THE PHILIPPINE JOURNAL OF SCIENCE

VOLUME 67

SEPTEMBER TO DECEMBER, 1938

WITH 61 PLATES AND 15 TEXT FIGURES

MANILA
BUREAU OF PRINTING
1938

24117

THE PHILIPPINE JOURNAL OF SCIENCE

Published by the Bureau of Science, Department of Agriculture and Commerce

[Entered at the Post Office at Manila, P. I., as second-class matter.]

CONTENTS

No. 1, September, 1938

[Issued October 26, 1938.]

No. 2, October, 1938

[Issued November 23, 1938.]

No. 3, November, 1938

[Issued December 2, 1938.]

No. 4, December, 1938

[Issued December 29, 1938.]

THE PHILIPPINE JOURNAL OF SCIENCE

VOL. 67 SEPTEMBER, 1938 No. 1

GENERA HYMENOPHYLLACEARUM [1]

By EDWIN BINGHAM COPELAND

Of the University of California, Berkeley

ELEVEN PLATES AND ONE TEXT FIGURE

Whoever devotes long and careful study to a group of plants becomes acquainted with their several significant characteristics and recognizes minor groups. He recognizes the groups of individuals as species, and is usually disposed to regard the definable groups of species as genera. Thus the men who have studied the Hymenophyllaceæ most comprehensively, Presl and van den Bosch, have felt constrained to recognize many genera. Prantl recognized a smaller number of genera, chiefly because he knew a smaller range of species. Hooker and Sadebeck, who cataloged very many species, the former in Species Filicum and Synopsis Filicum, the latter in the Pflanzenfamilien, and who went back to the genus concepts of Swartz, are not exceptions to this rule, because, however many species they may have seen, they did not devote to them the careful and detailed attention necessary to an understanding of significant characteristics and of the affinities which these peculiarities make plain.

I began the detailed study of these ferns without suspecting that it would result in dissatisfaction with the general view that

[1] This paper expresses the general results of intermittent studies carried on since 1908, and for a considerable part of my time since 1928. It has been composed in the Herbarium of the University of California, for the use of the facilities of which I gladly express my sense of obligation. I am indebted to Doctor Maxon for many items of counsel and material assistance, and to Mr. C. V. Morton for a very careful criticism of my manuscript; without committing these gentlemen to my conclusions, I thank them for their help.

two genera compose the family.[2] I knew already that some of Presl's genera, as *Cephalomanes* and *Pleuromanes*, were based on imaginary characteristics, and did not suspect that they nevertheless represented natural groups of species worthy of generic status. With time, my experience was exactly that of van den Bosch:[3] "Speciebus Hymenophyllacearum diligenter et accurate investigatis, generum statuendorum necessitas in dies magis me urget horumque notas et limites sensim melius perspicio." Because this improvement of understanding has been gradual, and

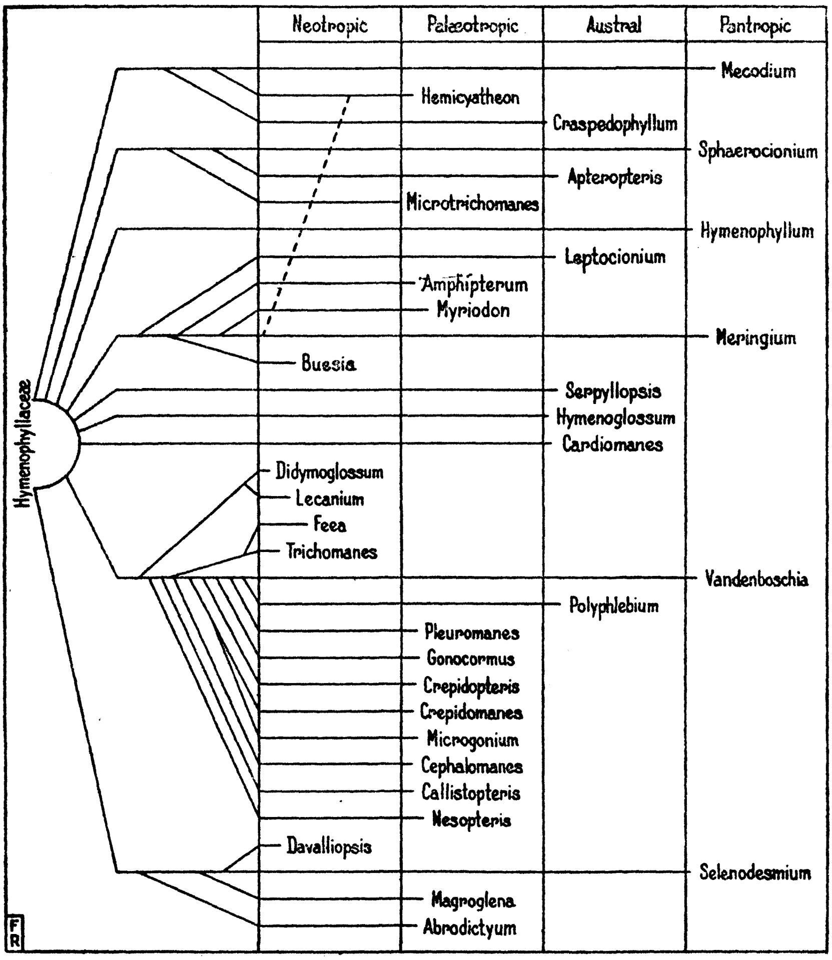


Diagram of affinities of genera.

[2] *Loxsoma* and *Loxsomopsis* are not included in this study.
[3] Hymenophyllaceæ Javanicæ (1861) 5, footnote.

without end, I have abstained from the publication of ideas on genera, until my familiarity with the species is as complete as it seems likely to become. Here, I would again follow van den Bosch,[4] quoting Fries: "Vana sunt nova genera, sine universali specierum cognitione et praecipue morphoseos historia."

