is short, and the lobe is slender and weak and forked at the end, which gradually pass into spicules which have the lobes variously divided into branches in a most unequal and irregular manner, gradually passing into others which have an orbicular horizontal disk at the end of the short spine instead of the lobes or hooks.

This order presents the greatest abundance of spicules and the most diversified forms of them. The spicules that form the greater part of the skeleton of these sponges are most frequently united together by an extra development of siliceous substance. Dr. Bowerbank has repeatedly denied that the latter is a true explanation of their structure, and calls them *siliceo-fibrous* sponges. Any one who will grind down any of the siliceous network of these sponges, so as to expose their internal substance, will see the perfect form of the spicules, and the additional deposit of siliceous matter which unites them together. This deposit is formed of thin concentric coats, like the spicules. The same thing may be seen by submitting a similar piece of the skeleton of the sponge to the action of a spirit-lamp, when the different layers of the cementing portion and spicules separate. This structure is well shown in Prof. Claus's beautiful work on *Euplectella*.

Dr. Bowerbank, in the 'Proceedings of the Zoological Society,' 1869, pp. 66 & 323, has published "a Monograph" of the "Siliceo-fibrous Sponges," illustrated with eight plates by Lens Aldous. I have the utmost confidence that these plates accurately represent the specimens in the slides placed before the artist; but knowing how many of the specimens so mounted were obtained and manipulated, I have great doubt of the fragments figured belonging to or fairly representing the structure of the species they are said to illustrate; at least, I know that they are taken from very different parts of the sponges. Thus what is figured as *Myliusia Grayii* was a very minute fragment which was nipped off from the upper margin of a minute sponge, about the size of a large thimble; and that which was described as *Dactylocalyx Prattii* is from a specimen cut from the expanded root of the sponge. Now it has never been proved that the structure of two such different parts of a sponge is identical, and therefore that fragments, taken from different parts, fairly represent the generic or even specific character of a sponge. The specimen which is described as the type of the genus *Myliusia* of Bowerbank, as distinct from my genus of that name, is taken from a very young and imperfectly developed sponge which, I believe, belongs to a very large species. It is to my mind very doubtful if the microscopic structure of such a young specimen can be taken to fairly represent the structure of the adult sponge; and I am more inclined to this opinion as the specimen, which is very like it, but rather more developed, has, even according to Dr. Bowerbank, a different structure, and the same structure as the adult specimen which Dr. Bowerbank refers to another genus. At any rate, it has to be proved that these coral-like sponges do not change their structure from the very early and thin paper-like state till they arrive at their usual thick coral-like condition. Until this is proved, a genus founded on such materials, I am afraid, must be placed in the same category as a genus of sponges from the cocoon of the common leech, and of that founded on the Foraminifera so common on the fronds of Algæ on the south coast of England. At least I think that one must lose confidence in the system proposed in this paper when one finds that a sponge which M. Valenciennes and even Dr. Bowerbank himself formerly considered to be one species, under the name of *Iphiteon paniceum*, is now divided into two genera, viz. *Dactylocalyx pumiceus* and *Iphiteon panicea*—that, of two sponges which I had regarded as belonging to the same species, having the type specimens before me, both, like the former species, coming from the West Indies, one is, according to Dr. Bowerbank, *Dactylocalyx pumiceus*, and the other *Iphiteon Ingalli*. It is natural to conclude that that cannot be a natural division, when it separates into different genera specimens which are so nearly allied that naturalists who have had considerable experience in sponges have regarded them as the same species, as I am still inclined to regard them, even after Dr. Bowerbank's prolix descriptions and figures, as I think all the differences may be derived from his having taken his fragments from different parts of the sponge; and the unnatural character of the genus becomes more apparent when we observe that in the genus *Iphiteon* he places *Myliusia* and *Aphrocallistes*—genera which have been adopted by Percival Wright, Oscar Schmidt, and others. In the same manner the genus *Dactylocalyx*, though separating species that have been regarded as the same, includes in it my *Macandrewia*—sponges which at any rate have a very different external appearance and general form.

In the West Indies there are, according to Dr. Bowerbank:—

1. *Dactylocalyx pumiceus*, p. 77; *Iphiteon panicea*, p. 324; *Iphiteon Ingalli*, p. 331.

2. *Iphiteon callocyathes*; *Myliusia Grayii*; *Dactylocalyx polydiscus*.

From Madeira and the Azores:—

3. *Dactylocalyx Macandrewii*; *Dactylocalyx Masoni*; *Dactylocalyx Bowerbankii*, p. 94; ?*Dactylocalyx Prattii.*

I believe, from the examination of the specimens, that all these names belong to only three species, belonging to the three genera *Dactylocalyx*, *Myliusia*, and *Macandrewia*, each of which, unfortunately, has several synonyms.

It is to be observed, with one or two exceptions (and they are more apparent than real), that all the species in this monograph are founded on a single specimen—in other words, that each specimen that has come under Dr. Bowerbank's examination is regarded by him as a distinct species or genus. This being the case in this beautiful family of sponges, which have such distinctive external appearance and characters, which are to be so easily observed, and which come from so few localities, it leads one to inquire, is the way in which Dr. Bowerbank examines sponges a good one for the determination of genera and species? And it leads one to look at his 'History of British Sponges;' and there one observes the same descriptions of species from the specimens collected in the same locality or at the same time; and, judging by this monograph, I think that it explains the reason why in that work so many sponges are described as new species.

I am glad to see that the Ray Society is about to publish figures of the species of British sponges, which must increase our knowledge of *Spongiadæ*; but these figures, being taken from slides prepared for the microscope, instead of from the actual examination of *one specimen*, will thus, unfortunately, have all the uncertainty attached to them that belongs to the figures of this monograph.

Dr. Oscar Schmidt, who stayed some time at St. Leonards, in his just published 'Spongienfauna,' observes that *Diplodemia vesicula* "appears to be a fragment or a young state of a *Chalina*" (p. 77); and in speaking of *Hymeniacidon Bucklandi*, he observes that Dr. Bowerbank, in the diagnosis of this sponge, says, "*Tension-spicules tricurvate, few in number.*" "These siliceous bodies, belonging to *Desmacidon*, have, without doubt, got into the preparation merely by accident" (p. 76). Mr. Carter informs me that this is a mistake on Dr. Schmidt's part. The spicular composition of this sponge is exactly as Dr. Bowerbank describes it. Schmidt observes, under *Desmacidon Jeffreysii* (which he says is a species of *Esperia*, and which Dr. Bowerbank now calls the cloaca of a new genus, *Oceanopia*):—"The anchor-shaped siliceous bodies have escaped Bowerbank's notice in this species. I suspect that that has been the case frequently, especially in the species of *Hymeniacidon*, which, according to his account, have knobbed spicules." Dr. Bowerbank does not mention them in the character of *Oceanopia*.

A friend observes:—"Indeed it is remarkable that one of the most practical men of the day in the examination of sponges, viz. Dr. O. Schmidt, has failed to identify the greater part of the sponges described by Dr. Bowerbank in his 'British Spongiadæ,' as may be seen by his attempt to synonymize the latter in his 'Atlantisch. Spongienfauna.'"

Surely the having the name of "Bowerbank" after each of the species can have had no influence in causing him to alter the generic names of the greater part of these sponges, and to make species of what I regarded as varieties; but it does look very suspicious to see the name of "Bowerbank" at full length after all the species but one in this monograph, placed there solely because he has changed the name. The same occurrence of this name may be observed in the work on British Sponges, where there are whole pages of names with the word "Bowerbank" at full length after each species. Botanists have observed that the having "*mihi*" or "*n. sp.*" after a name has influenced the manufacture of many nominal species; but that is not to be compared to the above system.

On a former occasion I have stated that Dr. Bowerbank assured me, in the presence of three other naturalists, in such a decided manner that there could be no misunderstanding, that the specimen of *Macandrewia azorica* that I described and figured was certainly the type of his manuscript species *Dactylocalyx Prattii*. In this work he describes *Dactylocalyx Prattii* for the first time, and gives East Indies, without any doubt, as the locality; but he afterwards states that Mr. Pratt "was not quite certain of his locality," at which I am not astonished, as my poor friend, for many of the latter years of his life, had entirely lost his memory—even more so than Dr. Bowerbank (for that is the excuse that his friends make for many of his statements); but he afterwards says that he found in the British Museum another specimen of the same sponge, brought from Formosa by Mr. Swinhoe (a sponge which I had called *Theonella*, P. Z. S. 1868, p. 565), and states that the acquisition of "this specimen from Formosa is in favour of Mr. Pratt's belief that the type one was really an East-Indian specimen;" and now he has described the Formosan specimen as *D. Prattii*, Bowerbank.

I do not see the force of this argument. Does Dr. Bowerbank think that Formosa in the Pacific Ocean is a part of

India? or is he not aware that it belongs to a different zoological region? I believe the specimen which Dr. Bowerbank first named is a sponge which Mr. Pratt obtained in Portugal, which he showed me along with the Hippurites which he collected during that excursion, and that it is most probably from Madeira or the Azores; and Dr. Bowerbank was right when he said that *Macandrewia azorica* was the type of his then *D. Prattii*. At any rate I should want much better authority than the very brief examination that Dr. Bowerbank bestowed on Mr. Swinhoe's specimen and the examination of the small piece which he cut away from its base, to convince me that the Formosa sponge is the same as Mr. Pratt's specimen, which is the type of Bowerbank's *D. Prattii*.

To obtain a clear view of the value of Dr. Bowerbank's very prolix and apparently minute descriptions, we have only to read the descriptions of *Isodictya robusta* and *Desmacidon Jeffreysia*, which he now informs us are only fragments of the same sponge which Mr. Norman has formed into a genus under the name of *Oceanopia*. It is remarkable that the sponges of the same or nearly the same locality, alike in general form and appearance, should belong to different genera and species. I think we may well say that the microscope may be a most deceptive aid in the hands of a man with strong predisposed opinions, who believes that he has nothing to learn, and works from slides prepared at different times, by different people, and, may be, from different species.

M. Bocage published a paper on new siliceous sponges of Portugal, in the 'Jornal des Sciencias Math., &c.' (1869), in which he has described some new genera, *Discodermia* &c. Dr. Oscar Schmidt, in his 'Spongien-Fauna,' which has just appeared, has noticed eighteen species of coral-sponges, dividing them into two families and ten genera; but, with the assistance of the detailed figures which accompany the book, and of microscopic slides containing parts of these sponges, which Dr. Schmidt has been kind enough to furnish me with, I have not been able to understand the characters of several of the genera and species. Indeed these coral-like sponges seem to have attracted much attention from many authors; but still, I may say, they appear to me to require a careful re-examination and illustration.

Fam. 5. **Macandrewiadæ.**

Sponge massive or expanded, fixed, fan-shaped or cup-shaped. Skeleton very irregularly reticulate, with roundish openings.

Macandrewia, *Theonella*, Gray, P. Z. S. 1868, p. 565.

The small cup-shaped specimen figured in the Proc. Zool. Soc. 1859, tab. 15, as *M. azorica*, has distinct conical vents on the inner surface; two much larger, circular, very sinuous specimens, also from the Azores, have only very minute vents on the upper surface; and the large circular sinuous specimen from Madeira, which is called *M. Bowerbankii*, has no visible vents on either surface: so I believe them to be only varieties. Mr. Carter observes, one should recollect that sponges often grow from the roofs of caves and rocks, dependent from above; and what appears, when the specimen is in a museum, to be the upper is in reality the lower surface, and the surface next the root is in reality the upper one.

Fam. 6. **Farreadæ.**

Sponge expanded or tubular. Skeleton nearly regularly reticulated, with four-sided openings.

Farrea, Kent, Microsc. Journ. 1870; *Sympagella*, O. Schmidt.

Fam. 7. **Dactylocalycidæ.**

Sponge massive or expanded or cup-shaped. Skeleton more or less regularly reticulated, with angular openings diverging from the centre.

Dactylocalyx, *Myliusia*, *Kaliapsis* (Bowk.), *Discodermia* (Bocage?).

Fam. 8. **Aphrocallistidæ.**

Sponge tubular; tube closed with a netted lid or a rounded end. Skeleton more or less regularly netted with angular openings.

Aphrocallistes, see Kent, Microsc. Journ. 1870.

C. *The sponge fixed, formed of fusiform spicules anchylosed together by siliceous coats. Hexaradiate spines in the sarcode.*

Fam. 9. **Corbitellidæ.**

Sponge tubular, attached, without any anchoring filaments at the base. The walls formed of irregular network or bundles of siliceous needle-shaped spicules loosely arranged in sheaves intersecting each other, and united by sarcode; spicules of skeleton and sarcode hexaradiate, free from one another.

Euplectelladæ, sect. B, Gray, P. Z. S. 1867, p. 530.

Corbitella and *Heterotella*, Gray, *l. c.*; *Habrodictyon*, W. Thomson.

I formerly regarded this family as a peculiar section of

Euplectelladæ, as I had not the opportunity of examining the sponges, and only knew them from having seen them in Paris and by the photographs of Dr. Wyville Thomson.

Dr. W. Thomson has since described them as a genus, observing, "as I am precluded from using either of Dr. Gray's names, I substitute *Habrodictyon*, which I had in MS. before I saw Dr. Gray's paper." Why he is precluded is not stated. When he sent me the photographs, with the permission to describe and name them (see Proc. Zool. Soc. 1867, pp. 530, 531), he did not communicate any name to me, or I would gladly have used his generic name; but I fear that now the question is out of both our hands, and must follow the recognized rules of nomenclature.

Fam. 10. **Askonematidæ.**

Sponge fixed, cup-shaped, formed of abundant elongate spicules, with scattered hexaradiate spines often denticulated on the edge of the rays; spicules with bifurcate ends repeatedly forked, and spherical groups of elongate spicules, which are capped at the end.

Askonema, Kent, Quart. Journ. Microsc. Science, 1870.

D. *Sponge fixed, formed of fusiform spicules imbedded in keratose matter. Hexaradiate spines in the sarcode.*

Fam. 11. **Carteriadæ.**

Sponge cup-shaped, formed of abundant netted fibres containing many fusiform spicules, with scattered six-rayed stellate spicules, ending in a circle of reflexed lobes; the rays are often abortive, producing a cylindrical axis terminating at each end in the reflexed lobe, and hence they have been called birotulate spines. Mr. Carter has found rudiments of side branches on the central axis, and some specimens have all the six lobes perfect and furnished with rays at the end, showing that the birotulate specimens are only the result of the more or less complete abortion of the lateral lobe, and that it belongs to this order.

Carteria, Gray, P. Z. S. 1867, p. 540.

Fam. 12. **Axidæ.**

Sponge arborescent, branched, with hexaradiate subcubical spicules, as if formed of six cubes placed on each side of a central one, and with three rayed stellate spicules.

Axos = *Echinospongia*, Gray, Ann. & Mag. N. H. 1870, vi. p. 272.

Order VI. SPHÆROSPONGIA.

Sponge generally massive, grumose; skeleton strengthened with numerous small spicules crowded into globular or stellate balls, and with elongate spicules terminating at the outer end in three recurved spines, which are simple or forked.

I. *The globular or oblong balls of spicules crowded, forming a coat to the outer surface of the sponge.*

Bowerbank regarded these balls of spicules as ovaria. I have called them in my arrangement of sponges ovisacs; but further research has convinced me that they have nothing to do with the ova.

A. *Sponge grumose, with elongate spicules, the long ones with two or three expanded or recurved acute branches.*

Fam. 1. **Geodiadæ.**

The spherical masses of spicules forming a thick external crust to the sponge.

a. Crust interrupted with a conical cloaca covered with a netted or perforated lid. *Geodia.*

b. The external crust continuous. *Cydonium* and *Pachymatisma.*

B. *Sponge calcareous, solid, with simple spicules between the outer layer and axis, which is formed of spheres of spicules.*

Fam. 2. **Placospongiadæ.**

Sponge branched, coral-like, with a central axis and a hard outer coat entirely formed of solidified spherules of spicules. The axis and outer lamina separated from each other by a layer of sarcode strengthened with bundles of spicules.

Placospongia.

II. *The stellate balls of spicules scattered in the outer surface and inner part of the sarcode.*

Tethyadæ, Gray, P. Z. S. 1867, p. 540.

Sponge oblong, massive, fleshy, armed with simple fusiform spicules, many having three prongs or three recurved points at the outer end or distal outward extremity, forming the surface or extending beyond the surface of the sponge, and often imbedded in the sponge; stellate spicules in the sarcode all crowded together.

A. *Sponge short, globose, with elongate spicules having three acute recurved branches on the outer end, which support the outer surface, or extend beyond it.*

* *Sponge attached to rocks, with an expanded base.*

Fam. 3. **Tethyadæ.**

The tricurvate spicules extending beyond the outer surface of the sponge. *Tethya.*

See *Tethya arabica*, Ann. & Mag. N. H. 1869, iv. p. 3, pls. 1 & 2.

The young, just hatched, of *Tethya*, as is proved by Mr. Carter (see this Number, p. 413), is furnished with elongate rooting fibres, which are lost when the animal becomes attached. But in certain genera, as *Euplectella*, *Hyalothauma*, &c., which remain free, these fibres are retained during life; and it is doubtful if *Lophurella*, which is only rather more than a quarter of an inch long, may not be a young specimen in a state of change.

Fam. 4. **Donatiadæ.**

The tricurvate spicules supporting the outer surface of the sponge.

Tethyadæ, sect. I.*, Gray, *l. c.* p. 541.

Donatia &c.; add *Tethyopsis*, Stewart.

** *Sponge free, with elongate anchoring spicules ending in three or four recurved spines.*

Fam. 5. **Theneadæ.**

Sponge oblong, with many excretory pores above, with tufts of spicules beneath, and numerous stellate masses in the flesh on the underside.

Thenea, Gray, P. Z. S. 1867, p. 541, = *Tethya muricata*, Bowerbank, B. S. fig. 35, and figs. 304 & 305. *Dorvillia agariciformis*, Kent, Microsc. Journ. 1870. *Tisiphonia*, Wyv. Thomson; *Stelletta*, O. Schmidt. *Wyville-thomsonia Wallichii*, Perceval Wright, is said to be the young state of this species.