Because I have discussed elsewhere [5] in some detail the two principles which must determine the recognition of genera, this phase of an introductory discourse may be treated briefly here. These are:

Naturalness.—A genus must be a natural group. Like a family of men, it must consist of "blood relatives", including all within some accepted measure of affinity, and only these. Such a genus is literally, not figuratively, natural; it exists in nature. Two species of diverse descent (beyond the accepted measure of affinity) do not belong in one genus, though their resemblance may reach apparent identity. In our verbal definitions of genera we use words describing their (usually visible) characteristics; but no such characteristic is fit to serve always as a generic criterion. Phyletic unity, so far as all our evidence lets us recognize it, is the sole categorical test of a genus. Literally speaking, the descendants of a given plant of a century ago are a natural group. The descendants of a plant of a million years ago are a natural group, perhaps, however, represented by several of our species. So also are the descendants of a plant of fifty million or more years ago.

If we knew the genealogies of our plants for these periods, the sole criterion in determining how far back we should go for the common ancestor of a genus would be the other principle:

Convenience.—Subject always to the preceding principle (naturalness), a genus should be delimited with all possible regard to our convenience. In its application, this principle develops several aspects. In the first place, it serves our convenience to establish genera which we can recognize easily by their verbal definitions. Again, it may be convenient to have our genera recognizable by a group of common characters, rather than by some one arbitrary criterion;[6] that is, the natural-

[4] Synopsis (1859) 5.

[5] The Oriental Genera of Polypodiaceæ. Univ. Calif. Publ. Bot. **16** (1929) 45–128.

[6] This may be disputed; but I believe that our comfortable acceptance of genera recognized by arbitrarily chosen criteria is the result of adjustment, by usage, to a procedure which would be uncomfortable without the adjustment.

ness of a genus should be reasonably recognizable. In other cases, it surely serves our convenience to distinguish as genera groups with few or single conspicuous characteristics. Again, very large genera are inconvenient. *Trichomanes* and *Hymenophyllum* have become inconveniently large genera. "But convenience will not justify us in dividing a genus of a thousand species along any except natural lines; nor let us maintain a genus of two species, unless they are nearly related." [7]

After the removal of several foreign elements *Trichomanes* of Linnæus remained a natural genus. It would be equally natural still, but would be very inconvenient, comprising the whole family. When Sir James Smith removed one species and set up *Hymenophyllum*, the result was two natural genera. However, with time, the two have not merely outgrown convenience, but they also have not remained convenient in other respects, nor even natural. That they have not remained convenient is attested by the number of species that have been referred to both *Trichomanes* and *Hymenophyllum*, because they share their formal articles of definition—consider *Didymoglossum, Meringium, Serpyllopsis.* That in recent time they are not natural, is illustrated best by *Sphaerocionium* and *Microtrichomanes,* together forming a natural group and reasonably forming a genus, but with the former treated as *Hymenophyllum,* the latter as *Trichomanes.*

As to the extent to which convenience is served by the recognition of more and more genera, workers cannot be expected to agree. The convenience of the man who wants merely to find names for his specimens, by the most superficial examination which will satisfy this purpose, is not that of the man who seeks to understand the phylogeny of the groups, by the most careful study of each species. The treatment which serves my convenience has changed essentially with the years of study. I find satisfaction in the fact that most of the genera I recognize are those long since set up or maintained by Presl and van den Bosch. Presl must have had a rather remarkable eye for genera. His diagnostic characters might range from imaginary to fantastic—consider *Cephalomanes, Pleuromanes,* and *Abrodictyum;* but each of these represents a natural genus. As to the number of genera, Presl and I are not far apart. Presl named twenty-nine genera, some of them almost undefined. Van den Bosch described twenty-four. Including two monotypic ge-

[7] Copeland, op. cit., p. 18.

nera and one of two species which they never saw, I recognize thirty-three.

The genera herein maintained or established are those which seem to me to merit recognition, after test by the two principles already presented. The family is diversified beyond the suspicion of those who have not given it particular study. The characteristics involved in this diversification are useful as generic characters whenever, in the evolution of the family, they have become fixed as attributes of natural groups conveniently to be treated as genera. The most careful study of these characteristics was that of Mettenius. Remembering always that naturalness is the indispensable criterion of a genus, and that characteristics are of systematic utility only as they serve to enable us to recognize natural groups,[8] some general discussion of the characters which are, or might be, useful in this family is in order.

The family as a whole is characterized by peculiarities: (*a*) Of the gametophyte, (*b*) of the reproductive structures of the sporophyte, (*c*) of the vegetative structures of the sporophyte.

The spores, so far as known, are uniform throughout the family. They are of the tetrahedral type, with three originally plane surfaces where they were in contact in the spore mother cell, and a convex face. The plane faces become convex, and the angle where they meet becomes inconspicuous. They contain chlorophyll, and commonly germinate very promptly. Most of our information as to the germination of the spores of different genera and species is due to the presence of young gametophytes in the sori of herbarium specimens. It has been assumed that their period of viability after dispersal is brief; but this is relative, and the assumption should be used very cautiously, in drawing conclusions against the possibility of their dissemination over stretches of ocean. The fact that they have so spread outweighs any antecedent improbability of their doing so.