Fam. 6. **Lophurellidæ.**

Sponge oblong, with a single excretory pore above, and with a depressed central cavity; lower part of the body with numerous scattered anchorate rooting spicules.

Lophurella, = *Tetilla lophura*, O. Schmidt, tab.
Dactylella, = *Tethya dactyloidea*, Carter, Ann. & Mag. N. H. 1869, vol. iii. p. 15.

*** *Sponge free; base surrounded by a funnel-shaped expansion or disk formed of elongated spicules united together.*

Fam. 7. **Casuladæ.**

Casula = *Tethya casula*, Carter, Ann. & Mag. Nat. Hist. 1871, vol. viii. p. 99, pl. 4.

B. *Sponge without elongate tricurvate spicules, with stellate groups of spicules in the outer surface and inner part of the sarcode.*

Fam. 8. **Chondrilladæ.**

1. Stellate spicules of one kind. *Chondrilla.*
2. Stellate spicules of distinct kinds. *Corticium.*

III. *Sponge without globular balls of spicules or stars, but with elongate spicules, two- or three-rayed and recurved at the outer end, on the margin of the sponge.*

Fam. 9. **Ancorinidæ.**

Ancorina, *Normania.*

Section B. *POTAMOSPONGIA.* (Freshwater Sponges.)

Sponge freshwater, of a green colour; ova coriaceous, strengthened with variously shaped spicules placed in the substance of the ovisacs; they are found in the substance of the massive branched sponge, which is strengthened by fusiform spicules; sponge spiculose, with fusiform spicules in a sarcode.

Fam. 1. **Spongilladæ**, Proc. Zool. Soc. 1867, p. 550.

1. The spheres thick, smooth, armed with birotulate spicules. *Ephydatia*, *Dosilia.*

2. Spheres tessellated on the surface, and with sunken fusiform spicules. *Metania*, *Acalle*, *Drulia.*

3. Spheres covered externally with fusiform spicules. *Eunapius* and *Spongilla.*

XLIX.—*Investigations upon the Structure and Natural History of the* Vorticellæ. By Dr. Richard Greef.

[Concluded from p. 397.]

The Contractile Reservoir of the Vorticellæ.

In many Vorticellæ, especially in *Epistylis flavicans*, *Carchesium polypinum*, &c., I have been able to observe the *rosette-like canal-system* ascribed by Stein* to many other Infusoria; but, as a rule, I could only see it very distinctly when the contractions were rendered slow by pressure &c. At the commencement of the systole, just as Stein describes, bubble-like vesicles make their appearance round about the margin of the reservoir; and these, as the central reservoir becomes smaller, acquire a *rosette-like* grouping, in which, however, the individual vesicles are not generally all of the same size, whilst during diastole they coalesce again into a single vesicle. Sometimes I have thought that I could observe a communication between the contractile reservoir and the initial portion of the alimentary tube (vestibulum), in the vicinity of which the former is always situated; but I could never attain to certainty upon this point.

The contractile reservoir of the Vorticellæ is always situated within the cortical layer of the body, pretty close to the external cuticula; it has a definite position here, which remains unaffected by the currents of the general contents of the body—a further indication that the cortical layer forms a firm parenchyma, which takes no part in the current of rotation, as otherwise the contractile vesicle, as also the other organs already mentioned with respect to this point (nucleus, alimentary tube, &c.), must also constantly change its position.

In *Carchesium polypinum* there is a very peculiar organ, which, so far as I know, has not yet been described, and which may take its place here provisionally, because it always adheres to the contractile reservoir. It is, like the latter, a vesicular but not contractile space, covered throughout its whole periphery with fine, short, straight bacilli, which, apparently, lie in a tangential direction to the surface (Pl. XIV. fig. 9, *r*). The bacilli, however, can be observed only in the fresh state, *i. e.* in the living animal; when the Vorticellan is dead, or too strongly compressed, they become indistinct, or entirely disappear; sometimes also I have missed them even in uninjured individuals, whilst the organ under notice is itself never wanting. Its inner space seems to contain a hyaline fluid, which, however, does not always entirely fill it, so that indentations and processes are often produced on its surface.

* Der Organismus der Infusionsthiere, i. p. 88.

Sometimes I thought I could detect a connexion with the contractile reservoir, sometimes, as in the case of the latter, a union with the initial portion of the alimentary tube—that is to say, an opening into it; but I was unable to arrive at any certain information upon this point, as, indeed, upon the significance of the whole structure.

Reproduction and Development of the Vorticellæ.

The asexual reproduction of the Vorticellæ by fission is one of the oldest observations of the kind upon the Infusoria and lower animals in general, and has been confirmed times out of number. In all Vorticellæ (if we except the genus *Lagenophrys* belonging to the Ophrydinæ, which increases, according to Stein, by diagonal fission), it occurs as longitudinal fission, and, indeed, as a division into two more or less completely similar halves. The introduction to fission is always that the Vorticella retracts the ciliated organ into its interior, contracts the peristome firmly over it, and remains in this contracted, spherical condition for some time, during which the contractile-stalked forms repeatedly spring back. Soon after this the spherical form is seen to become flattened from before backwards, whilst the lateral parts gain in extension (Pl. XII. fig. 1). At the same time the cord-like nucleus places itself transversely—probably, in the first place, because the whole body is drawn out to the right and left; and the contractile reservoir is also driven to the median longitudinal axis (Pl. XII. figs. 2 & 8). Now the constriction commences. First of all we see a slight depression make its appearance in the middle of the anterior surface of the body (Pl. XII. fig. 1); and this is soon followed by an emargination on the posterior base of the body attached to the peduncle. The two constrictions, occupying the two longitudinal poles of the body, advance towards each other, so that the whole body is soon surrounded by a median longitudinal annular furrow, which in the first place divides the surface into two equal lateral halves (Pl. XII. figs. 2 & 8). This annular furrow cuts in deeper and deeper, whilst the jerking back by means of the peduncular muscle is more frequently repeated, by which the contractions and the whole process of constriction are evidently forwarded. The nucleus, the contractile reservoir, the ciliated organ, and the peristome are drawn in to take part in the act of fission; and finally, when the two halves are completely separated, and only connected at their base by the peduncle, each fissional scion has almost completely the organization of the parent animal, and does not even differ greatly in size from the latter. Owing to the continual strong contraction of the body, however, it is difficult to ascertain how the alimentary tube behaves in the act of fission; but at any rate each half receives one or the other section of it, replacing the deficient portion by new formation. In the Vorticellæ which do not form stocks, as is well known, only one of the fissional scions remains upon the parent stalk, or in the parent cell; the other separates completely after it has formed what is called the posterior circlet of cilia, which commences by a transverse annular furrow making its appearance at the posterior end of the body where the conical base passes into the bellied bell-shaped portion, and afterwards becoming a cushion-like ridge. Upon this ridge the circlet of cilia is developed (Pl. XII. fig. 3, *h*).

Besides bifission, a second kind of asexual propagation has been described among the Vorticellæ, and, indeed, long ago, namely by Spallanzani and others in the last century. This is a formation of buds, by which a comparatively small portion of the body of the parent is pushed out in the form of a bud at the side walls, and gradually constricted off as a new scion. Stein has the merit of having furnished the very interesting proof that these bud-like structures observed on the bodies of Vorticellæ are in reality *not buds* (that is to say, *products of their bearer*), but small fissional scions produced by the several times repeated longitudinal fission of other individuals, which swim from without to the larger individuals, and attach themselves to their lateral walls, becoming united with them, and thus completing an "act of conjugation." Stein has traced this extremely remarkable process by a series of careful investigations, and named it *gemmiform conjugation*.

It would carry us beyond the purpose of this little memoir if we were to follow, even in abstract, Stein's series of observations on gemmiform conjugation and the reproduction of the Vorticellæ in general, which have been treated by him with the most minute detail, but unfortunately are still entirely unillustrated by figures, which would facilitate our comprehension of them. I will therefore for the present confine myself to presenting briefly my own observations in comparison with Stein's, in the hope of being able, hereafter, in continuation of this, to offer something further, as, with regard to both the Vorticellæ and other Infusoria, there is still much obscurity that requires clearing up; or at least the clearness which Stein supposes to have been attained is far from existing. It is only by the most many-sided and unprejudiced observations both of the Infusoria and of the other sections of the Protozoa, without at once drawing from every detail far-reaching general conclusions (which often rather hinder than forward knowledge), that it may be possible to separate those things which really belong to the cycle of reproduction from other phenomena, and to group them together so as in time to obtain a fixed point of view.

In the first place I have been able in many cases to confirm the important observation of Stein that the gemmiform appendages of the Vorticellæ are not products of their supporters, or true buds of them, but smaller individuals penetrating from without and uniting with them, and that, consequently, throughout the Vorticellæ, no reproduction by gemmation or sprouting seems to occur.

The first observations relating to this point were made several years ago during a sojourn in the North Sea (at Ostend) on a marine form which is abundant there, usually adherent to Algæ. In this Vorticellan I was at once struck by the comparatively very frequent occurrence of bud-like structures on the lateral walls of the individual animals, these otherwise in general only rarely coming under observation. In the above-mentioned Vorticella, which differs in its whole habit from the marine *Vorticella patellina* of Ehrenberg, found by him near Wismar, in the North Sea, and therefore may probably be a distinct species, I was able to trace the whole process of the so-called gemmiform conjugation, step by step, as I have represented it in Pl. XIII. figs. 1–7. In fig. 1 a small individual furnished with the posterior circlet of cilia has swum up to a larger one. The ciliary organ is retracted, and the conical base directed perpendicularly towards the lateral walls. Thus we see the smaller individual creep about upon the surface of the larger one by means of the cilia, which are constantly in undulating movement, sometimes skipping up and down, sometimes creeping round it, and apparently feeling and seeking everywhere. In spite of the frequent jerkings back of the larger individual, which seem as though it was trying to escape from the irritations produced by the intruder, the latter obstinately persists in holding the position which it has once selected. Even if it is now and then shaken off for some distance by a sudden and violent jerking, it makes its appearance again the next moment, always swimming again upon the same animal in order to renew its attacks. After some time we observe that the conical base of the smaller Vorticella, which previously projected acutely, becomes retracted, so that a posterior pit is produced, which then frequently sinks so deeply that the posterior circlet of cilia is also retracted or borders the margin of the pit. This pit serves as a *sucking-disk*, with which the animalcule now adheres to the side walls of the other, for which purpose a position on the hinder part of the body, nearly corresponding to the bottom of the body-cavity, is generally selected (Pl. XIII. fig. 2).

After a short time the smaller Vorticella adheres firmly to the larger one, so that, if the process has not been traced, one supposes one sees a bud-formation. By careful examination, especially with the aid of cautious compression, we now make the further interesting observation that the conical base which was at first retracted to form the sucking-pit is again extended, and serves as an organ for boring into the subjacent side wall of the larger Vorticella (Pl. XIII. fig. 3). The conical process thus formed gradually penetrates deeper and deeper; and this is the introduction to a complete amalgamation of the two individuals. The intervening walls are absorbed, and soon there is an unobstructed communication between the two body-cavities. The pressure exerted in this process is so strong that we frequently see clear, bead-like drops of parenchyma make their appearance at the margin of union (Pl. XIII. fig. 4). The bud-like structure now contracts or shrivels more and more, its contents being, as it were, sucked up by the large Vorticella; so that finally there is only left on the side wall a tubercle with a small external aperture, the contours of which pass directly into those of its bearer, and in which we can no longer recognize the Vorticellan form and organization. In this way in course of time the whole contents of the small Vorticella pass into the larger one; and at last only a more or less thin lobe projects from the wall of the latter, evidently the contracted and shrivelled empty skin of the former bud-like individual (Pl. XIII. fig. 6, *k*). This lobe is usually apparently beset all round with fine hairs or bristles, which, however, are probably only the expression of the numerous foldings of the originally annulated integument. Finally the lobe itself is constricted off, and often remains connected with its supporter only by a thin tenacious filament (fig. 7, *k*), until this also is torn by a sudden jerking back of the Vorticella, and the lobe is cast off, by which the process of amalgamation of the two individuals is completely finished.

I must expressly remark that, notwithstanding I have repeatedly sought for them, I have never observed in this marine Vorticellan the so-called *rosettes* of fissional scions produced by rapidly continued division, but always only bifissions, although these, singularly enough, are remarkably frequent in combination with the bud-like amalgamation. It is, therefore, not to be supposed that the smaller individuals, which, however, are sometimes but little inferior in size to those selected for union, had proceeded from simple bifission without rosette-formation. Moreover I have not observed the action on the nucleus described by Stein in this form, but have limited myself to the above-described external phenomena of the act of union.

In freshwater Vorticellæ, however, especially from the Poppelsdorf Castle-pond near Bonn, I had abundant opportunity of observing both the rosette-formation of the fissional scions and the internal processes arising from the gemmiform amalgamation. In the first place, it was again in an animalcule belonging to the genus *Vorticella* (*Vorticella campanula*?), which is characterized by a comparatively large body and an unusually long peduncle (Pl. XIII. fig. 8), that I found many gemmiform unions. In that represented in fig. 8 an open union of the two body-cavities and a complete external amalgamation had already occurred. The body-cavity of the smaller Vorticella (*k*) was filled with oval, sharply contoured, dimly shining corpuscles which passed through the interior with *a brisk skipping motion*, and also repeatedly passed over into the larger Vorticella. I could not perceive a nucleus in the gemmiform appendage. The body-cavity of the other individual, however, was filled with comparatively large corpuscles, also of an oval form and sharply circumscribed, which strikingly resembled hard-shelled ova. Here also I could perceive no nucleus. It seems probable, therefore, that, in accordance with Stein's observations, we may regard the two different bodies in the bud-like individual and its supporter as produced by the breaking up of the nucleus in consequence of the "gemmiform conjugation." I have been unable, however, to observe any further development of these bodies, as material of the same *Vorticella*, afterwards obtained, showed no trace of gemmiform unions.

The remarkable *rosettes*, and the bud-like individuals which separate from them and unite with the larger Vorticellæ, were first of all repeatedly observed by me in *Epistylis flavicans*. The rosettes occurred as groups of from four to eight individuals; and we may often see several rosettes at the same time upon one stock (Pl. XV. fig. 1, *r*, *r*, *r*, *r*). The groups often remain together in the form of a rosette without being in direct, firm union either with each other or with the stock, their conical bases converging towards one another, and being held in companionship by constant undulation of the posterior circlet of cilia. Besides these, I also met with many gemmiform unions, but without succeeding in observing the internal phenomena possibly connected therewith.

I was enabled most definitely to observe both the external circumstances (*i. e.* the rosette-formation and gemmiform unions) and the inner changes of the nucleus accompanying or rather proceeding from these, in *Carchesium polypinum.*

In the first place, in the nucleus, which, in *Carchesium polypinum*, is usually very long and bent and twisted like a worm (Pl. XIV. fig. 1, *n*), I frequently saw appear those clear, usually double-contoured, nucleoles which Stein had previously observed in *Vorticella microstoma*, and which often produce the impression of nuclei with large nuclear corpuscles (fig. 2). In others the whole nucleus was broken up into separate segments of a roundish or oval form, which, however, were still surrounded by the common membrane of the nucleus, and also placed together in the form of the original nucleus (fig. 3). In the interior of the individual segments, again, there were several of the above-mentioned nucleoles (fig. 3, *l*). Lastly, in other individuals the membrane of the nucleus was evidently broken through, and the whole contents evacuated into the body-cavity. Sometimes larger and smaller oval or round disks representing the nuclear segments (Pl. XIV. fig. 4), but containing a comparatively far larger number of nucleoles than before, swam about—sometimes individual nucleoles already separated from the common envelope, and then sometimes enlarged three or four times. The larger nucleoles, especially when oval, again produced exactly the impression of hard-shelled ova (Pl. XIV. fig. 4, *a*).

In discussing the above observations I must in the first place remark that by these, as by Stein's observations, I have not attained to any complete and clear insight into the signification of the "gemmiform conjugation," as Stein called it, and therefore do not at present venture to append to them definite ideas and consequences, as Stein has done, especially as I have detected exactly the same alterations of the nucleus which I have described above, on the whole in accordance with Stein, as the results of gemmiform union, where I could not discover, either on the individuals in question or in the whole colony of *Carchesium*, any external trace of gemmiform unions, which of course does not exclude the possibility that such unions may have previously taken place. Stein even goes so far as to assume that, by swarming forth, such individuals of the stock as have completed the gemmiform union, and in consequence of this are filled with the products of the nucleus (called by him the *placenta*), might give origin, by adhesion and renewed colonization, to the building up of an entire stock, the individual members of which, of course produced by bifission from those first formed, are all provided with placental disks. This, however, is only a more or less probable supposition, which, for the present, is destitute of that support of actual observation which alone could prove it.

Moreover, in one and the same species, namely *Epistylis flavicans*, besides the gemmiform unions, I have made extremely remarkable observations of another kind, which also indicate a mode of reproduction, but of a very different nature. These may be briefly noticed here at the close of this communication. Like most of the Vorticellæ, *Epistylis flavicans* possesses a cord-like nucleus, bent more or less into a horseshoe shape. Frequently this nucleus, in all the individuals of the stock, is filled only with a finely granular and otherwise homogeneous parenchyma (Pl. XV. fig. 10); but sometimes the nuclei of *Epistylis flavicans* exhibit very remarkable alterations. In the first place we sometimes find individuals, almost always several upon the same stock, the nucleus of which is considerably thickened, but at the same time shortened, so as to acquire the form of a somewhat crooked sausage, which, by its dark contents, shows sharply from the interior, and therefore catches the eye even under a low power and in the living and moving animals (Pl. XV. fig. 9). If the nucleus of this form be examined more closely, and with a higher power, we see that it acquires its dark appearance from a mass of capillary structures with an undulating course, which give the whole organ the appearance of being filled with a ringlet-like mass of filaments resembling spermatozoids (Pl. XV. fig. 5, *n*). No movement can be detected in them. If this substance be isolated by tearing or bursting the nucleus, we find that it consists of nothing but capillary bacilli, slightly curved in a sickle-like form, which appear to be a little dilated at one end and pointed at the other. All are rigid, dimly shining, and sharply defined (Pl. XV. fig. 6). These, no doubt, are similar structures to those first found by Johannes Müller and his pupils Claparède, Lachmann, and Lieberkühn, and afterwards by Stein, Balbiani, and others, in the nucleus and nucleolus of many other Infusoria, and which have subsequently been regarded as the spermatozoids of the Infusoria. One is very much inclined, in the present case, to regard the structures in question in *E. flavicans*, from their whole mode of occurrence and appearance, as spermatozoids. However, especially taking into consideration the "gemmiform conjugation" which occurs in this species also, I do not venture at present for my own part to treat these as the spermatozoids of the Vorticellæ, as has already been done by others, perhaps too definitely, although, of course, I am no more inclined to accept the second supposition, that they are parasitic structures.

In the same colonies of which some animals bear a nucleus with the above-described hair-like structures, there are others the nucleus of which has retained the ordinary elongated, horseshoe-like form. But on closer examination we observe, even in these, very noteworthy alterations, which, when we pass under review a series of different individuals, show a certain gradational sequence. The first stage appears to be that, in the midst of the nucleus, a clear, irregularly formed, and often repeatedly interrupted longitudinal axis makes its appearance (Pl. XV. fig. 11). In a subsequent stage this longitudinal axis is seen as a uniform cord, filled with dark granules, passing through the substance of the nucleus (fig. 12), so that, especially taking into consideration the following structures, one is vividly reminded by it of the rhachis of the Nematoda. Further investigation shows us the axial cord surrounded by large pale nucleoles, which have apparently sprouted from the former (fig. 13). These nucleoles constantly increase in number with a gradual increase in size (fig. 14), so that finally they occupy nearly the whole of the nucleus. Subsequently I have fancied that I detected such nucleoles also floating in the body-cavity, but have been unable to arrive at any certainty upon this point.

It is indeed very seductive to express the opinion, which might be supported by many analogies with other observations, that the above-described phenomena in the nucleus stood in connexion with the spermatozoid-like structures in the nucleus of other individuals—in other words, that we are here in presence of a sexual reproduction in the Infusoria, and this not merely brought about by special organs to be regarded as ovarium and testes, but even by these organs being distributed upon different individuals of the same stock, so that these animals are of separate sexes (monœcious). But, with reference to the above remarks, I prefer in this case also simply to communicate the discovery, leaving a decision upon it for further investigations.

It seems, however, to be beyond doubt that both the organization and life-history, not only of the Vorticellæ, but of the Infusoria in general, are comparatively rich and highly developed, but that only a little of it has hitherto been deciphered with certainty—and that Ehrenberg, although he may have erred much in details, especially in the interpretation of the organs and structures first seen or discovered by him (and this must be borne in mind), nevertheless, on the whole, supported by his extended and indefatigable investigations and abundant observations, has recognized with just tact and acuteness the high organizational value of the Infusoria.

EXPLANATION OF THE PLATES.

Plate XII.

Figs. 1–6. Representation of the asexual propagation by bifission of *Vorticella marina* (sp. n.?).

1. Commencement of the division by retraction of the ciliated organ and contraction of the whole body, with increase of the transverse diameter.
2. Segmentation and gradual deepening of the constriction which divides the body into two similar halves: the nucleus (*n*) and contractile vesicle are divided at the same time.
3. Division completed: one fissional scion is separating from the peduncle and forming the posterior circlet of cilia (*n*).

4, 5, & 6. Free, swarming fissional scions.

Figs. 7–11. Fission of *Cothurnia imberbis.*

7. The animal retracted within its envelope.
8. Constriction into two halves.
9. One fissional scion separating from the envelope and forming the posterior circlet of cilia (*n*).

10 & 11. Fissional scions which have swarmed out of the envelope.

Fig. 12. Single *Cothurnia* extended out of its envelope: the arrows indicate the current of rotation in the interior; the cuticula shows a distinct transverse annulation.

Plate XIII.

Figs. 1–7. Representation of the various stages of "gemmiform conjugation" in *Vorticella marina*: *k*, the bud-like Vorticella; *l*, contractile vesicle.

1. The bud-like fissional scion (*k*) furnished with the posterior circlet of cilia has attached itself to a larger Vorticella for the purpose of conjugation.
2. The conical hinder part of the body of the bud-like Vorticella is retracted, and the base thus converted into a sucking-cup.
3. The union is completed by means of this sucking-cup.
4. The pressure during the amalgamation, which is constantly becoming firmer, is so strong that bead-like drops of parenchyma make their appearance round about the point of union.
5. The bud-like Vorticella has become contracted into a mere tubercle.
6. The contents of the bud-like Vorticella have completely passed into the larger Vorticella, so that merely the external sac of integument remains projecting from the latter as an empty lobe.
7. The cutaneous lobe is thrown off after some time: the spinous appearance usually observable upon it is produced by the collapsed, annulated cuticula.

Fig. 8. Gemmiform conjugation in *Vorticella campanula* (see p. 467).

Plate XIV.

Fig. 1. *Carchesium polypinum*: *m*, mouth; *b*, contractile vesicle; *n*, nucleus; *k*, bud-like scion in the act of attaching itself to a larger Vorticella; *s*, nucleiform corpuscles arranged in longitudinal series following the course of the muscles.

Fig. 2. Nucleus of *Carchesium polypinum* after gemmiform conjugation: *e*, nuclei.

Fig. 3. The nucleus broken up into separate segments, as a further effect of gemmiform conjugation.

Fig. 4. The segments of the nucleus (*placenta*, Stein), and in part also the nucleoles contained in them, have escaped from the common nuclear envelope, and are driven about freely in the body-cavity of the Vorticella: 4 *a*, free larger nucleoles of the nuclear segments.

Fig. 5. *Epistylis minuta*, sp. n. The whole stock shown magnified about 400 diameters.

Fig. 6. *Zoothamnium alternans* (North Sea).

Fig. 7. A single branch of *Zoothamnium alternans* with two small individuals, more highly magnified.

Fig. 8. The conical base of the body of *Carchesium polypinum* seen from below (in transverse section). The circles of granules indicate the lumina of the muscles of the body and peduncle.

Fig. 9. Representation of the course of the ciliary spiral in *Carchesium polypinum*: *s*, commencement of the spiral; the arrows indicate the course of the spiral from the right of the buccal orifice towards the left, to penetrate, after one circular turn (*w*), in a curve into the vestibulum; *p*, the outer peristome; *v*, entrance into the vestibulum (buccal orifice); *g*, the long seta projecting from the vestibulum; *a*, anus; *b*, contractile vesicle; *r*, the noncontractile receptacle, covered with bacilli (see p. 462).

Plate XV.

Fig. 1. *Epistylis flavicans*, under a low power: *r*, rosettes of fissional scions; *k*, gemmiform conjugation.

Fig. 2. The posterior extremity of the peduncle of *Epistylis flavicans*, more highly magnified (300–400 diam.).

Fig. 3. *Epistylis flavicans* seen from the point of junction with the peduncle. The fibres radiating from the peduncle indicate the longitudinal muscles, and the concentric circles the transverse annulation of the skin.

Fig. 4. Transverse section of the peduncle of *Epistylis flavicans*.

Fig. 5. *Epistylis flavicans*, magnified 300 diam.: *n*, nucleus filled with spermatozoid-like corpuscles; *k*, paired capsules with rolled-up threads in their interior (urticating capsules?) situated under the skin; *g*, the longitudinal fibres (muscles) and transverse striæ of the cuticula (compare fig. 3).

Fig. 6. Isolated spermatozoid-like bodies from the nucleus of fig. 5, magnified about 800 diam.

Fig. 7. Isolated (urticating) capsules, more highly magnified: *a*, with the threads rolled up in the interior; *b*, with protruded threads.

Fig. 8. The same, magnified about 300 diam.

Fig. 9. A branch of *Epistylis flavicans* with two individuals, of which the dark prominent nucleus is filled with spermatozoid-like bodies.

Figs. 10–14. Development of nucleoles (germ-granules) in the nucleus of *Epistylis flavicans*.

10. Nucleus filled with finely granular substance, in which no further form-constituents are recognizable.
11. A clear longitudinal axis, still consisting of separate pieces, runs through the middle of the nucleus.
12. The longitudinal axis is continuous and filled with dark granular substance.
13. Nucleiform structures issue from the longitudinal axis, finally enveloping it.

Fig. 14. The longitudinal axis of the nucleus entirely filled with granules.
Fig. 15. Bud-like scion from a rosette of *Epistylis flavicans*, magnified about 300 diam.: *n*, nucleus; *b*, contractile vesicle.
Fig. 16. Encysted *Epistylis flavicans*.
Fig. 17. Branch of *Epistylis flavicans* on which the nuclear formations described under figs. 10-14 occurred. For distinction from those of fig. 9 the nuclei are not visible.
Fig. 18. Large variety of *Epistylis flavicans*: *x*, the parasitic (?) Flagellata seated on the peduncle.
Fig. 19. The parasitic (?) Flagellata under a higher power.

PLATE XVI.

Fig. 1. Representation of the alimentary system of *Epistylis flavicans*. The animals have been subjected to a carmine diet. The arrows indicate the current of rotation of the coloured material (balls of nutriment) in the interior of the digestive body-cavity: *m*, buccal orifice (entrance into the vestibulum); *o*, œsophagus; *v*, funnel-like termination of the œsophagus; *d*, canaliform continuation of the funnel. The colour-balls issuing from the funnel glide as spindle-shaped bodies (*b*) through the canal, and project at *b′* with a little knob from its hinder opening; *n*, nucleus.
Fig. 2. The alimentary tube of *Epistylis flavicans* isolated. The arrows indicate the direction of the flow of the food: *m*, mouth; *k* & *k′*, valvular partitions; *o*, œsophagus; *v*, funnel; *d*, canaliform continuation of the funnel; *h*, anus, from which a long seta projects outwards.
Fig. 3. Alimentary apparatus of *Epistylis plicatilis*.
Fig. 4. Branch of *Epistylis plicatilis*: *k*, contracted animal; *n*, nucleus with nucleoles; *b*, contractile vesicle; *g*, muscles.
Fig. 5. Posterior adherent extremity of the peduncle of *Epistylis plicatilis*: *f*, foot with sole.

L.—*On Indian Mud-Tortoises* (Trionyx). By Dr. J. E. GRAY, F.R.S. &c.

BEFORE I saw the 'Annals' of last month, I was told that Dr. Anderson had examined nearly two hundred specimens of Indian mud-tortoises. I observed that I supposed he had availed himself of my suggestion, and was about to give us a paper worthy of his position in the Museum and University. But when I saw the paper, this delusion was dispelled. The paper might be shortly written thus:—The mud-tortoises of India have been properly divided into two species. He might have added, with truth and justice, that the species had been well characterized, and their synonymy well made out; but this would show the ridiculousness of the vain boast which terminates his paper. The species are so distinct that the native fishermen and market people know them by different native names, and the cooks as of different values as articles of diet. The short paper itself is most confused and most carelessly written, but with a most unwarranted assumption of high scientific importance. The same species is referred to under different names; and the names given are rarely used by the authors quoted. For one example among many, he speaks of "*Trionyx javanicus*, Schweigger," but that author never uses such a name. I suspect this is from carelessness and want of consideration*. But a friend has pointed out that he gives one author as the authority for a name when he differs from that writer, and gives another author for the same name when it meets with his approval, both being on the same authority.

Dr. Anderson, when in London about a year ago, stated that he did not think that I properly estimated the late Dr. Fleming, a gentleman whom I knew personally and much esteemed, but I was not aware that I had ever expressed or written a word respecting his writings; and he stated that for all he (Dr. Anderson) knew in zoology he was indebted to the lectures and teaching of that professor. I did not in the least doubt his assertion, but only observed that Dr. Fleming belonged to a time long passed away, and that his best book was a very diluted abstract of part of Cuvier's 'Règne Animal,' published in 1815, and entirely superseded by the second edition of that work. Dr. Anderson's paper in the last Number of the 'Annals' confirms this statement; for here, in 1872, we just have what Dr. Buchanan Hamilton did at the end of the eighteenth century, and what I did in the 'Synopsis of the Reptiles,' published in 1831.

Any one reading Dr. Anderson's paper would imagine that my 'Illustrations of Indian Zoology' was a modern publication, whereas it appeared in 1832, when, I believe, there was not a single specimen of *Trionyx* from India in this country; but knowing that Dr. Buchanan Hamilton had studied the genus, I published copies of his figures in my 'Illustrations,' with his names, and compared them with figures in Hardwicke's collection of drawings from Indian specimens, and published the results of my examination in my 'Synopsis Reptilium,' in 1831. It is to be remembered that that very industrious naturalist, General Hardwicke, to whose exertions Indian zoology owes such a debt of gratitude, formed no less than three collections, and had the misfortune to lose each of

* Dr. Anderson published a paper in the 'Annals' for 1871, vol. viii. p. 324, entitled "On *Testudo Phayrei*, Theob. & Dr. Gray;" but the whole paper is about a *Trionyx*, which must not be confounded with *Testudo Phayrei* of Blyth.

them by shipwreck on their way to this country, escaping with difficulty with his life. After his second shipwreck, and when no longer young, he left England to form a third collection; and that shared the same fate as the preceding two; so that we can only use his drawings and the few materials which were then in our hands. Now Dr. Anderson observes that he has examined 45 living specimens of one and 120 living specimens of another species; but, curiously enough, his paper contains nothing that is not to be found in Hamilton's and Hardwicke's drawings, and in my Synopsis, and other works published years ago.

The two Indian mud-tortoises are:—first, the *Testudo gotaghol* of Hamilton, the *Trionyx javanicus* of Geoffroy St.-Hilaire, and the *Emyda javanica* of Schweigger, which are characterized in my Synopsis before quoted by the very characters which Dr. Anderson gives to distinguish them. The second is *Trionyx hurum* of Hamilton, which is described and figured, just as Dr. Anderson describes it, at p. 47 of my Synopsis, and figured at t. x in the same work, from Hardwicke's drawing; but perhaps Dr. Anderson thinks it forgotten.

Dr. Anderson observes that the skulls of these two species are very different—certainly no new observation; for one is the type of the modern restricted genus *Trionyx*, and the other the type of the genus *Potamochelys*, established on the differences in the skulls. The skulls of both have been repeatedly figured. Truly Dr. Anderson seems to have learned little since he attended my late esteemed friend's lectures. Fortunately there are several very good zoologists and comparative anatomists in India, who are doing good work and extending the science.

BIBLIOGRAPHICAL NOTICES.

A History of the Birds of New Zealand. By WALTER LAWRY BULLER, Sc.D., F.L.S., F.G.S., &c. London (John Van Voorst) and New Zealand (the Author): 1872. 4to. Part I. With 72 pages and 7 coloured plates.

THE first work professing to give a complete account of the ornithology of New Zealand must needs be an important one. This ornithic fauna presents so many points of general biological interest, that only those of the islands east of Africa can be compared with it. The last remnant of a former continent, and probably the oldest country on the face of our globe, New Zealand is, or was, tenanted by ornithic forms which have arrived at the verge of life; already a number of gigantic flightless birds have gradually succumbed (may be through internal decline, accelerated by the unceasing attacks of men and of a bird of prey twice the size of an eagle), and their only surviving representative, the dwarf race of *Apteryx*, will probably soon follow. Geographically considered, this fauna may be expected to be composed of forms most aberrant from European types; and, indeed, this is the case in a great measure; yet, in spite of essential structural differences, some of the birds most characteristic of New Zealand show, with regard to their habits and the place they fill in the economy of nature, such striking analogies with our European species, as to remind us at once of our starlings, thrushes, wrens, &c. The birds peculiar to New Zealand may be considered its oldest inhabitants; they are mixed with Polynesian forms and others having a still more extended range; and the total number amounts to some 150 species.

It was high time that a complete account of this fauna should be given by a competent naturalist. Some of the most interesting forms have already become almost, if not quite, extinct; others are fast expiring, or obliged to accommodate themselves to the changed conditions of the country. This change in the fauna is effected by several agencies:—first, by one which, we believe, is universally at work so steadily as to be almost imperceptible, and which, therefore, is not generally recognized. Every species, as it has its origin and period of fullest development, so it has its period of decline finally leading to its extinction; and if this be really the case, we may expect that in New Zealand, which is presumed to be the oldest country on the face of the globe, certain of its most highly developed animal forms are disappearing from this innate cause. The second agency is the progress of colonization and culture, which, rapidly spreading over a country not larger than Great Britain, will deprive a part of the species of their retreat and food, and conduce even more effectually to their extirpation than the increased number of guns, traps, and cats. The third cause of the change is the introduction of European birds. Sparrows, larks, robins, starlings, thrushes, pheasants, are most easily acclimatized and multiply; of necessity they will take up a not inconsiderable portion of the range occupied by the native birds, and, readily accommodating themselves to the conditions of culture, will replace those which cannot reconcile themselves to these conditions. We do not say that the majority of the native species will not survive, though in diminished numbers of individuals; but it is quite probable that some of these survivors will be preserved by accommodating themselves to the new state of things, modifying in a more or less perceptible manner their nidification, food, or some other part of their mode of life: and if such changes should occur, the student of a future generation will find in Dr. Buller's work the means of comparing the birds of his time with those of the past.

Having made these remarks, in order to show the interest attached to the subject, we will state in a few words the plan of the work. It will comprise an introductory treatise on the ornithology of New Zealand, a diagnosis of each bird (male, female, and young) in Latin and English, with the synonymy and references to the more important portion of the literature, and a detailed description of the external characters, of variations, and of the habits. About one half of the species are represented by coloured illustrations. The work will be published in five parts, each containing not less than seven plates. Moreover we understand that the author intends to conclude the work with an account of the osteology of the more remarkable forms.

There can be no doubt that Dr. Buller is eminently qualified for carrying out this task. Resident in the colony for many years, he has made this part of the fauna his special study; his official position has enabled him, during a period of more than twelve years, to visit nearly every part of the country, bringing him into frequent intercourse with the various native tribes, who assisted him in collecting specimens and information. By his previous preliminary publications he had entered into fruit-bearing communication with ornithologists in Europe; and in New Zealand itself he had in Mr. Potts a most indefatigable and trustworthy fellow-labourer. Finally, by a lengthened visit to England, he derived the great advantage of examining types in European collections, especially in the British Museum, and of availing himself of that typographic and artistic skill in which this country excels.