Beginning with the germination of the spores, the gametophytes are known for so few species that it is unsafe to draw general conclusions. In the majority of observed cases the entire cell (spore) divides into three approximately equal cells; this occurs in *Trichomanes crispum, T.* (*Cardiomanes*) *reni-*

[8] De natuur kent geene karakters; zij brengt typen voort, wier wezen wij te erkennen en wier verwantschap wij te beoordeelen hebben naar het geheel harer bewerktuiging, zigtbaar in hetgeen wij habitus noemen.—van den Bosch, Eerste Bijdrage (1861) 303.

forme, T. (*Microtrichomanes*) *digitatum, H.* (*Mecodium*) *abruptum, H.* (*Mecodium*) *polyanthos, H.* (*Meringium*) *bivalve, H. tunbridgense, H.* (*Mecodium*) *capillaceum, H.* (*Meringium*) *fusciforme,*[9] *H.* (*Mecodium*) *undulatum* (Hedwig, cited by Mettenius), *H.* (*Mecodium*) *rarum* (Sadebeck), *H.* (*Mecodium*) *dilatatum, T.* (*Microtrichomanes*) *palmatifidum,*[10] and *T.* (*Vandenboschia*) *draytonianum.*[11] In other cases three cells are cut off at the "corners" of the spore, leaving a larger central cell; this occurs in *T.* (*Vandenboschia*) *schmidianum* (Taschner), *T.* (*Crepidopteris*) *humile, T.* (*Vandenboschia*) *pyxidiferum* (Mettenius), and *T.* (*Gonocormus*) *diffusum* (Goebel).

The further development is known for still fewer species. As generalizations, in "*Hymenophyllum*" one of the three original outgrowths develops, after forming a short protonema, into a thalloid structure, one cell thick except along a narrow axis, bearing archegonia in clusters on cushions near the margin, and antheridia in various places. The species observed belong to *Hymenophyllum* and *Sphaerocionium*. *Cardiomanes* behaves in the same manner (Holloway); and so, I believe, does *Serpyllopsis*. In "*Trichomanes*" the protonema forms an extensively branched structure, ultimately producing thalloid structures which bear the archegonia on short special branches in *T. alatum* (Bower) and *T. sinuosum* (Goebel), or, without thallus, bearing such branches on the branched filament, in *T.* (*Vandenboschia*) *pyxidiferum, T.* (*Gonocormus*) *diffusum, T.* (*Selenodesmium*) *rigidum,* and *T.* (*Macroglena*) *strictum.* Holloway describes the gametophyte of *T.* (*Selenodesmium*) *elongatum,* which "has but a brief filamentous stage, and develops into a large strap-shaped tissue body whose meristem is situated at the base of a sinus at its forward end, the archegonia being borne on a series of cushionlike thickenings behind the meristerm,"[12] whence it appears that this structure varies within *Selenodesmium.* There are a number of observations of other peculiarities. Mettenius reported exceedingly slow growth of the gametophyte of *T. pyxidiferum;* and there are other observations to the same effect. It seems to be of indefinitely long life, and in both known forms to be capable of vegetative multiplication by the dying off of old parts and independent survival of the branches. Infection

[9] Mettenius, Hymen. (1864) 489–491, pl. 4.
[10] Goebel, Organographie 2 (1930) 1089.
[11] Campbell, Mosses and Ferns (1905) 373.
[12] Holloway, Trans. N. Zeal. Inst. (1923).

of the rhizoids by fungi has been observed for several species. A remarkable pitting of the walls is reported for one. The formation of gemmæ seems to be general, and they are of at least two types. Both apogamy and apospory are reported. Goebel reports countless lateral antheridiophore outgrowths from the ribbonlike thallus of *T.* (*Didymoglossum*) *Kraussii.*

The paucity of these observations, and their indiscriminate distribution among the genera I recognize, makes it impossible at this time to use gametophytic characters for the characterization of the genera. With regard to the Polypodiaceæ our information is more extensive, and, aside from the Vittarieæ, there is such uniformity that the gametophyte is valueless in taxonomy. Among the Hymenophyllaceæ so much diversity is known that more complete information seems likely to make the gametophyte very useful in an understanding of the evolution and in the correct classification of the group.

The division of the family into two genera has been based on the form of the involucre (indusium), supposed then to be composed of two mutually free "valves" in *Hymenophyllum,* and to be a tube in *Trichomanes.* The condition ascribed to *Hymenophyllum s. lat.* exists in many species of *Hymenophyllum s. str., Sphaerocionium,* and *Mecodium.* Since the involucre begins at the base of the receptacle, the valves are not free unless the whole sorus protrudes beyond the margin. It is usually more or less immersed, in which case there is at least the beginning of a tube. It is wholly immersed in *H.* (*Sphaerocionium*) *Lyallii,* leaving no free lips, so the species is moved to *Trichomanes; T.* (*Apteropteris*) *Malingii,* equally without free valves, was moved in the other direction. Even if the sorus is not immersed, there is a tubular or obconic base in very many species called *Hymenophyllum*—Presl's *Meringium, Leptocionium,* and others. Conversely, two groups of *"Trichomanes," Crepidomanes* and *Didymoglossum,* have the mouth of the involucre divided into two lips, more deeply so in some species of *Crepidomanes* than in some species of *Meringium.* To provide for these very many species that do not conform to the definition of either genus, Presl and van den Bosch, who recognized many genera, set up intermediate groups of genera, Sectio Didymoglosseæ Presl, and Tribus Leptocioneæ van den Bosch.

At the base of the sorus the fertile vein may give rise to a branch running up each side of the tube; this phenomenon is observed in some but not in all species of *Mecodium, Meringium,* and *Vandenboschia*. The tube is more than one layer of cells thick in *Trichomanes s. str.* but not in all groups of *Trichomanes s. lat.;* this difference merits detailed study.

The receptacle is typically included—that is, not longer than the involucre—in "*Hymenophyllum;*" of indefinite length, by basal intercalary growth, in *Trichomanes*. In *Trichomanes s. lat.* there is uniformity of type, the globose tip and the inflated base on which respectively Presl based his genera *Cephalomanes* and *Ragatelus* being illusory. The receptacle of *Meringium* and its derivatives and of *Leptocionium* is like that of *Trichomanes*, indefinitely long. That of *Hymenophyllum s. str.* is of the same type but of limited growth, not typically exceeding the involucre. In *Mecodium* and *Sphaerocionium*, growth ceases by the time the sporangia develop, the latter being simultaneous.—*Simplices*, of Bower. In each of these genera there are natural groups of species with cylindrical receptacles, and others with more or less globose receptacles, all having longer or shorter sterile bases. These are illustrated for very many *Mecodium* species in my Hymenophyllum.[13] I place in *Mecodium* some American species with extruded receptacle. The sporangia may be sessile on the body of the receptacle, or may be borne on more or less prominent outgrowths, sporangiophores. Some species produce basal paraphyses.