The author has shown unremitting care in adducing all the information that can possibly throw light on his subject; he has spared no pains in illustrating it in the most perfect manner; and the result is that a most valuable work is placed before the student of ornithology, which will offer to every lover of natural history real and permanent enjoyment, and which, by its attractive form, will allure many a young man in that colony from the pursuit of other branches into the camp of ornithology. We do not mean to say that the critical eye does not detect faults; but they refer to isolated details, and do not affect the character of the work. There is only one point in which we may be allowed to caution the author; and that is, to weigh carefully his reasons when he enters into questions of natural affinity of various groups. Nobody will deny that *Stringops*, by its nocturnal habits, and consequent external modifications of a portion of its head and plumage, reminds us of the owls; but if (as the author justly observes), "in all the essential characteristics of structure, it is a true parrot," it cannot supply, "in the grand scheme of nature, the connecting link between the owls and parrots." This view would be as little true as that the shrew-mice are a connecting link between the Insectivora and Rodents. If such a connecting link were in existence, we feel sure it would be in a part of the world where the Stringine and Psittacine types are more developed than in New Zealand.

A Synonymic Catalogue of Diurnal Lepidoptera. By W. F. Kirby. 8vo, pp. 690. London: Van Voorst, 1871.

The Diurnal Lepidoptera have long been a favourite study, and at the present time, in this country at least, are receiving an amount of attention which has probably never been surpassed. Every quarter of the globe is being ransacked for novelties; and the results of numerous expeditions are being constantly made known through the pictorial works of Mr. Hewitson and Mr. Butler, as well as through the medium of the Proceedings and Transactions of those societies whose pages are open to such matter. At a time when most writers and collectors are striving only how they may increase the number of described species, it is a pleasure to find a man who will undergo the self-imposed drudgery of revising the whole subject with a view of putting the synonymy of the established species in proper accordance with modern ideas. And this is what Mr. Kirby has done in his recently published Catalogue of Diurnal Lepidoptera. He has carefully collated all the references to descriptions of the butterflies described since the time of Linnæus (very properly, we think, selecting the 12th edition of the 'Systema Naturæ' as his starting point) down to the date of the publication of his book (1871). So far as we can see, and the list of authors quoted whose works Mr. Kirby has consulted in whole or in part aids us in forming an opinion*, the literature of the Diurnal Lepidoptera has been pretty thoroughly searched; and this catalogue may be trusted with reasonable confidence as including a sufficiently accurate list of the described species for practical reference by future writers.

It will thus be seen that this work will be of very great service in arranging a cabinet and in the determination of species.

In the internal arrangement of his subject we think that Mr. Kirby has hardly been so successful. In his preface he says that it appeared to him that any arrangement of the species in each genus was better than an alphabetical one; here, we think, he was wrong, and that, had he adopted such an arrangement, several difficulties involving error would have been avoided. It is hardly to be supposed that Mr. Kirby should be autoptically acquainted with nearly all the species he was arranging; and we think we trace to Mr. Hewitson and Mr. Butler, whose aid he frankly acknowledges, the criticisms respecting the validity of many species scattered throughout his pages. To the former we attribute the free use of the term "variety," and to the latter the minute specific subdivisions by which all his work is characterized. These two systems, if such they are, cannot be made to work harmoniously in the same book; and this we think Mr. Kirby ought to have seen.

* Mr. Kirby marks the names of the authors the whole of whose works he has consulted with an asterisk (*), those which he has seen only in part thus †; he omits to tell us the state of his knowledge concerning those works which bear no special mark at all.

We next come to the treatment of genera; and here Mr. Kirby has made a conscientious attempt to introduce order into an extremely complex and unsatisfactory subject. But we cannot help thinking that in many of the changes made an overstrained idea of justice to old authors has been kept in view rather than the interests of the living science.

The source of this, we think, is to be traced to the absolute indifference shown by Mr. Kirby as to whether a genus is intelligibly defined by its author or not. With him (and he does not stand alone) a genus is merely a name under which a greater or a less number of species are arranged, and the practical working of the system is that some one of such species is chosen as the type of the genus, and the student is left to find out its generic characters for himself! Space will not permit us to pursue this uninviting subject far; but we will quote one instance of a name changed by Mr. Kirby which will, we think, show how disadvantageously to the true interests of science the system he adopts may be made to work.

For a well-known genus [we were going to write of "Erycinidæ;" but this term is denied us] Mr. Kirby adopts Hübner's title *Euselasia*, proposed in 1816 with the following valueless definition:—"Alle Flügel oben zeichenlos, glatträndig; unten zierlich gezeichnet." In 1836 Boisduval gave the name *Eurygona* to an insect of the same genus, one side of the figure of which gives the formula of the neuration. This latter name was adopted by Mr. Westwood in the 'Genera of the Diurnal Lepidoptera,' where a full and elaborate description of the genus is given. According to Mr. Kirby's method, if we want to find the generic characters of this group, what is the process? After rejecting Hübner's definition as absolutely worthless, we must turn to the 'Genera,' and then having found all we want, we are still to reject the name there used! But the change does not stop here, for Mr. Kirby forbids us to use Mr. Bates's subfamily name Eurygoninæ, proposed in an exhaustive catalogue of the species of this family, and thrusts *Euselasia* again before our eyes in the form of *Euselasiinæ*. Without defending the use made in the 'Genera' of some of Hübner's names, we still think that the estimate then made of the 'Verzeichniss bekannter Schmetterlinge' was a proper one, and that to many of Hübner's names the courtesy attaching to manuscript names was alone due. The obligation to use them ought not to be imperative; and they certainly ought not to be made to supersede well-characterized generic titles.

In closing these remarks we will only call attention to one other matter which we cannot help thinking also shows a certain amount of misapprehension as to the nature of genera. Mr. Kirby, in the first rule he imposes upon himself, says, "The name of every homogeneous genus, if not a synonym, or previously used in zoology or botany, should be retained for some part of it."

This rule has puzzled us much; and we are at a loss to discover what its meaning is; for if a genus is homogeneous, it appears to us that the necessity, nay, even the possibility of dividing it ceases to exist.

MISCELLANEOUS.

The late George Robert Gray.

Since our last publication, zoology, and ornithology in particular, has sustained a severe loss by the death of George Robert Gray, Assistant Keeper of Zoology in the British Museum, whom we have no hesitation in pronouncing one of the most distinguished ornithologists of the present day. He was the youngest son of Samuel Frederick Gray, himself a distinguished chemist, pharmacologist, and naturalist, and brother of Dr. John Edward Gray, the present Head Keeper of the Department of Zoology in the British Museum, so well known and so eminently famed for his numerous zoological and other labours. Born in July 1808, he was educated at Merchant Tailors' School, in the City of London, and early in life assisted the late Mr. Children in the arrangement of his extensive collection of insects. In this congenial occupation he spent several years, until 1831, when he became an Assistant in the Zoological Department of the British Museum, of which Mr. Children was the Keeper. He contributed greatly to the enlarged translation of Cuvier's 'Animal Kingdom,' then in progress under the charge of Mr. Griffith, and published various works on insects, the chief of which was a revision of the Phasmidæ—and at a later period gave to the world a revision of some of the divisions of the Linnæan genus *Papilio*, and an account of insects parasitical on other insects and on plants, most elaborately worked out. In 1840 he printed privately a 'List of the Genera of Birds,' containing 1065 genera, and noting the type species on which each genus was founded; and in the following year he published a second edition with additions and corrections, in which he extended the list to 1232 genera. The third edition of this work, entitled a 'List of the Genera and Subgenera of Birds,' contains 2403 genera and subgenera. The last of this set of "Lists" was a 'Hand-list of the Genera and Species of Birds,' containing not only the generic and subgeneric names, but also a comprehensive list of the species belonging to each. Of these works it may be sufficient to say that they were elaborated with the utmost care, that they are almost unequalled for the accuracy of their details, and that no ornithologist can possibly work without constant reference to them and to the authorities on which they are founded and to which they refer.

In 1844 he commenced, in connexion with the late David William Mitchell, who undertook the illustration of the book, the publication in numbers of a work entitled 'The Genera of Birds,' which he completed in 1849. In this work the genera figured amounted to about 800, selected from the larger list contained in his other works as the most essential, and they were accompanied by descriptive characters and by an extensive list of species belonging to each genus. It was on this list that the much more enlarged catalogue contained in his 'Hand-list' was chiefly founded, containing upwards of 11,000 species which the author considers authentic, and no less than 40,000 references to specific names given by various authors.

In all these works, which are of such essential value to writers on ornithology, it is difficult to overestimate the labour, the accuracy, and the importance attached to their compilation. The author was indefatigable in his researches, and spared no pains in searching out all that had been done in ornithology from every available source; and his success was in most respects commensurate with his labours. His chief fault lay not in an overweening confidence in his own conclusions (for he was always most ready to avail himself of any suggestions or corrections that were made to him), but in an over-sensitiveness which made him impatient of criticisms which he considered carping, or of suggestions made without due consideration on points which he had himself studied with the utmost attention.

In his official capacity he was always most ready to attend to and assist the numerous students who visited the Museum, and to give them whatever information he possessed on the subjects on which they were engaged; and many of our leading ornithologists will readily admit that they owe much to his kind assistance and advice. In private life he was equally kind-hearted and liberal, with somewhat of the same over-sensitiveness to which we have above referred as distinctive of his scientific character. But a truer-hearted and a better friend has seldom existed; and there are many, both in public and private, who will sincerely deplore his loss. He died on the 6th of May, in the 64th year of his age, leaving a blank in the world of science which will not readily be filled up. He became a Fellow of the Linnean Society in 1845, and of the Royal in 1866.

Jukella, *a new Alcyonarian from Sir C. Hardy's Island.* By Dr. J. E. Gray, F.R.S. &c.

Jukella.

Coral hard, fleshy, forming a thick, smooth, barren stem, marked by irregular longitudinal grooves or ridges; divided at the top into irregular transverse foliaceous expansions, sinuated or lobed on the margins, which are covered with close retractile polypes on each of their sides. All parts of the coral studded with calcareous cylindrical spicules, which have four more or less large, prominent, separate, transverse plates, which are largest in the middle and more or less small or rudimentary at the ends.

Jukella cristata.

Hab. Sir C. Hardy's Island, South Pacific. Presented by J. B. Jukes, Esq. Brit. Mus.

Attached to a shell and part of a rock. The stem is about four inches high; and the crests, of very irregular form and size, are nearly parallel to each other, as if placed across the fleshy stem.

Thouarella antarctica, *from the Falkland Islands.* By Dr. J. E. Gray, F.R.S. &c.

This species was first described by M. Valenciennes in the 'Voyage of the Vénus,' t. ii. f. 2, from a specimen found by Admiral Dupetit Thouars in the Falkland Islands. The British Museum has lately received, by the kindness of Capt. Henry Toinbee, of the Meteorological Office, a very fine specimen of this species (which shows that the one figured by Valenciennes must have been in a very imperfect state), which was obtained by Capt. James Clark, R.N.R. (now Captain of the 'Western Empire'), when dredging, on a calm day, off Burwood Bank, lat. 54° 27′ S., long. 59° 40′ W., in 45 fathoms, on the 1st of January 1872.

The corals were brought up in great abundance. The specimen sent by Capt. Clark to the Museum consists of five similar branches of very unequal length, the longest being 18 inches long, and of an elongate cylindrical shape, each being surrounded by very numerous club-shaped branchlets ending in a polyp. The branches are of unequal length, and make it like a cylindrical bottle-brush, but attenuated towards the tip; they are all of a bright yellow colour.

Mr. Carter has kindly examined the cells under the microscope, and observes that they are formed of oval imbricated scales, lacerated on the edge, with radiating lines and scattered circular dots of a calcareous secretion.

Capt. Clark obtained at the same time, and sent to the British Museum, a fine specimen of a *Porella*-like *Porella cervicornis*, of a bright crimson colour, with pale compressed forked tips; it may be called *P. antarctica*.

Prize Question proposed by the Danish Royal Society of Sciences for the Year 1872.

It is now a hundred years since the celebrated observations of O. F. Müller upon the agamic reproduction (gemmiparity) of the *Naïdes* were published; and although there is no reason to doubt their perfect exactitude in all essential points, it would be very desirable that they should be taken up again from the present scientific point of view, and with the means which science has now-a-days at her disposal. Schultze, Leuckart, and Minor have furnished valuable contributions to the history of this mode of reproduction in the *Naïdes* proper, as have Claus and Lankester for *Chætogaster*; nevertheless more is wanted to place science in possession of sufficient materials for the comprehension of all the points which it is necessary to take into account. We do not know exactly what is the first origin of the buds or new individuals; and consequently the relations between the scissiparous and gemmiparous modes of reproduction need to be better elucidated. The complete evolution, from the moment when a Naïd escapes from the ovum until, among the generations issuing from this Naïd, sexual ones again occur, has not been investigated in all its phases; and we may still inquire whether the same individuals (zooids) are gemmiparous and sexual, or whether the sexual and agamic reproductions are strictly confined to different individuals or generations.

With regard to the other two groups of Annelides in which agamic reproduction has hitherto been observed, namely the Syllidea and the Serpulidea, the question is nearly in the same position.

For these reasons the Society wishes to induce a thorough investigation, in accordance with the present requirements of science, of agamic reproduction and of all the points relating to it in one of the groups of these setigerous Annelides. It therefore offers its gold medal as a prize to any one who shall solve this question in a satisfactory manner, either for one or several species of the group of Naïds (including *Chætogaster*), or for one or several species of Syllidea or tubicolar Annelides. The memoirs must be accompanied by the necessary drawings, so as to elucidate the points to which the investigations have been specially directed.

The memoirs in answer to this question must be sent in before the end of October 1873, addressed to Councillor Japetus Steenstrup, Secretary of the Society. They may be written in Latin, French, English, German, Swedish, or Danish. The memoirs must not bear the names of the authors, but must be furnished with mottoes; and each memoir must be accompanied by a sealed packet bearing on the outside the same motto as the memoir, and enclosing the name, profession, and address of the author. The value of the gold medal is stated at 450 francs.

The Ears of Sea-lions and Sea-bears. By Dr. J. E. Gray, F.R.S. &c.

Dr. Peters, in his 'Revision of the Eared Seals' (*Otaria*), used the length of the ears as a subgeneric and specific character; but, as only preserved skins of these seals were to be observed and compared, I had very little faith in the characters taken from those parts, as I know by experience that the variation of the length and size of the ears and the length of the lobes of the fins is produced by the manner of preserving the animals, even by the most careful taxidermists.

In the Zoological Gardens there are now two species living, which are the sea-lion from the Falkland Islands (*Otaria jubata*) and a sea-bear or fur-seal (*Arctocephalus antarctica*) from the Cape of Good Hope. The latter, my granddaughter informs me, has the ears more than an inch long, the ears of the sea-bear being very much more developed and larger those of the sea-lion; but I do not know whether this may be a generic distinction or a specific peculiarity. These remarks are confirmatory of Dr. Peters's observation of the skins; for he describes the ears of the subgenus *Otaria* (*jubata*) as short, 15 or 20 millims., and the ears of his subgenus *Arctocephalus* and some of the other subgenera as longer. Do the elongated palate and the short ears of the sea-lion and the long ears and short palate of the sea-bear characterize the groups?

The Sea-Serpent again!

"*To the Editor of the Natal Colonist.*

"Sir,—Thinking that a truthful description by an eye-witness of that marvel of the ocean, the sea-serpent, may interest your readers, I crave your kind indulgence for the insertion of the following particulars:—

"During my late passage from London I saw no less than three sea-serpents; but an account of the last will suffice.

"On the 30th of December last, on board the 'Silvery Wave,' in lat. about 35° South and long. 33° 30′ East, at 6.20 p.m., solar time, an enormous serpent passing nearly across our bows compelled the alteration of our course. He was at least 1000 yards long, of which about one third appeared on the surface of the water at every stroke of his enormous fan-shaped tail, with which he propelled himself, raising it high above the waves and arching his back like a land-snake or a caterpillar. In shape and proportion he much resembled the cobra, being marked by the same knotty and swollen protuberance at the back of the head on the neck. The latter was the thickest part of the serpent. His head was like a bull's in shape, his eyes large and glowing, his ears had circular tips and were level with his eyes, and his head was surmounted by a horny crest which he erected and depressed at pleasure. He swam with great rapidity and lashed the sea into a foam, like breakers dashing over jagged rocks. The sun shone brightly upon him, and with a good glass I saw his overlapping scales open and shut with every arch of his sinuous back, coloured like the rainbow.

"I am &c.,

"J. Cobbin."

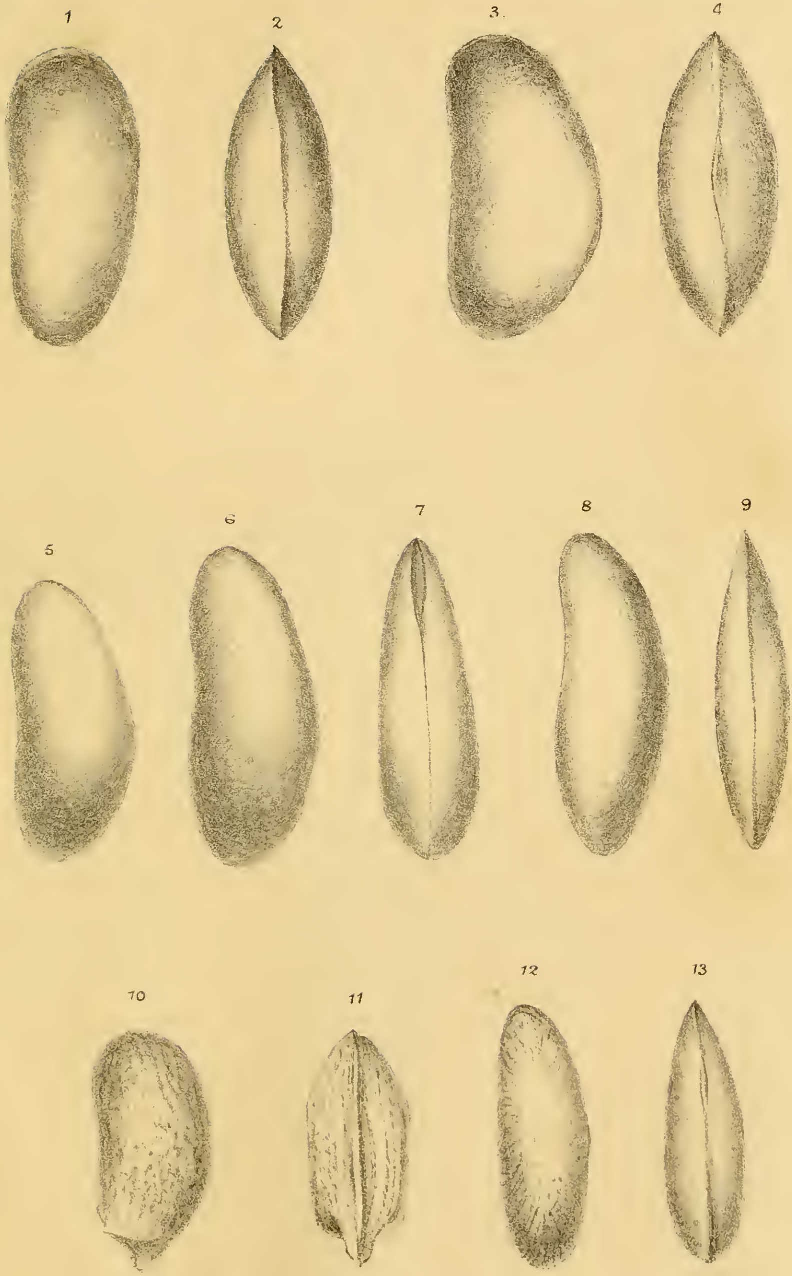
"West Street, Durban, Jan. 22, 1872."

Observations on the Extinct Whalebone-Whales (Balænoida) *the Remains of which have been found in the Vienna Basin.* By Prof. J. F. Brandt.

This memoir relates to the numerous remains of marine Mammalia which are met with in the Sarmatian deposits of Vienna; and the author shows, that in the neighbourhood of Vienna and Linz no fewer than three genera of whalebone-whales, namely *Cetotherium*, *Cetotheriopsis*, and *Pachyacanthus*, are represented, the last two being only known from this district. *Cetotheriopsis* includes only the animal hitherto known as *Balænodon lintianus*, whilst the genus *Pachyacanthus* embraces two species of small, heavily built Cetaceans, remarkable for the incrassation of their vertebral processes, and belonging solely to the Sarmatian deposits of Vienna.—*Anzeiger der Akad. der Wiss. in Wien*, April 18, 1872, p. 82.

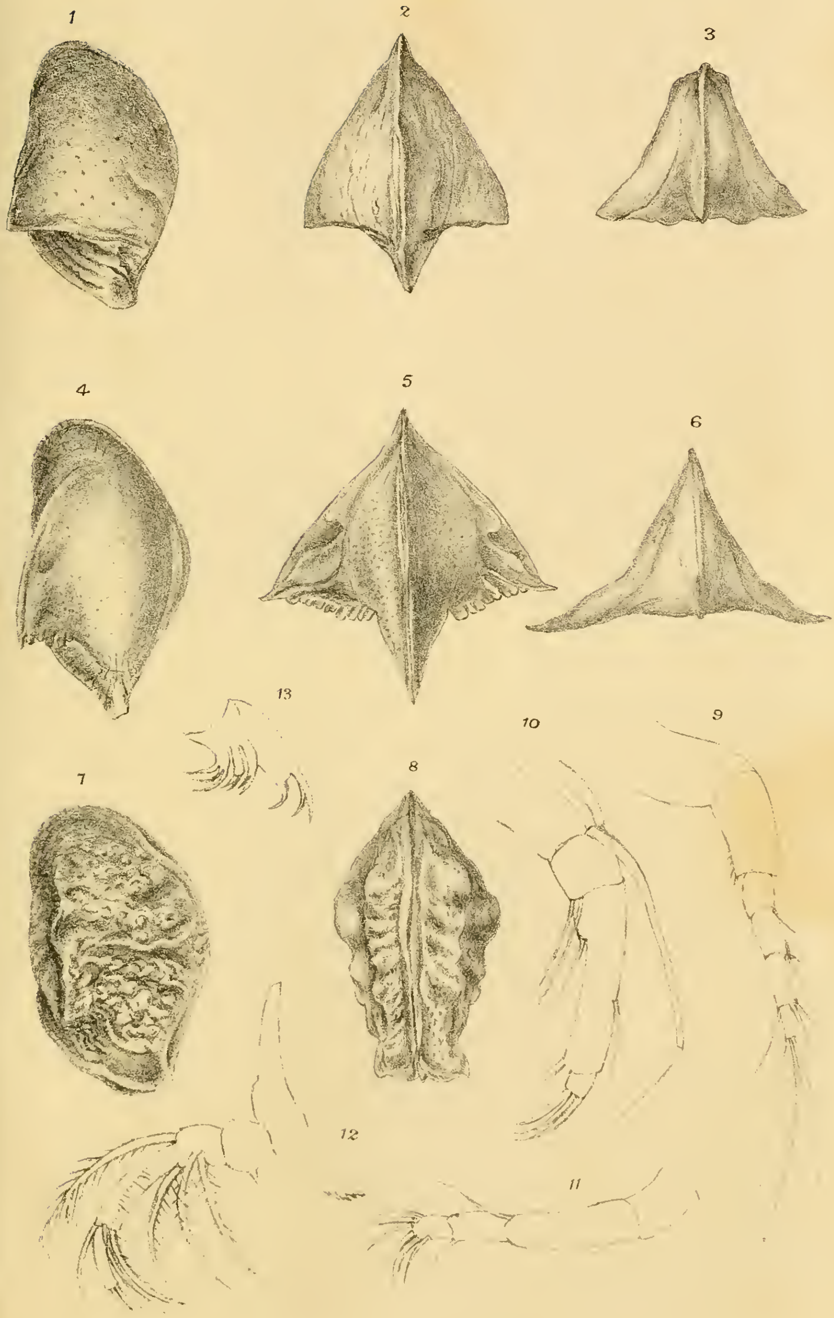
INDEX TO VOL. IX.

END OF THE NINTH VOLUME.



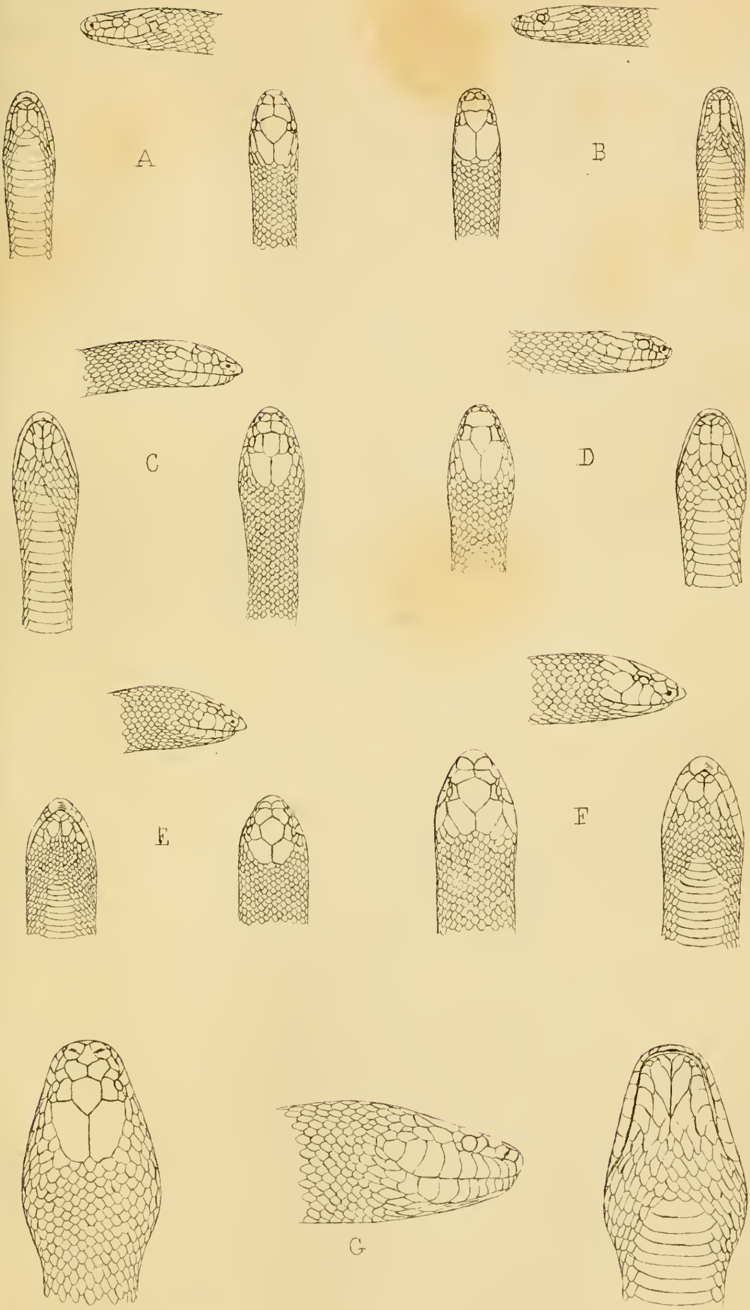
G. S Brady del. et lith.

W. West & Co imp.



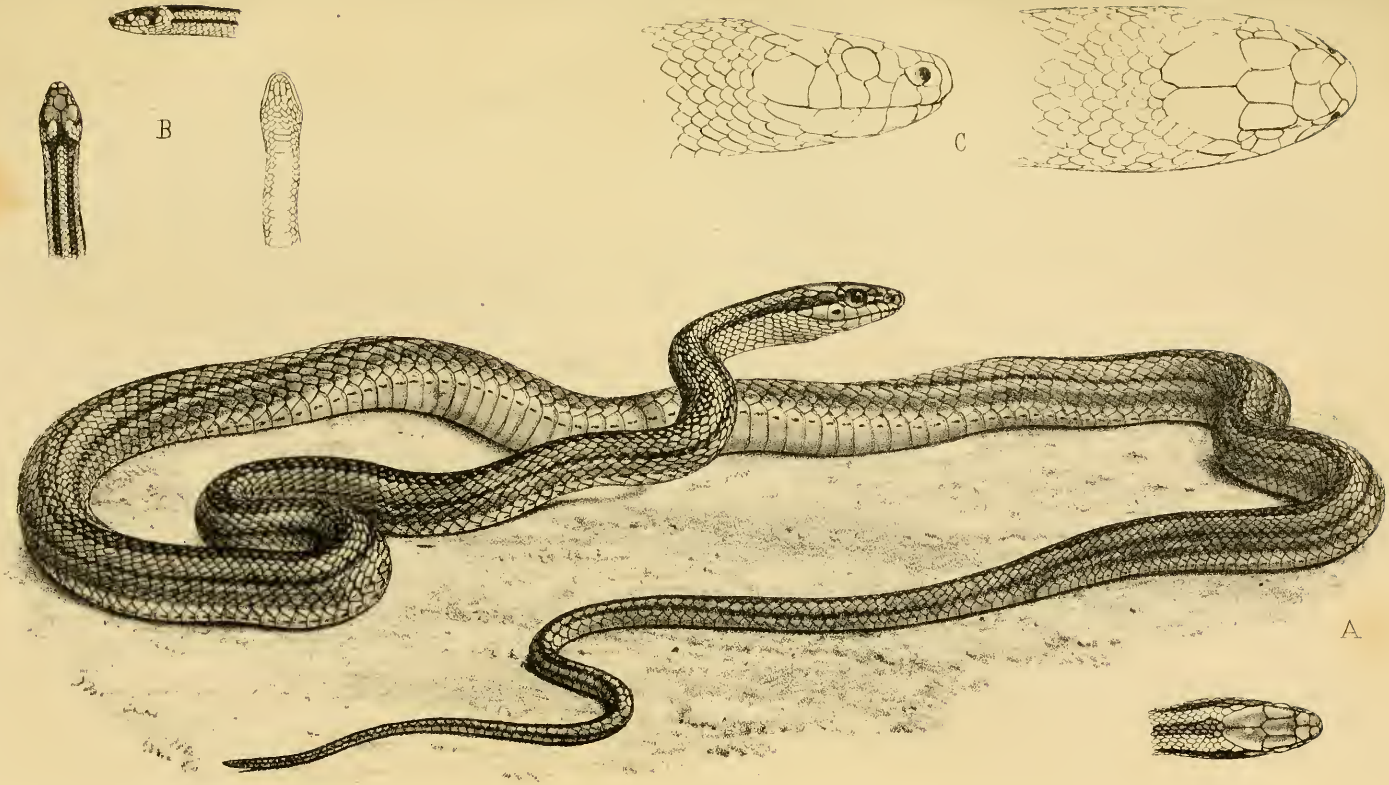
G. S. Brady, del et lith

W. West & Co imp



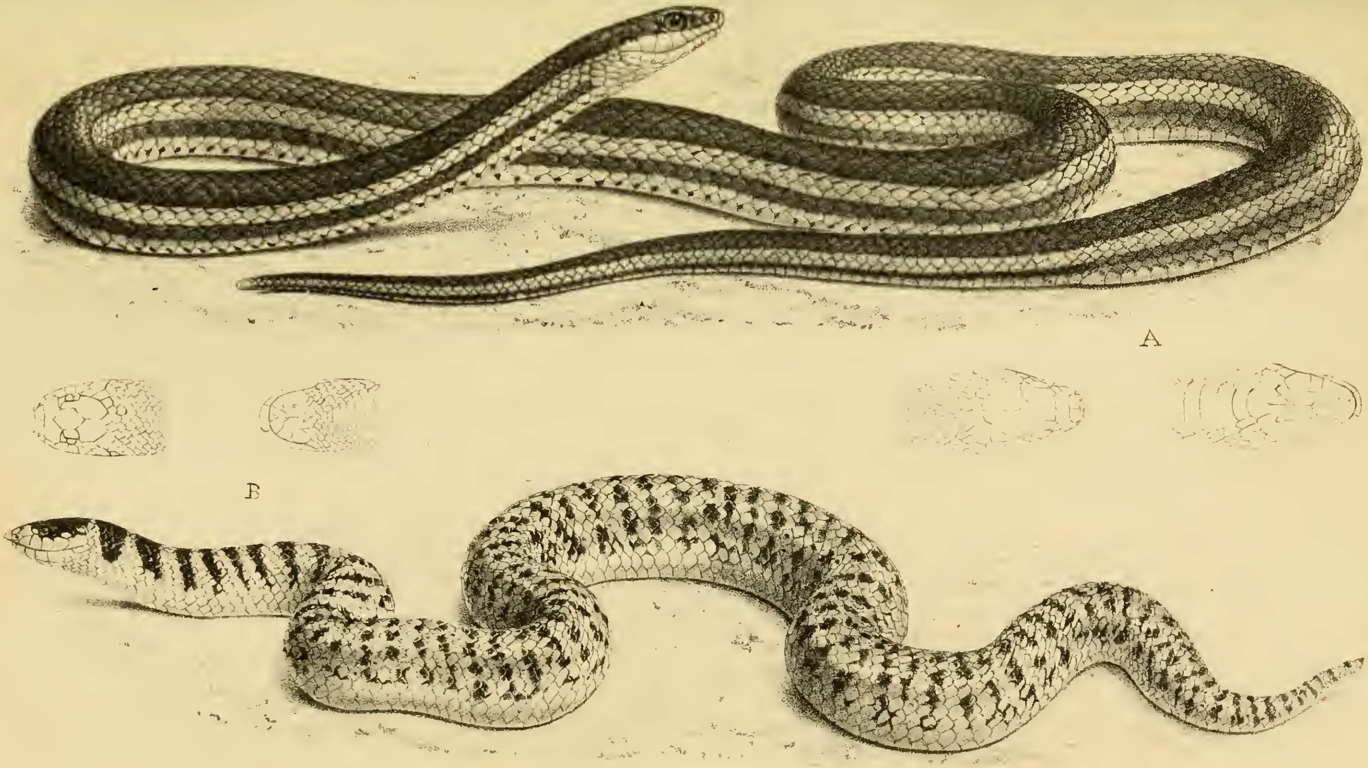
G.H. Ford

Mintern Bros. imp.



C.H Ford. Mintern Bros imp.

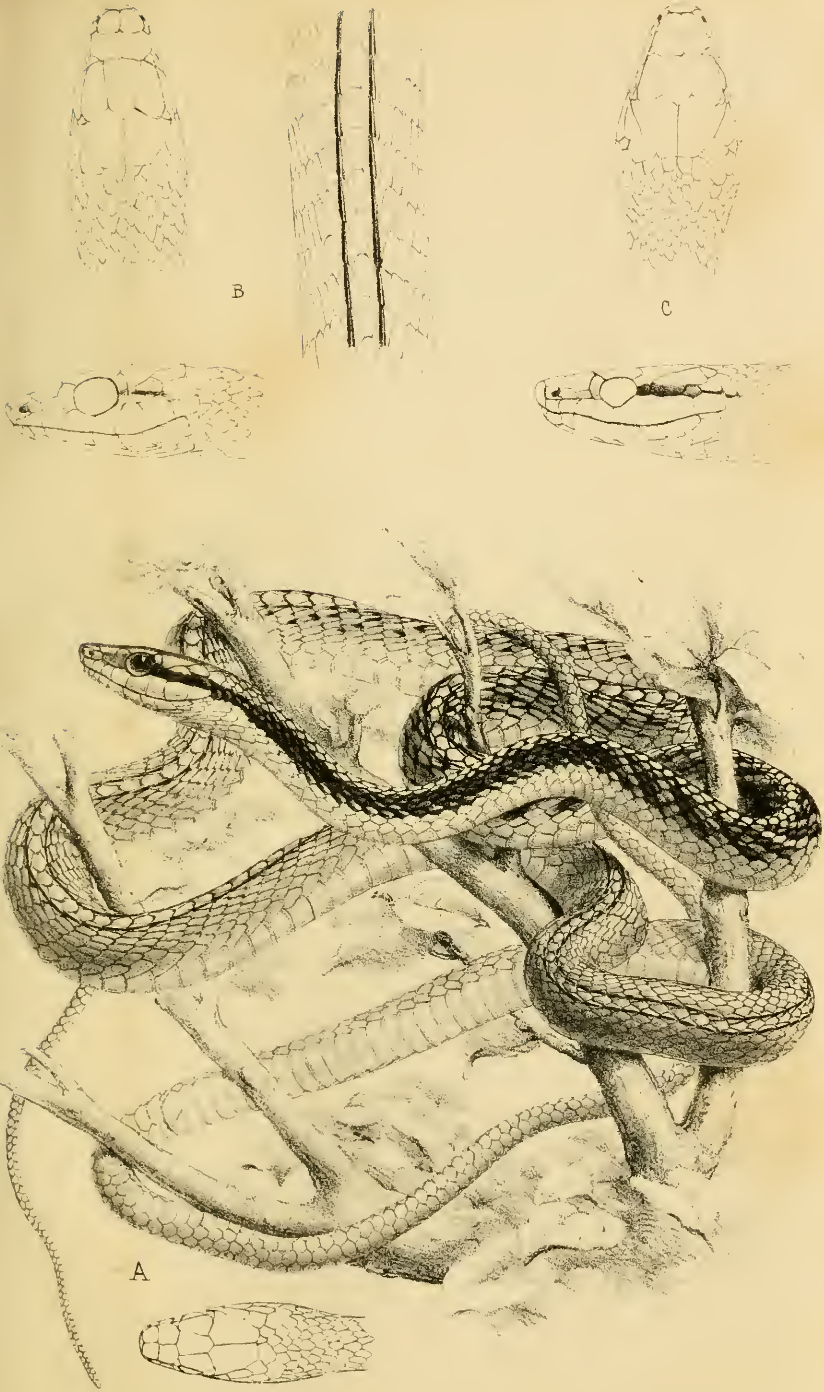
A. PHILODRYAS PSAMMOPHIDEUS.
B MICRODROMUS VIRGATUS. C. PSEUDO-NAJA AFFINIS.