The sporangia are uniform in type, sessile, with an obliquely transverse annulus interrupted by the stomium. In general they are large, with many superficial cells and up to 256 or 512 potential spores in *Hymenophyllum s. lat.;* small, with few superficial cells and comparatively few spores, in *Trichomanes s. lat.* Bower has studied these most amply, and concludes that species producing very numerous sporangia produce correspondingly small ones. However, *Cardiomanes* bears very long receptacles with indefinitely many sporangia as large as are known in any leptosporangiate fern.

In the range of modifications in vegetative form and structure in adaptation to a generally humid environment, the Hymenophyllaceæ exceed any other family in the plant kingdom. This statement may astound those accustomed to the summary dictum that these are plants of very simple structure, but I make it with confidence. In a humid environment transpiration is limited. The leaf structure, evolved in perfect adaptation to the environment, then demands that the transpiration be lim-

[13] Philip. Journ. Sci. 64 (1937) 1.

ited, and the group is incapable of adaptation to constantly dry environment. In the internal economy of such plants the typical stem plays a minor part. It is a creeping rhizome bearing remote distichous fronds in most genera; this is the primitive stem of the family. In *Trichomanes s. str.*, *Selenodesmium*, *Davalliopsis*, *Nesopteris*, *Callistopteris*, and *Cephalomanes*, it shortens and is ascending or erect, with congested polystichous fronds. The bundle is of the concentric fern type. When, in stem or leaf, it becomes collateral, it does so by reduction, and these collateral bundles are not homologous with those of other plants.

Root bundles are usually diarch, but range from monarch to nonarch. The most remarkable phenomenon as to the roots of the family is their disappearance. Mettenius found them absent in *T.* (*Vandenboschia*) *pyxidiferum* and *schmidianum*, *T.* (*Gonocormus*) *saxifragoides*, *T.* (*Crepidomanes*) *intramarginale*, *latemarginale*, and others, *T.* (*Microgonium*) *cuspidatum* and others, *T.* (*Didymoglossum*) *Petersii* and others, *T.* (*Lecanium*) *membranaceum*, and *T.* (*Crepidopteris*) *humile*. The number of species usually rootless is very large, but a root can occasionally be detected on species normally rootless. Rootlessness in general seems to characterize all of the genera just named in parentheses, with the exception of *Vandenboschia*.

In the absence of roots, stems take their place. These metamorphosed stems may be long, slender, freely branched, with suppression of the leaves. In substitution for root hairs, they produce rhizoides, cut off by a septum at the base. *Hymenophyllum* (*Mecodium*) *axillare* produces similar metamorphosed leafless stems, except that they bear roots. Besides the ordinary functions of absorbing liquid and anchoring the plant, the stout roots of old plants of *Trichomanes s. str.*, *Cephalomanes*, and *Selenodesmium* serve as braces or props, to hold up the erect stems, which are not directly fixed in the ground.

The leaves vary from entire to flabellate, many times dichotomous, and as many as five times pinnatifid. *Cardiomanes* and *Hymenoglossum* have simple fronds of considerable size; those of *Didymoglossum*, *Microgonium*, and *Craspedophyllum* are very small, even down to 5 mm or less long. The minute fronds of *Microgonium* and *Didymoglossum* are flat, not circinate, in vernation, unlike those of any other leptosporangiate ferns. Fronds up to several decimeters long are erect, in the genera with erect stems, or pendant in *Sphaerocionium*, *Mecodium*, and *Vandenboschia*. The systems of branching in the axes of the fronds are of the same types as in other ferns. Really reticulate venation occurs only in certain species of *Trichomanes*. A marginal vein connects the ends of the veins in most species of *Microgonium*. Besides veins with the usual structure, "false veins" occur. These are placed like veins, and may represent reduced or aborted veins, in *Trichomanes s. str.* spp., *Didymoglossum, Lecanium,* and in part in *Microgonium;* or they are structures *sui generis* in no way related to real veins, in *Crepidomanes* and in part in *Microgonium*. These are sometimes distinguished as striæ. There are also marginal structures, presumably protective, loosely spoken of as false veins, characteristic of *Pleuromanes, Crepidopteris, Craspedophyllum,* and *Hymenoglossum*. The elements of the striæ of *Crepidomanes* are like those surrounding the axes and forming sclerenchymatous sheaths. They are silicified, and in structure are peculiar to the family; Mettenius named them "Deckzellen," 'tapetal cells.'

The family is commonly defined as having the lamina a single cell thick. This is true in general, and precludes the differentiation of the tissues and tissue systems characteristic of other vascular plants. *Cardiomanes* and *Davalliopsis* have leaves uniformly three, four, or five cells thick, as do also *H.* (*Mecodium*) *dilatatum* and *scabrum*. In these cases the superficial cells are essentially like those of the family in general, and the differentiation of the internal cells does not extend beyond some difference in size, and the absence of chlorophyll. There are no intercellular spaces. I do not regard these thick leaves as primitive, but agree with Goebel that they are "tertiary" modifications. Fairly conclusive ontogenetic evidence to this effect is presented by Holloway.[14] The colorless internal cells, without intercellular spaces, would surely not be expected in an intermediate evolutionary stage between the leaf of any ordinary fern and that of *Hymenophyllum*. There are a considerable number of known cases of fronds partly two cells thick. This discussion applies only to the parenchymalike cells; striæ and specialized margins are commonly two or more cells thick.

There are remarkably specialized cell walls, which sometimes serve to characterize genera. Remarkable coarse-bordered pits of essentially the same general design are found in *Selenodesmium* and *Meringium,* with exceptions that may be primitive

[14] Trans. N. Z. Inst. 54 (1923) 587.

in New Zealand but are almost surely tertiary in Malaya. Similar walls occur in some species of *Macroglena.* The most remarkable plant in the family, in the structure of its walls and the form and arrangement of its cells, is *Abrodictyum.*

As to the cell contents, van den Bosch has described them in general terms for a great number of species, but his data have not been found available for the characterization of groups. *Sphaerocionium,* so far as the species have been tested, is remarkable for very small and numerous chromatophores. Remarkably large cells characterize *T.* (*Vandenboschia*) *philippianum* and most species of *Macroglena;* those of *Cephalomanes* also are large.

This is not an exhaustive list of the morphological peculiarities exhibited by members of the family, still less of the groups and species which demonstrate them. Most of our information up to date is the work of Mettenius, comparatively little having been added by Prantl, Giesenhagen, Boodle, Bower, Campbell, and other successors—somewhat more by Goebel.

One of the most unique such features shown by any genus is the loss of distinction between rhizome and stipe in *Gonocormus.* With this exception, proliferation by the frond is rare in the family, confined to *Trichomanes s. str.* and its derived genus *Feea.*

The trichomes of the family merit a separate paragraph, having a taxonomic value which has been too little appreciated. Hairs of one, two, or more cells protecting the apices of stems and very young leaves are general in the family and are usually caducous. They may seem to be attached above the base, and in this case have been called paleæ. Club-shaped bicellular hairs are more persistent in *Nesopteris,* and fringe the mouth of the involucre of two species. Long, soft hairs are common enough to be characteristic of *Trichomanes s. str.* and *Meringium.* In *Pleuromanes* they are borne on the broad axial pad, but not on the unilaminate "parenchyma." Large, stalked, stellate trichomes characterize *Sphaerocionium,* and their modifications are characteristic of the minor groups of that genus. Their stalk cells may disappear, leaving a sessile, stellate cluster of setæ. By further reduction these setæ become paired, and finally single. Such setæ persist on some, not all, species of the derived genus *Microtrichomanes.* They occur also on *Didymoglossum,* but not on *Microgonium,* whether or not the latter has a marginal vein.

Real paleæ, superficially expanded trichomes, such as characterize the *Cyathea-Dryopteris*, *Matonia-Polypodium*, and *Oleandra-Davallia* phyla of Polypodiaceæ, are unknown in Hymenophyllaceæ. The structures so construed in *H.* (*Buesia*) *mirificum* are mostly cut-off fragments of the common wing of the axis, as was recognized by Presl in the case of *H.* (*Ptychophyllum*) *plicatum*.[15] "Stipes bifarie paleaceus vel potius margine frondis utriusque in dentes acuminatos paleae formibus dissoluto instructus." One New Guinea species of the *Meringium* group, with much-crisped (overfull, plicate) lamina, has the whole of the wing of the frond broken up in this manner. It is thus destitute of any venulate green laminar area, a condition so remarkable that I have tried to give it adequate emphasis by constituting it a genus (*Myriodon*), although its relation to *Meringium* is perfectly clear. There is a better known and repeatedly illustrated derivative of *Sphaerocionium*, whose photosynthetic area consists of innumerable short filaments standing out in all directions from the axes; this also is worthily treated as a genus (*Apteropteris*).

While adaptation to a humid environment is the general principle in the evolution of this family, the fact is not to be overlooked that a large part of them are epiphytes, and that epiphytes in general are of necessity able to endure temporary dryness. Polypodiaceous epiphytes, as a generality, are structurally equipped to retain water during temporary outside dryness, but such structural equipment is comparatively rare in Hymenophyllaceæ. The colorless internal cells of *Cephalomanes reniforme*, *H. dilatatum*, and *H. scabrum* seem to serve for water storage. The hairy covering of many species of *Sphaerocionium* is a protection against loss of water. *H.* (*Apteropteris*) *Malingii* is the one plant in the family structurally apparently highly modified to live as an exposed epiphyte. As Giesenhagen emphasized, there are devices of form by which liquid water is conserved outside the leaf.

Most commonly, as I pointed out long ago, the epiphytes of this family are fitted to their environment by enduring the loss of water, as do the mosses, and still more perfectly the lichens. In my experience most species change their form during desiccation, but Holloway [16] reports that *H. rarum* and *H. flabellatum*, and even the prothalli of the former, remain unchanged while

[15] Hymenophyllaceæ (1843) 121.
[16] Trans. N. Z. Inst. 54 (1923) 591.

the moss they grow in curls up with dryness. Shreve[17] has reported concentration of the cell sap amounting to nearly or quite half-normal salt.

The bad state of the nomenclature of these plants has been remarked upon repeatedly, sometimes by those who contributed to the evil. Thus Prantl[18] could note "die in einem heillosen Zustande befindliche Synonymik," but deliberately reject *Feea* and *Cephalomanes* in favor of later names. Giesenhagen described the taxonomy of a part of the family as "eine ausserordentliche Verwirrung," and "ein wirres Durcheinander."

I have tried to bring order into the generic nomenclature by a scrupulous observance of the accepted rules, the essential principle of which is that any group now treated as a genus must bear the oldest tenable generic name of any species now included in it. Such a species is the type species of the genus, and the generic name cannot be dissociated from it. This rule is exceptionally easy to apply in this family because the older and larger genera were mostly described originally, each with a single species, leaving no chance for difference of opinion as to the type.

The generic names proposed for these plants are shown in chronological order, by the following enumeration. For convenience I include, but indent, the names imperfectly proposed for genera, or proposed for groups of infrageneric rank. The type species is given in each case. The genera retained are in boldface type.

Trichomanes Linnæus (1737). *T. crispum.*

> *Pyxidaria* Gleditsch (1764). (This name has no status at all.)