G. H. Ford.

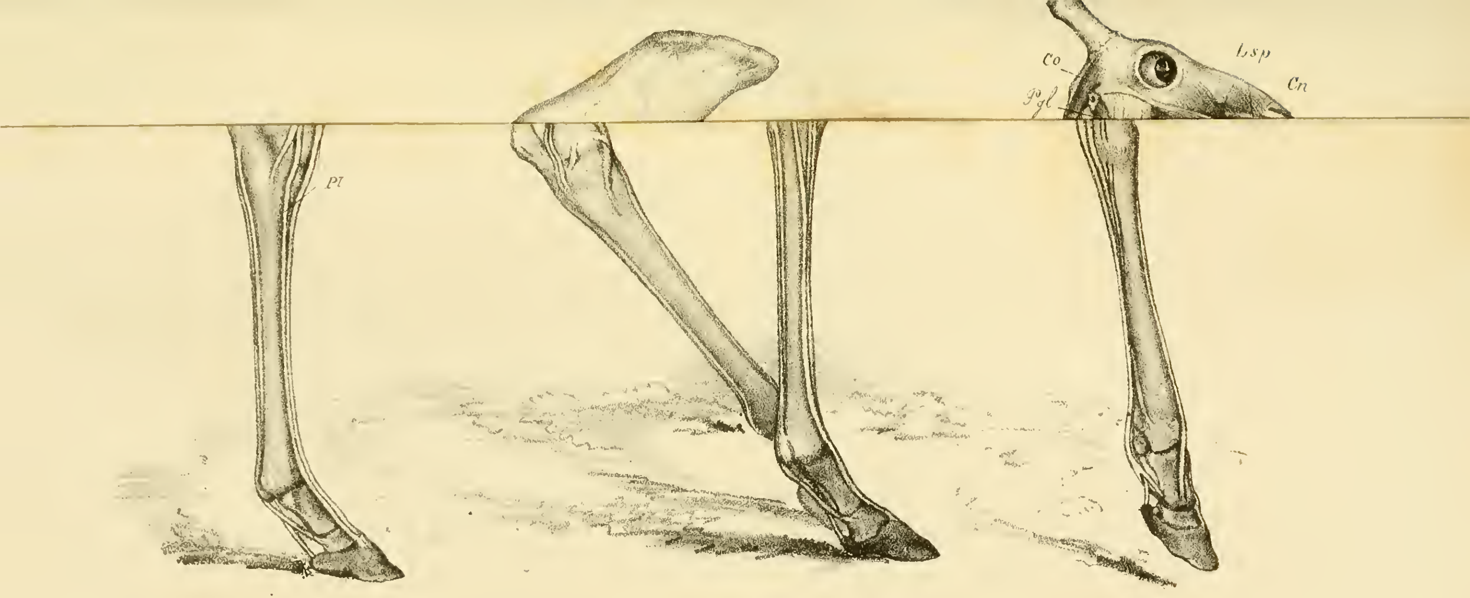
Mintern Bros imp.

A. DROMICUS MADAGASCARIENSIS.
B. RHINELAPS FASCIOLATUS.



G.H.Ford. Mintern Bros. imp.

A. AHÆTULLA DIPLOTROPIS. B. DIPLOTROPIS BILINEATA.
C. AHÆTULLA MODESTA.



J Berjeau lith.

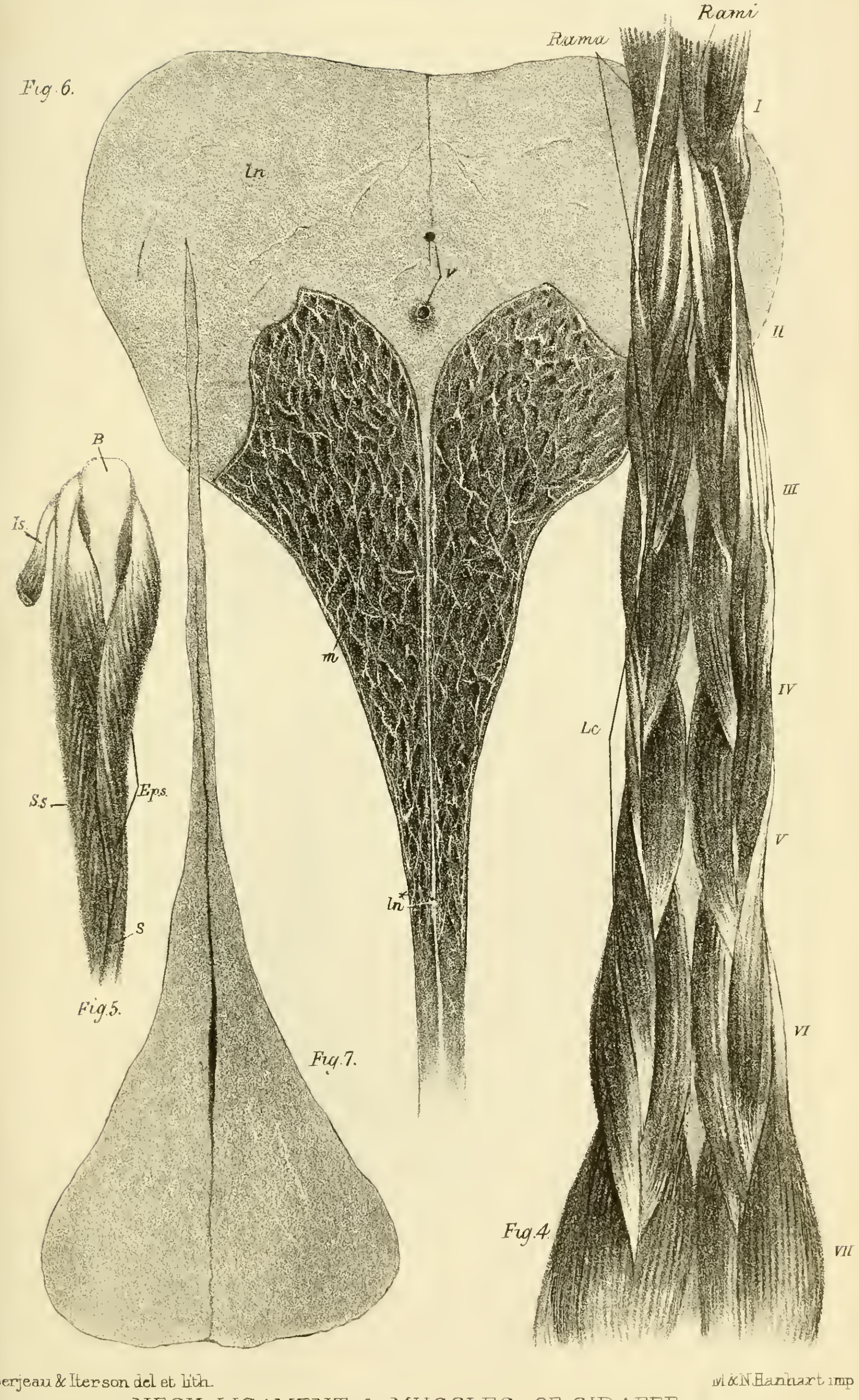
M&N Hanhart imp

CAMELOPARDALIS GIRAFFA.

I. Berjeau lith.

M & N Hanhart imp.

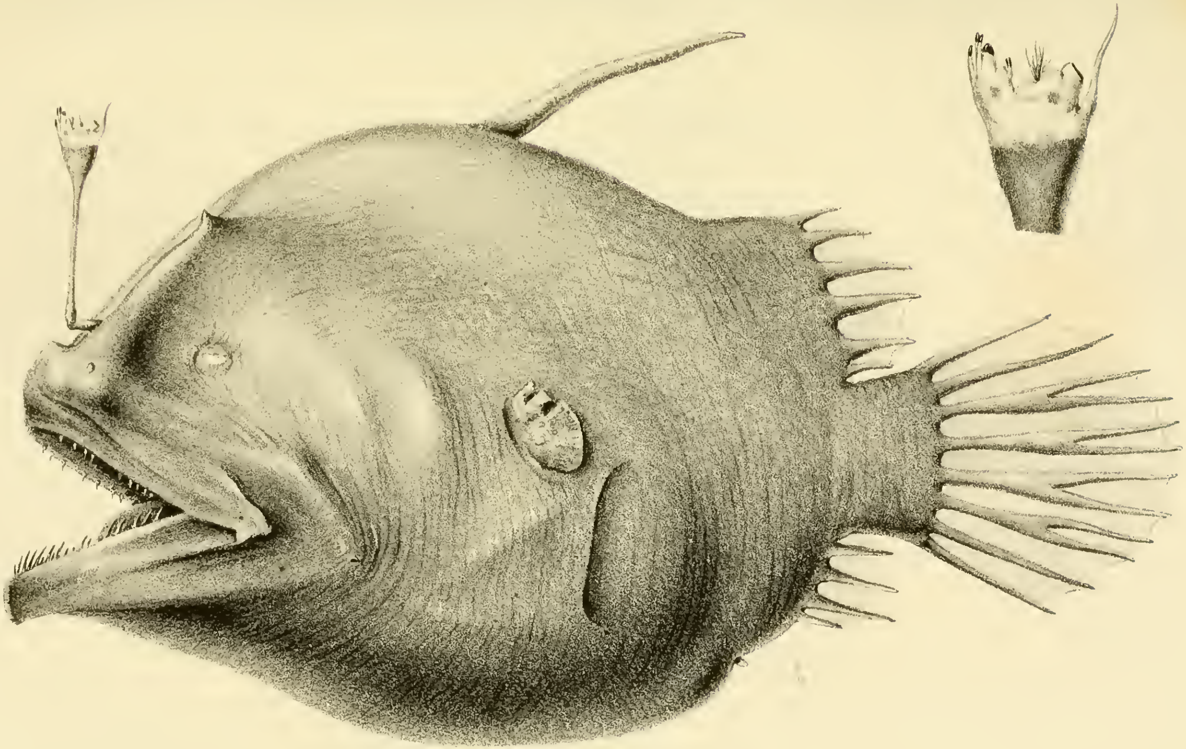
CAMELOPARDALIS GIRAFFA.



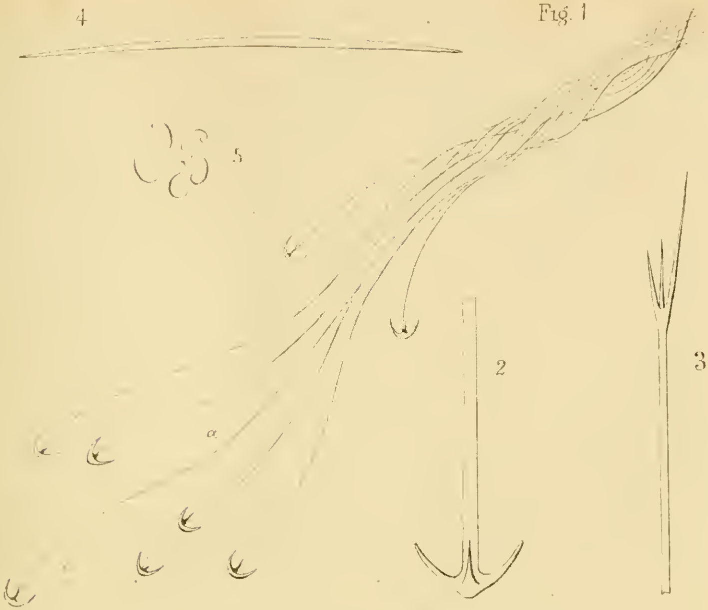
Berjeau & Iterson del et lith.

M & N Hanhart imp

NECK LIGAMENT & MUSCLES OF GIRAFFE.