Achomanes Necker (1790) = *Trichomanes.*

Hymenophyllum Smith (1793). *H. tunbridgense.*

Ptychomanes Hedwig (1800) =*Hymenophyllum.*

Feea Bory (1824). *F. nana* Bory = *F. botryoides* (Kaulf.) v. d. B.

Hymenostachys Bory (1824). *H. elegans* (Rudge) = *Trichomanes diversifrons* (= *Feea*).

Didymoglossum Desvaux (1827). *D. muscoides* Desv. (= *Trichomanes hymenoides*).

Lecanium Presl (1843). *L. membranaceum* (L.) Presl.

Cardiomanes Presl (1843). *C. reniforme* (Forster) Presl.

> *Achomanes* Presl (1843) = *Trichomanes.*
>
> *Eutrichomanes* Presl (1843). Included spp. of *Didymoglossum, Sphaerocionium, Gonocormus, Crepidomanes,* and many others, but not *Trichomanes crispum.*

[17] Bot. Gaz. 51 (1911) 204.
[18] Hymenophyllaceæ (1875) 53.

Pachychaetum Presl (1843). *Trichomanes luschnatianum* Presl = *T. rupestre.*

Ragatelus Presl (1843). *R. crinitus* (Sw.) = *Trichomanes.*

Cephalomanes Presl (1843). *C. atrovirens.*

Neurophyllum Presl (1843), *non* T. & G. (1840). *N. Vittaria* (D. C.) = *Trichomanes.*

Microgonium Presl (1843). *M. cuspidatum* (Willd.).

Abrodictyum Presl (1843). *A. Cumingii* ("*Habrodictyon* Presl" v. d. B.).

Chilodium Presl (1843). *D. Neesii* (Blume) = *Meringium.*

Crepidium Presl (1843), *non* Blume 1825. *D. humile* (Forster) = *Crepidopteris.*

Meringium Presl (1843). *M. Meyenianum.*

Hemiphlebium Presl (1843). *H. pusillum* (Sw.) = *Didymoglossum.*

Leptocionium Presl (1843). *L. dicranotrichum.*

Myrmecostylum Presl (1843). *M. tortuosum* = *Meringium.*

Ptychophyllum Presl (1843). *P. plicatum* = *Meringium.*

Sphaerodium Presl (1843). *Hymenophyllum Wilsoni* Hooker.

Euhymenophyllum Presl (1843), incl. *Hymenophyllum tunbridgense.*

Cyclogossum Presl (1843). *Hymenophyllum caespitosum* Gaud. = **Serpyllopsis.**

Craspedophyllum Presl (1843). *Hymenophyllum marginatum.*

Sphaerocionium Presl (1843). *S. hirsutum* (Sw.).

Hymenoglossum Presl (1843). *H. cruentum* (Cav.).

Homoeotes Presl (1848). *H. heterophylla* (H. B. W.) = *Feea.*

Macrogloena Presl (1848). *Trichomanes meifolium.*

Pseudochomanes Presl (1849–1851). *Trichomanes sinuosum* Rich. = *Trichomanes.*

Odontomanes Presl (1849–1851). *O. Hostmannianum* (Kl.) = *Trichomanes.*

Crepidomanes Presl (1851). *C. intramarginale* (H. & G.).

Pleuromanes Presl (1851). *P. acutum.*

Taschneria Presl (1851). *T. Filicula* (Bory) = *Crepidomanes.*

Leucomanes Presl (1851). *L. album* (Blume) = *Pleuromanes.*

Amphipterum Presl (1851). *A. fuscum* (Blume).

Mecodium Presl (1851). *M. sanguinolentum* (Forster).

Dermatophlebium Presl (1851). *D. tomentosum* (Kze.) = *Sphaerocionium.*

Neuromanes Trevisan (1851). *N. affine* = *Trichomanes hostmannianum.*

Tetralasma Philippi (1860). *Hymenophyllum quadrifidum.*

Craspedoneuron van den Bosch (1859–1861). *C. album* (Blume) = *Pleuromanes.*

Phlebodium van den Bosch (1859), *non* J. Sm. (1841). *Trichomanes venosum.*

Serpyllopsis van den Bosch (1859–1861). *S. antarctica* = *S. caespitosa* (Gaud.) C. Chr.

Diploophyllum van den Bosch (1859–1861), *non Diplophyllum* Lehm. (1814). *Hymenophyllum dilatatum* = *Mecodium.*

Gonocormus van den Bosch (1861). *G. minutus* (Blume).

Adiantopsis van den Bosch (1861), *non* Fee (1850)
Davallopsis van den Bosch (1861).
} *Trichomanes Prieurii* = *T. elegans.*

Lacostea van den Bosch (1861); Prantl (1875). *Trichomanes Ankersii* = *Trichomanes.*

Maschalosorus van den Bosch (1861). ***M. Mougeotii*** **v. d. B.** = ***Feea osmundoides.***

Phlebiophyllum van den Bosch (1861), *non Phlebophyllum* Nees (1832). *Trichomanes venosum* = *Polyphlebium.*

Ptilophyllum van den Bosch (1861); Prantl (1875) *non aliorum prior.* = *Trichomanes.*

Pachyloma van den Bosch (1861), *non* D. C. (1828). *Hymenophyllum marginatum* = *Craspedophyllum.*

Trigonophyllum Prantl (1875). *Ptilophyllum Bancroftii* = *Trichomanes arbuscula.*

Acarpacrium Prantl (1875). *Ptilophyllum ptilodes* = *Trichomanes alatum.*

Leptomanes Prantl (1875). *Trichomanes tenerum* Spr. = *Vandenboschia.*

Lacosteopsis Prantl (1875). *Trichomanes "radicans* Sw." = *T. rupestre* (?).

Selenodesmium Prantl (1875). *Trichomanes rigidum.*

Holophlebium Christ (1897).

Hemicyatheon Domin (1913). *Hymenophyllum Baileyanum.*

Acanthotheca Nakai (1926), *non* D. C. (1837). *Hymenophyllum acanthoides* = *Meringium.*

Buesia Morton (1932). *Hymenophyllum mirificum.*

Myriodon Copeland (1936). *Hymenophyllum odontophyllum.*

Apteropteris Copeland (1936). *Hymenophyllum malingii.*

Artificial key to the genera of the Hymenophyllaceæ.

Real lamina wanting, and replaced.
- By filaments cells .... 5. *Apteropteris.*
- By veinless teeth .... 10. *Myriodon.*

Typical lamina present.
- Involucre valvate.
  - Margin entire and naked.
    - Frond large, simple .... 14. *Hymenoglossum.*
    - Frond minute, simple.................................... 2. *Craspedophyllum.*
    - Frond pinnately divided.
      - Accessory wings present .... 9. *Amphipterum.* p 46
      - Accessory wings absent.
        - Walls thick, coarsely pitted.............. 8. *Meringium* spp. p 39
        - Walls not coarsely pitted.
          - Fronds pinnate, axes red-pilose....13. *Serpyllopsis.* p 49
          - Fronds more compound or without red hairs.
            - Base of involucre cyathiform, receptacle exserted...... 3. *Hemicyatheon* (*Baileyanum*).
            - Base of involucre not cyathiform or receptacle included .... 1. *Mecodium.*
  - Margin hairy.
    - Receptacle included .... 4. *Sphaerocionium.*
    - Receptacle long-extruded .... 12. *Leptocionium.*

Margin toothed.
Receptacle long-extruded.
Accessory wings present .... 9. *Amphipterum.*
Accessory wings wanting.
Base of involucre obconic .... 8. *Meringium.*
Base of involucre cyathiform.
3. *Hemicyatheon* (*Deplanchei*).
Receptacle not long-exserted.
Receptacle cylindric or clavate. (Cf. also *Mecodium Reinwardtii* and others.) .... 7. *Hymenophyllum.*
Receptacle subglobose .... 11. *Buesia.*
Involucre tubular or obconic, not valvate.
Rhizome filiform, fronds remote.
False veinlets present.
Fronds pinnately divided or compound.
False veinlets in the position of veins.
28. *Didymoglossum.*
False veinlets unrelated to veins.... 21. *Crepidomanes.*
Fronds simple or lobed.
With marginal vein .... 22. *Microgonium.*
Without marginal vein.
Without marginal scales...... 28. *Didymoglossum.*
With marginal scales .... 29. *Lecanium.*
False veinlets absent.
Fronds marginate.
With hairy axial pads .... 18. *Pleuromanes.*
Naked, without axial pads .... 20. *Crepidopteris.*
Fronds not marginate.
Axes of fronds proliferous .... 19. *Gonocormus.*
Axes not proliferous.
Veins branched within segments.
17. *Polyphlebium.*
Segments one-nerved.
Fronds dichotomous or simple.
6. *Microtrichomanes.*
Fronds pinnate in plan.
Axes coarsely red-pilose.
13. *Serpyllopsis.*
Axes not red-pilose.
16. *Vandenboschia.*
Rhizome stout or fronds clustered.
Cells transversely elongate .... 33. *Abrodictyum.*
Cells not transversely elongate.
Fronds simple .... 15. *Cardiomanes.*
Fronds once pinnate.
Oriental .... 25. *Cephalomanes.*
American.
Fronds not dimorphous .... 26. *Trichomanes.*
Fronds dimorphous.
Sterile fronds pinnate...... 26. *Trichomanes.*
Sterile fronds pinnatifid .... 27. *Feea.*

Fronds more divided.
Segments stiff and very narrow........ 32. *Macroglena.*
Segments broader or soft.
Rhizome creeping, fronds remote.
Fronds soft in texture. (Cf. also *Trichomanes rupestre* and others.)
16. *Vandenboschia.*
Fronds harsh .... 30. *Selenodesmium.*
Fronds clustered.
Fronds 1 cell thick.
Walls thick, coarsely pitted.
30. *Selenodesmium.*
Walls not coarsely pitted.
American .... 26. *Trichomanes.*
Palæotropic.
Stipes bristly.
23. *Callistopteris.*
Stipes not bristly.
24. *Nesopteris.*
Fronds thicker .... 31. *Davalliopsis.*

1. Genus MECODIUM Presl

Mecodium PRESL, Epim. Bot. (1852 ?) 258, *Nomen.*

Diploophyllum VAN DEN BOSCH, Eerste Bijdrage (1861) 322, *non Diplophyllum* Lehm. (1814).

Hymenophyllum, § *Euhymenophyllum auct. plur., nec rite.*

Hymenophyllum, § *Sphaerocionium part.* C. CHR., Suppl. Tert. (1934).

Analoga Pleuromanis in Hymenophyllaceis existunt plura, nempe . . . inter Hymenophylloidas Mecodium sanguinolentum (Hymenophyllum sanguinolentum Swartz).—PRESL, loc. cit.

Epiphyticae, rhizomate gracile, frondibus remotis, mediocribus vel majoribus, pinnatim decompositis, marginibus integris nudis, parietibus cellularum typice tenuibus, soris pantotactis, involucris aut ad basim aut usque ad laminam frondis bivalvibus, receptaculo incluso.

Type, *M. sanguinolentum* Presl (*Trichomanes sanguinolentum* Forster).

A pantropic and austral genus of about 100 recognized species, the largest genus of the family.

This genus as a whole has remained without a name, first because both Presl and van den Bosch failed to grasp it, leaving it partly or largely in *Hymenophyllum,* and later (beginning with van den Bosch) because it was wrongly construed as *Hymenophyllum* by those who recognized *H. tunbridgense* as foreign to it, and assigned that species to *Leptocionium.*

Presl certainly did not adequately describe his genus *Mecodium*. His description would be inaccurate, even if what he wrote were correct, which it is not. He misconstrued the axial pads of *Pleuromanes;* and there is nothing to justify the statement as to *M. sanguinolentum,* more than as to most species of the family, that it is "analogous" to *Pleuromanes,* as the latter is, still less as he thought it to be. I adopt his generic name because it exists, and its use is preferable to the invention of a new name. The only other generic name proposed for any of these ferns is *Diploophyllum,* invalidated under present rules by *Diplophyllum* Lehm. (1814).