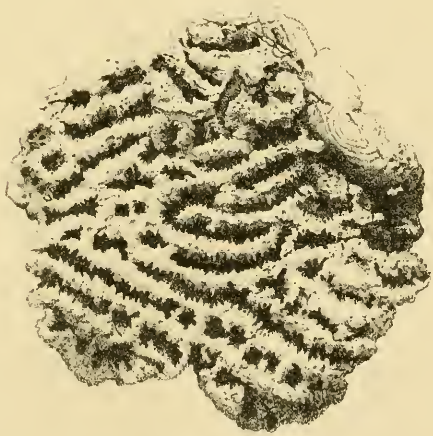


Oneirodes Eschrichtii



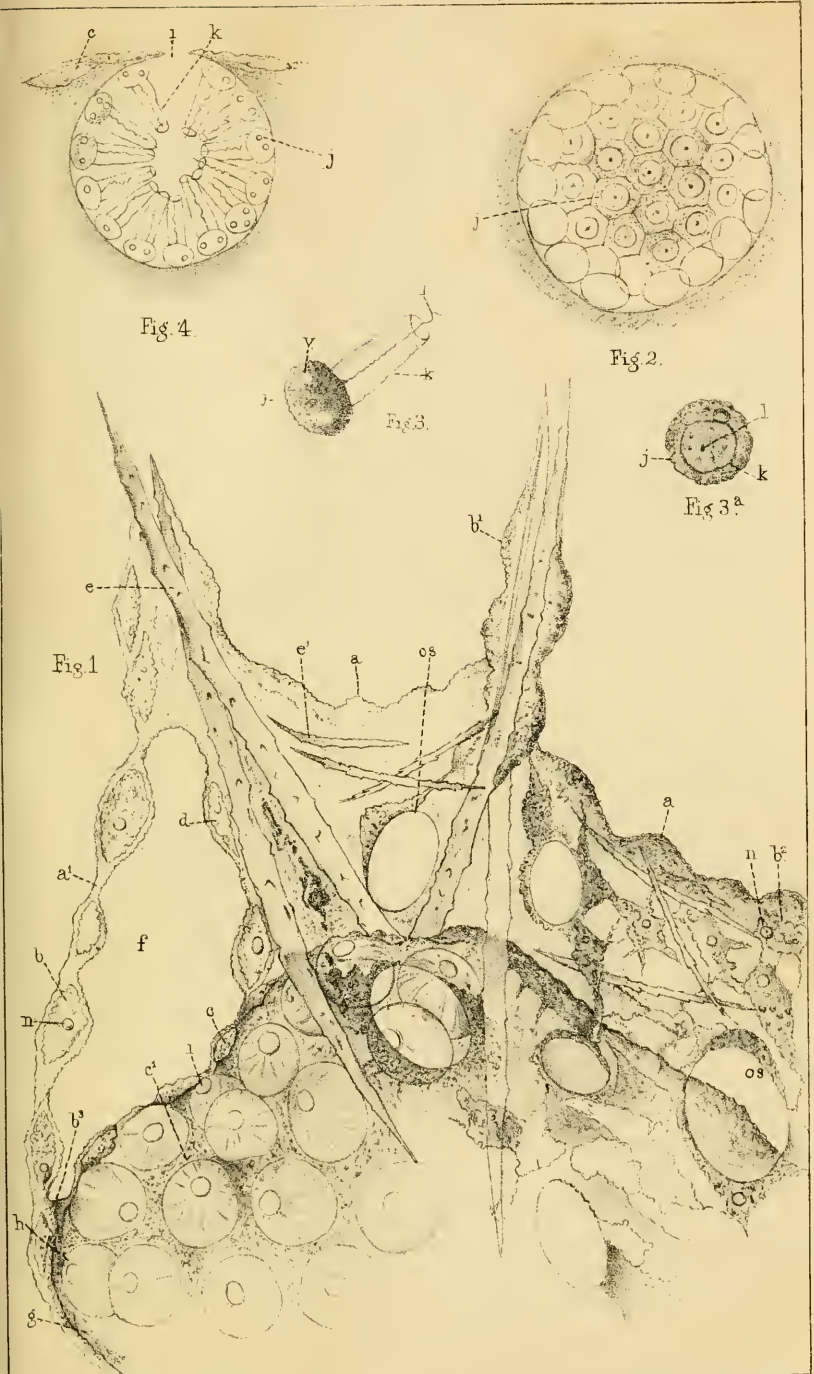
E.T.C. del

Fig 6



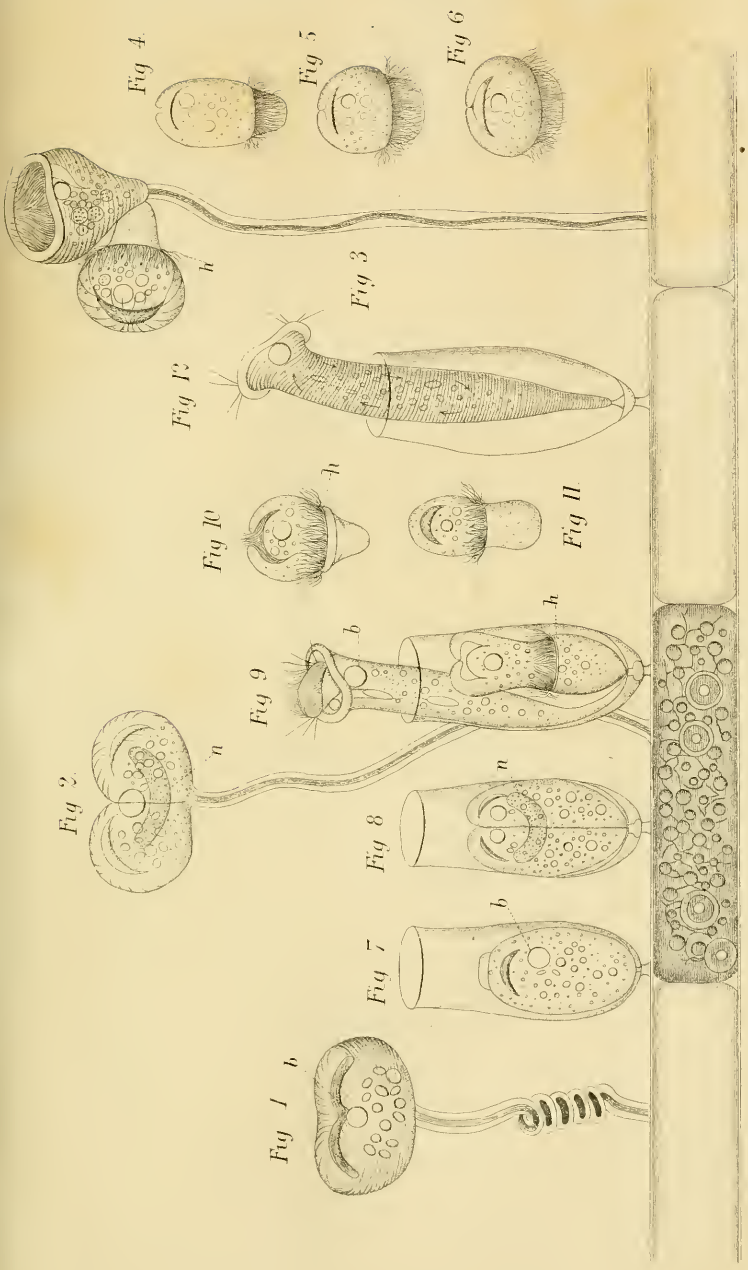
J.F.L. photo

Mintern Bros lith



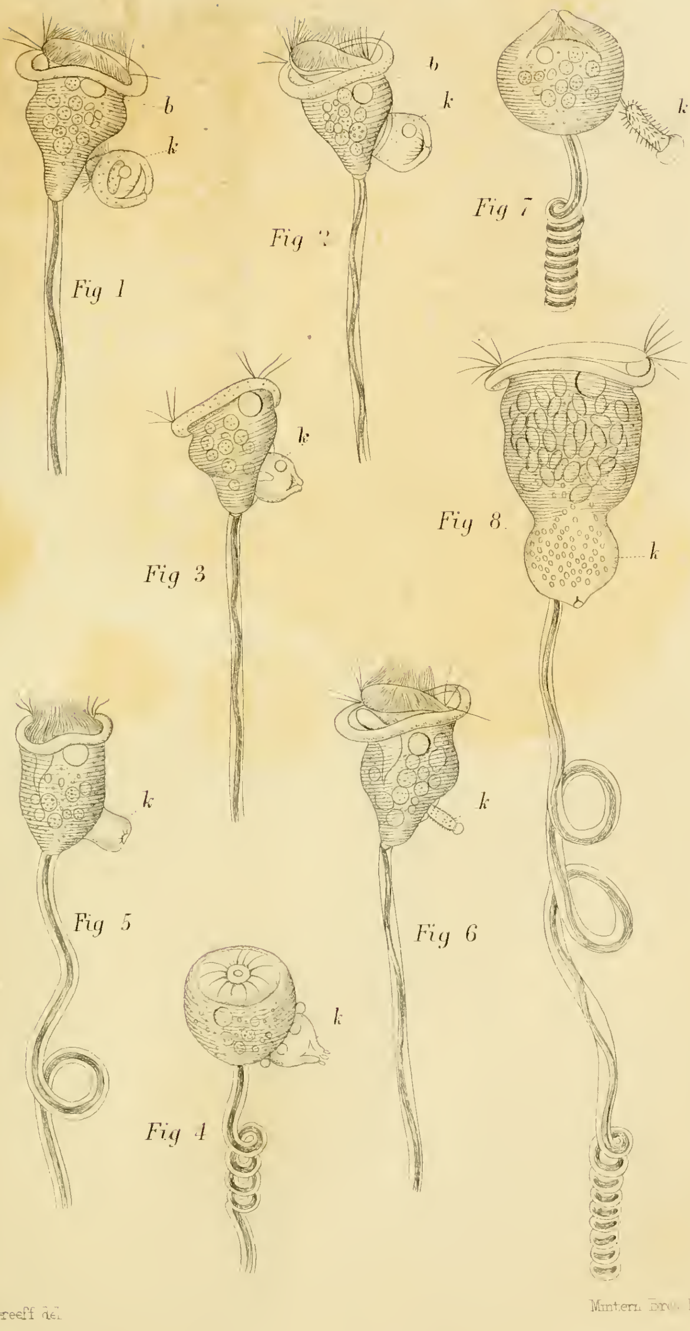
Mintern Bros. lith.

SPONGILLA ARACHNOIDEA. J.C.

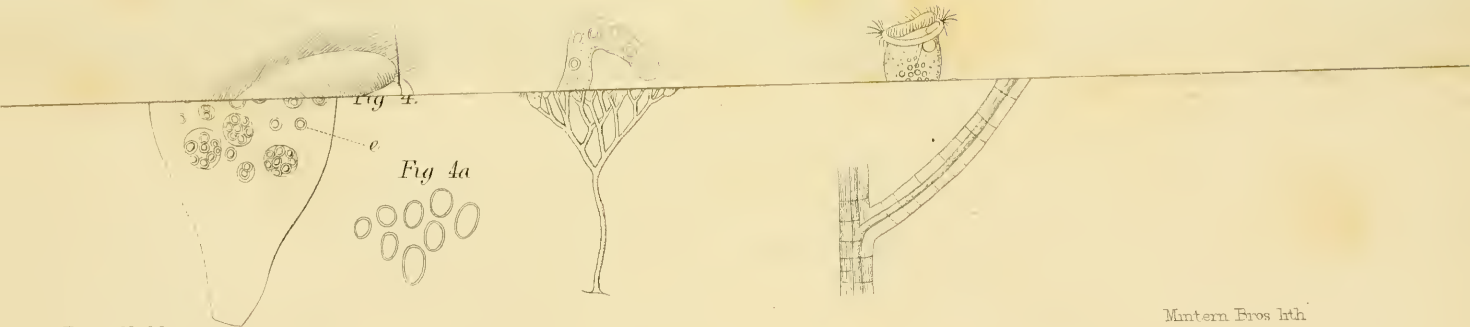


R Greeff del

Mintern Bros lith



I. Greeff del.   Mintern Bros. lith.



R Greeff del

Mintern Bros lith

Mintern Bros lith.

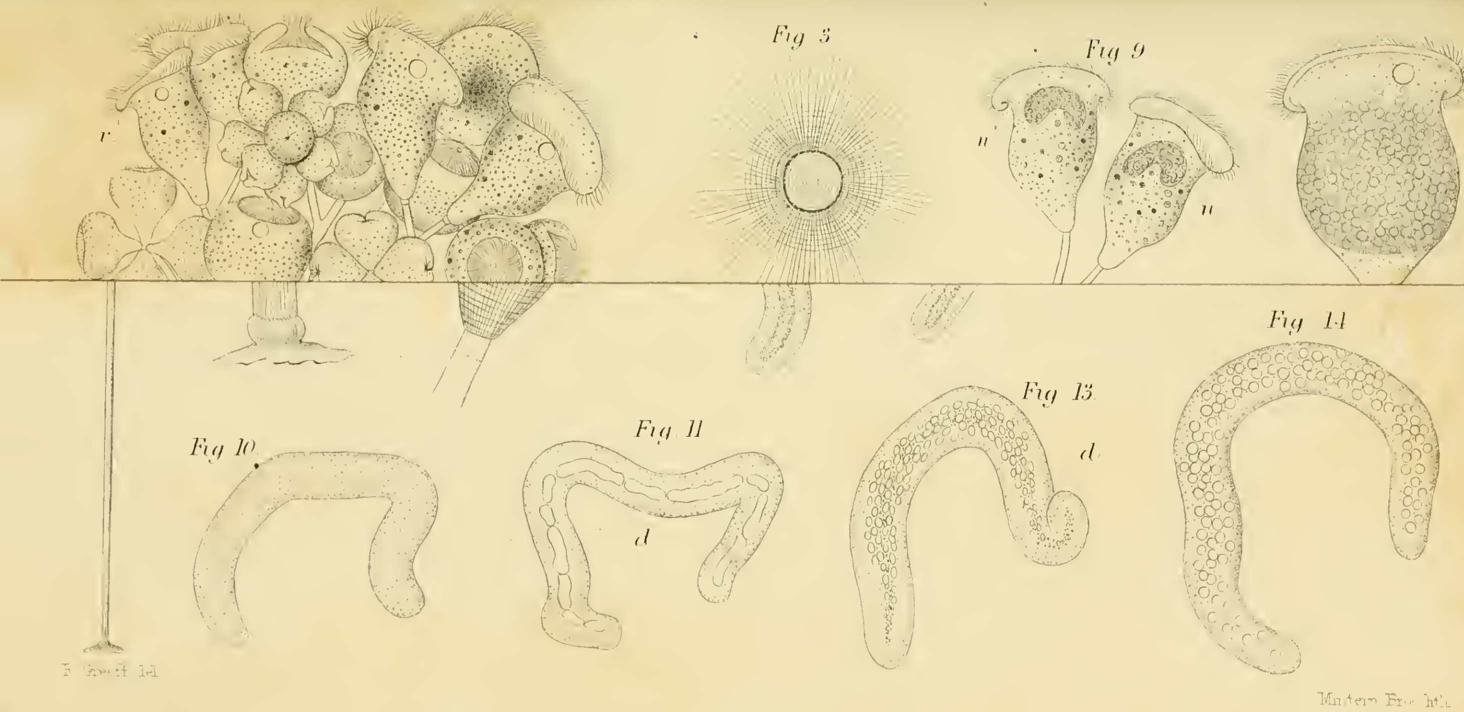


Fig 8
Fig 9
Fig 10
Fig 11
Fig 13
Fig 14
F. Kent del.
Mintern Bros lith.

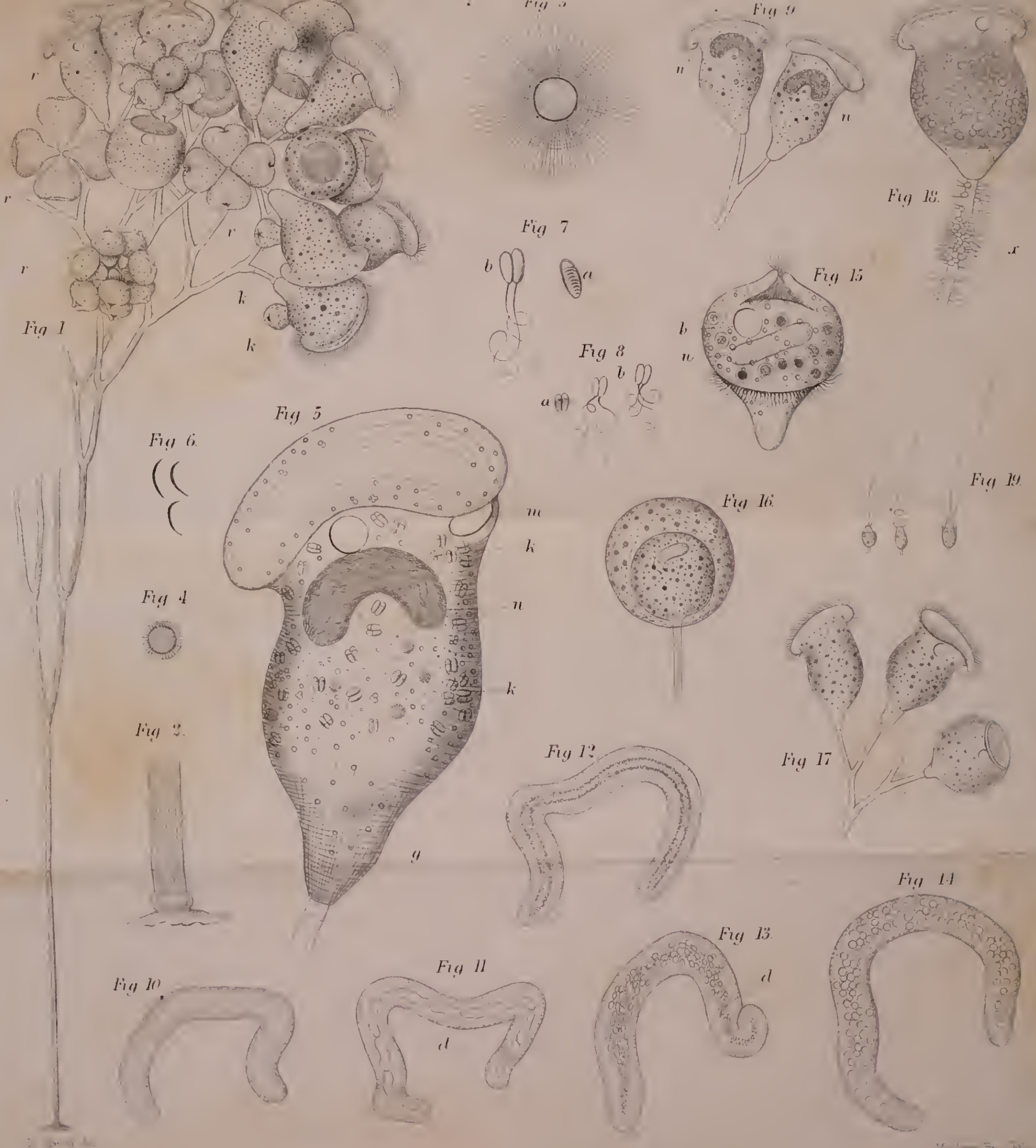
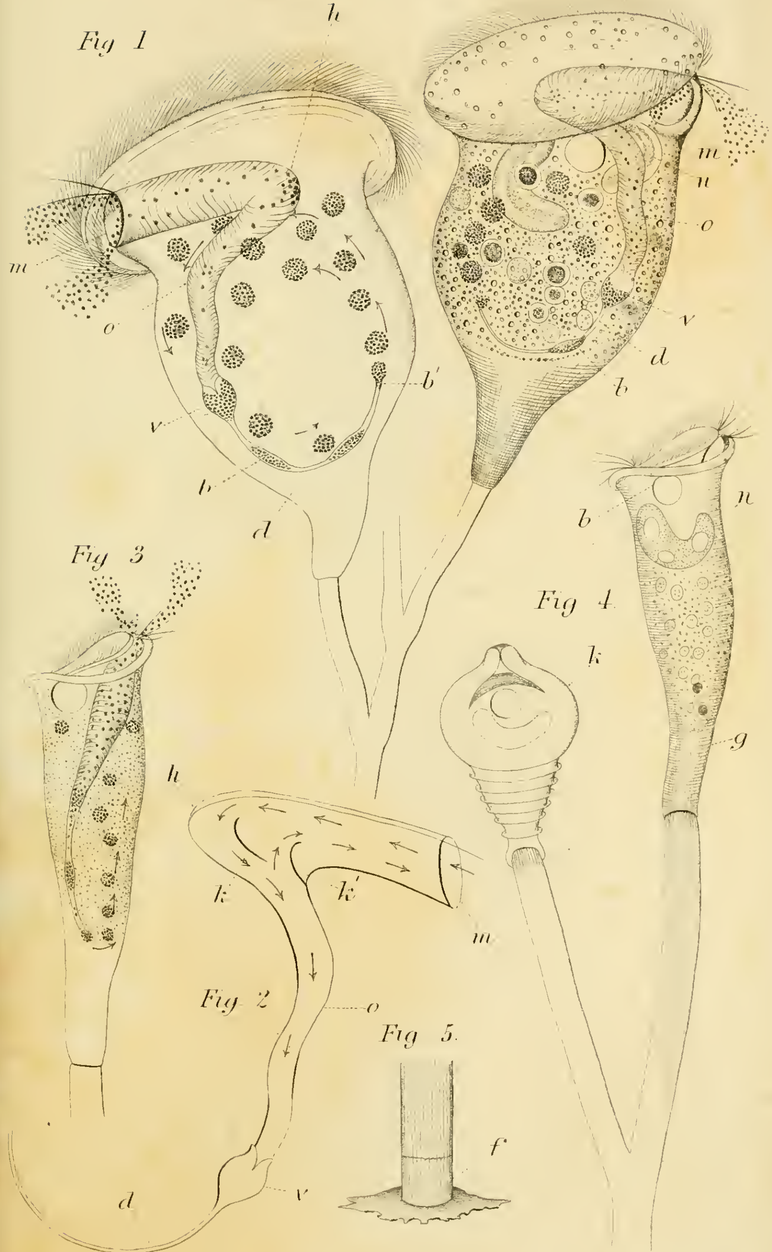
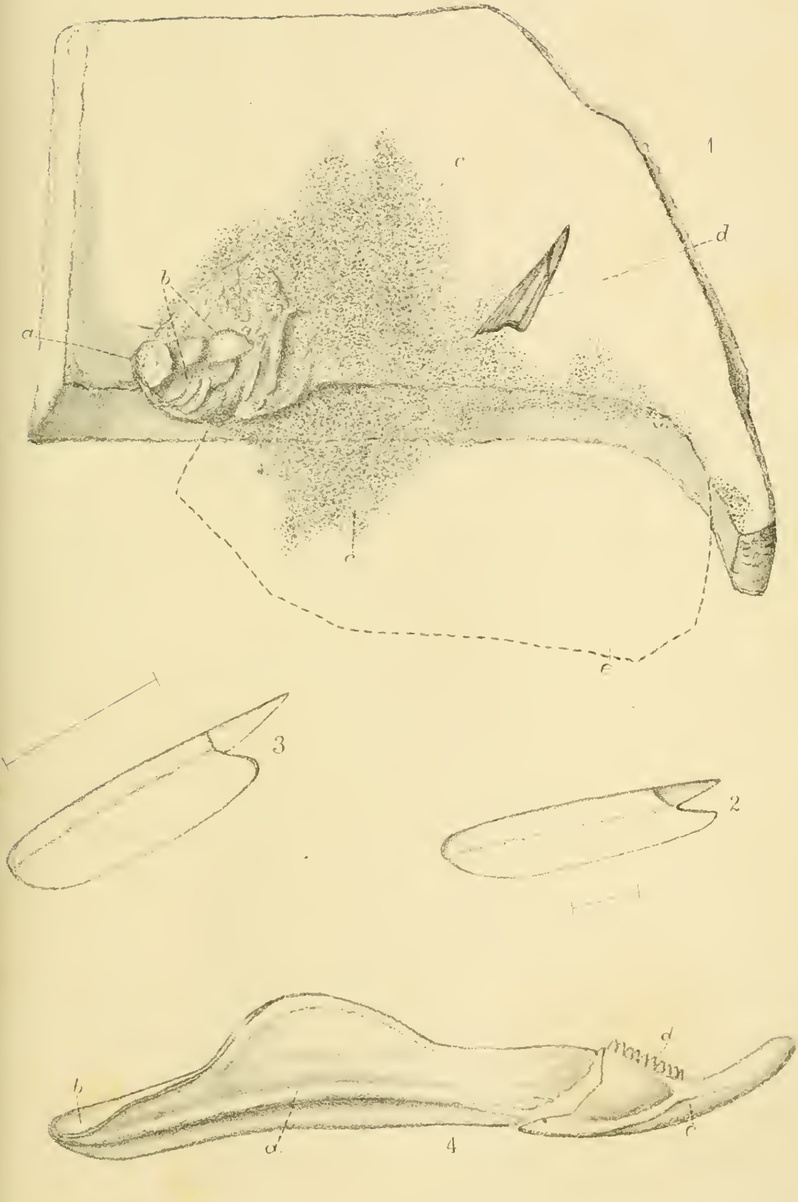


Fig 1
Fig 2.
Fig 3
Fig 4
Fig 5
Fig 6.
Fig 7
Fig 8
Fig 9
Fig 10
Fig 11
Fig 12
Fig 13.
Fig 14
Fig 15
Fig 16.
Fig 17
Fig 18.
Fig 19.



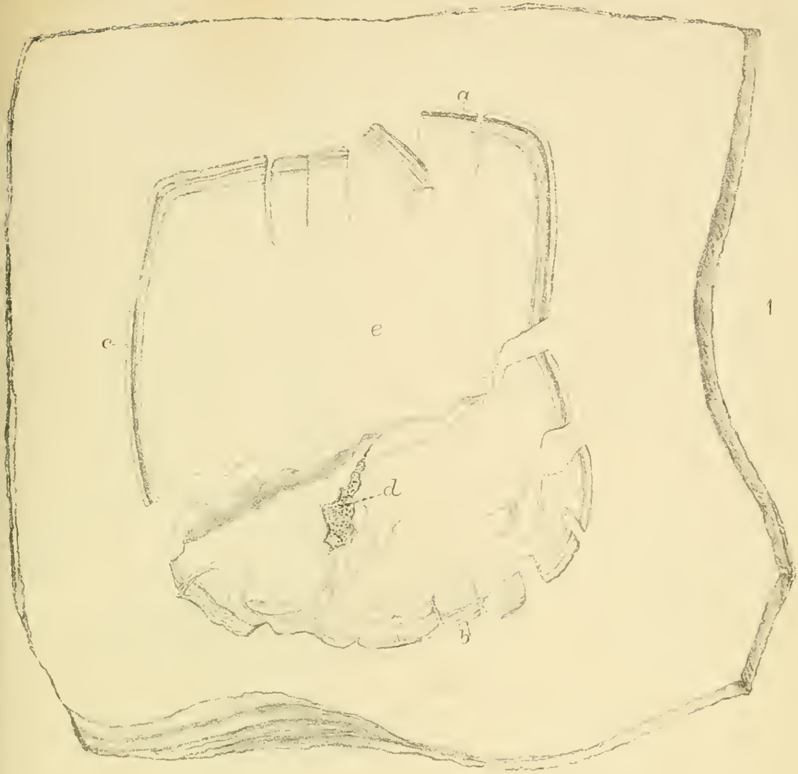
R. Greeff del.

Mintern Bros lith.



A. Hancock del.

Mintern Bros. lith.



1

2

A Hancock del. Mintern Bros lith.

Fig 1

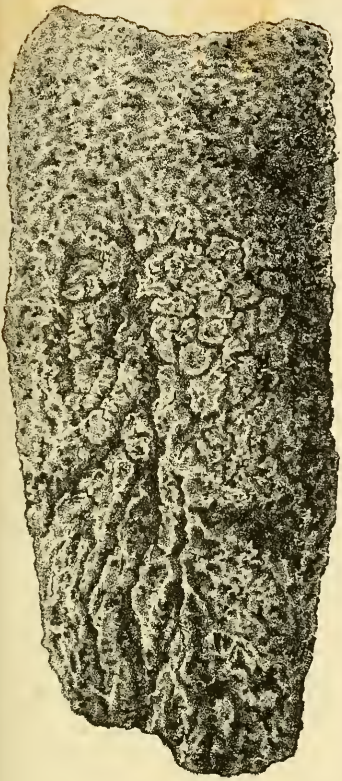


Fig 7.

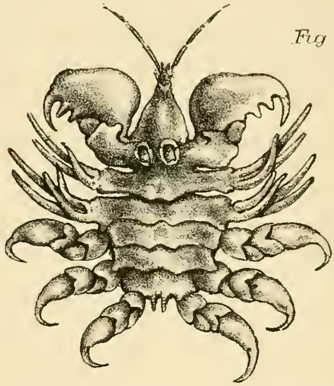


Fig 6.

Fig 5.

Fig 4

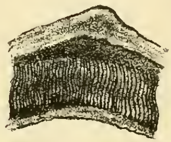
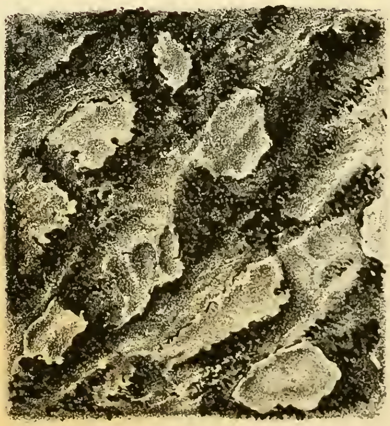


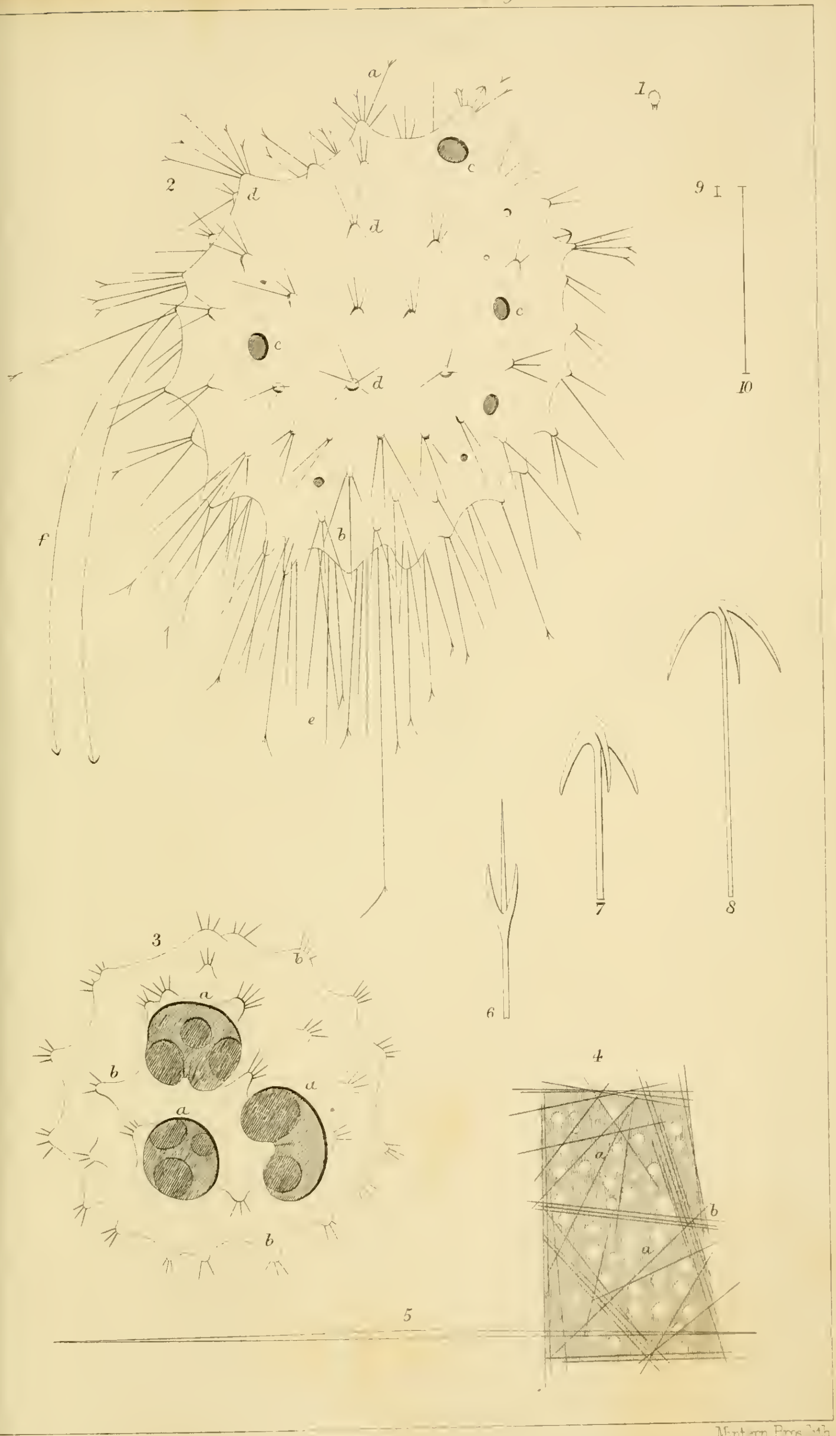
Fig 2

Fig 3

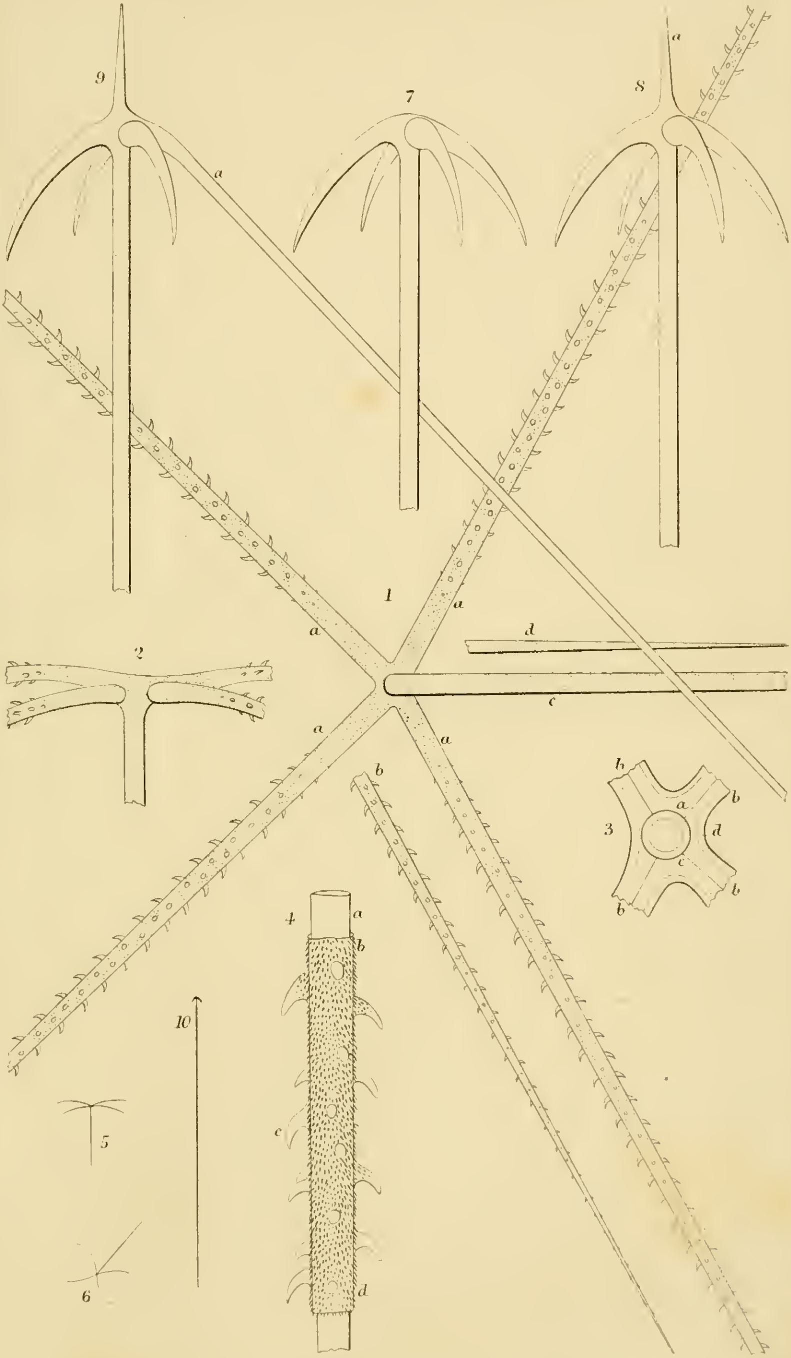


Berjeau lith. Mintern Bros. imp.

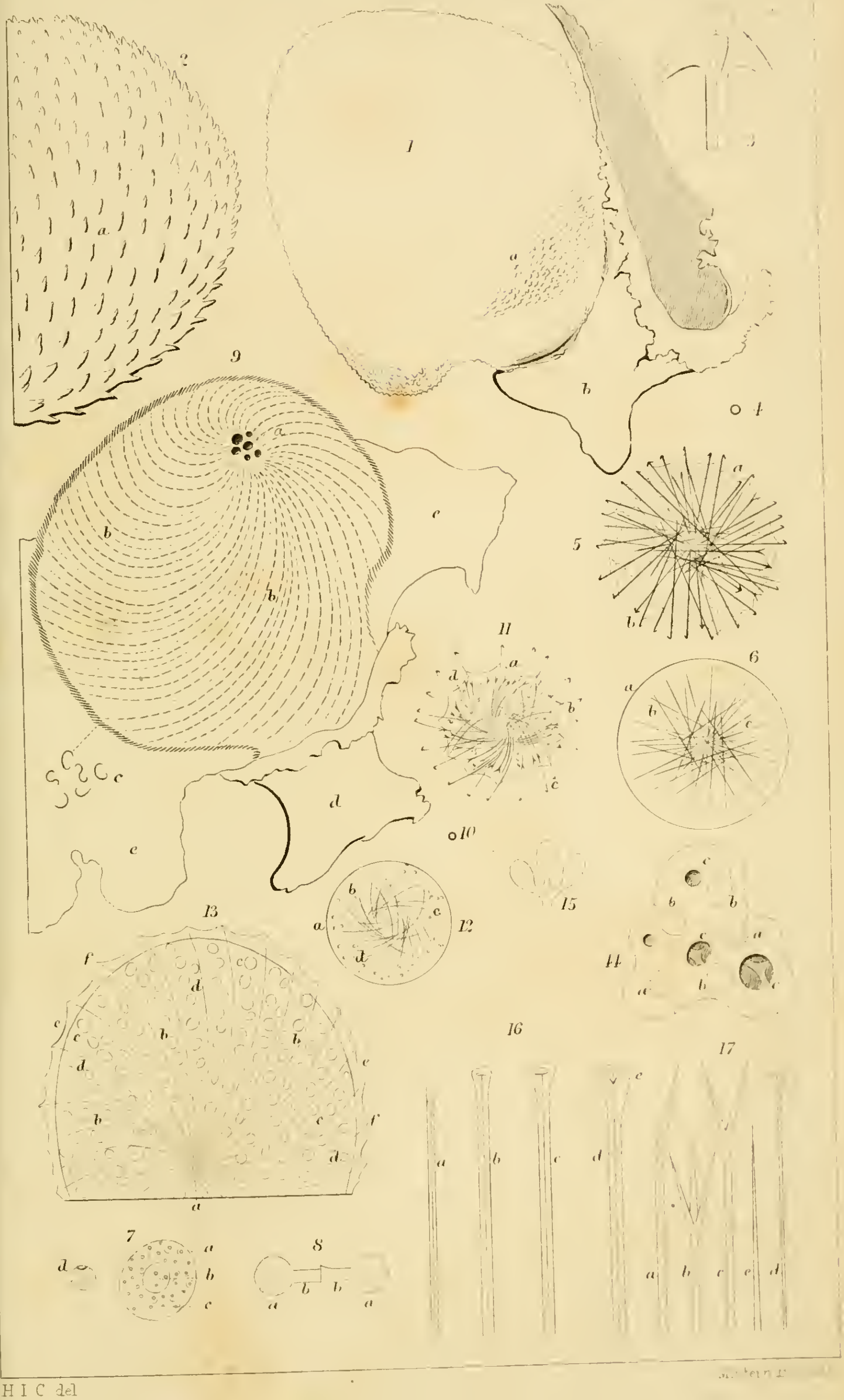
SKIN OF RHYTINA & PARASITE.



I. C. del.   Mintern Bros. lith.



H. I. C. del.



H I C del