Like *Meringium* and *Vandenboschia, Mecodium* includes aberrant species in the far South, vestiges, as I picture the case, of a flora antedating the present evolution of the family, with these genera satisfactorily uniform in the Tropics of both hemispheres. In the Tropics and in the Southern Temperate Zone, with the exceptions just noted, *Mecodium* is one of the most uniform and easily recognized of large genera. Within it are groups common to the two hemispheres—whether because of transoceanic migration or because of separate descent from common Antarctic ancestors, I do not guess. Certainly, however, *M. badium* and *M.*[19] *caudiculatum* are more nearly related to one another than either is to *M. polyanthos*. In both hemispheres, receptacles, elongate or globose or otherwise dilated, with or without sporangiophores, characterize groups of species; but these differences are so gradual, from species to species, that it would be impracticable (as well as, I believe, unnatural) to use them, as Presl attempted, as generic criteria. This seems to me true also of the branching of the bundle at the base of the sorus, to which van den Bosch attached supergeneric significance; it is conspicuous in *M. rarum* and some relatives, and in occasional other plants, including forms of *M. polyanthos* which I do not distinguish specifically.

Laminæ more than one cell in thickness are a far more remarkable peculiarity. I use them to characterize *Davalliopsis* and *Cardiomanes,* but do not recognize a genus *Diploophyllum,* partly for the reason advanced by Mettenius, that besides fronds wholly thick (when mature and on adult plants) there are

[19] These combinations are made in the list of species, immediately following; their use here in anticipation does not constitute publication, and is less awkward than citation under older names.

others in *Mecodium* which are partially so (*M. demissum, M. australe*), so that the distinction is not a sharp one; but more than this, it is because the several species with thick leaves seem independently related to species of the typical family structure, which makes it impossible to combine as a genus the two known species with fronds usually thick throughout.

Included in *Mecodium* are three species, *M. Reinwardtii, M. thuidium,* and *M. samoense,* with toothed margin. This margin is denticulate rather than serrulate, and the teeth do not appeal to the eye as the same as those of *Meringium*. *M. thuidium* has little fronds crisped in a degree reminiscent of *Meringium acanthoides*. I have invoked intergeneric hybridization to explain some such resemblances, but in this case do not believe that any affinity exists. It may be recalled that a series of *Meringium* species has entire margins.

SPECIES OF MECODIUM

MECODIUM POLYANTHOS (Swartz) Copeland comb. nov.

Trichomanes polyanthos SWARTZ, Prod. Fl. Ind. Occ. (1788) 137.
Hymenophyllum polyanthos Swartz, COPELAND, Hymen. (1937) 97, pls. 46, 47.

Pantropic, with very many synonyms.

MECODIUM KUHNII (C. Christensen) Copeland comb. nov.

Hymenophyllum Kuhnii C. CHRISTENSEN, Index (1905) 363; COPELAND, Hymen. (1937) 106, pl. 48.
Hymenophyllum Meyeri KUHN, *non* Presl.

Tropical Africa.

MECODIUM PANICULIFLORUM (Presl) Copeland comb. nov.

Hymenophyllum paniculiflorum PRESL, Hymen. (1843) 147; COPELAND, Hymen. (1937) 110, pl. 51.

PHILIPPINES; BORNEO; JAVA.

MECODIUM NITIDULOIDES Copeland.

Hymenophyllum nitiduloides COPELAND, Hymen. (1937) 112, pl. 52.

LUZON.

MECODIUM OOIDES (F. v. M. and Baker) Copeland comb. nov.

Hymenophyllum ooides F. v. M. and BAKER, Journ. Bot. 28 (1890) 105; COPELAND, Hymen. (1937) 107.

PAPUA.

MECODIUM SANGUINOLENTUM (Forster) Presl.

NEW ZEALAND.

MECODIUM RECURVUM (Gaud.) Copeland comb. nov.

Hymenophyllum recurvum GAUDICHAUD, Freyc. Voy. Bot. (1827) 376; COPELAND, Hymen. (1937) 108, pl. 49.

HAWAII.

MECODIUM PRODUCTUM (Kunze) Copeland comb. nov.

Hymenophyllum productum KUNZE, Bot. Zeit. 6 (1848) 305; COPELAND, Hymen. (1937) 113, pl. 54.

JAVA; SUMATRA; BORNEO; PHILIPPINES.

MECODIUM TODJAMBUENSE Kjellberg.

CELEBES. Differs from *M. productum* in having a wingless stipe.

MECODIUM ANGULOSUM (Christ) Copeland comb. nov.

Hymenophyllum angulosum CHRIST, Philip. Journ. Sci. § C 5 (1908) 269; COPELAND, Hymen. (1937) 109, pl. 50.

PHILIPPINES.

MECODIUM REINWARDTII (van den Bosch) Copeland comb. nov.

Hymenophyllum Reinwardtii VAN DEN BOSCH, Pl. Jungh. I (1856) 567; Hymen. Javan. 52, pl. 42; COPELAND, Hymen. (1937) 115, pl. 55.

MALAY ISLANDS.

MECODIUM THUIDIUM (Harr.) Copeland comb. nov.

Hymenophyllum thuidium HARRINGTON, Journ. Linn. Soc. Bot. 16 (1877) 25; COPELAND, Hymen. (1937) 116, pl. 56.

PHILIPPINES; NEW GUINEA.

MECODIUM SAMOENSE (Baker) Copeland comb. nov.

Hymenophyllum samoense BAKER, Journ. Bot. 1876) 10; COPELAND, Hymen. (1937) 117, pl. 57.

SAMOA; FIJI; QUEENSLAND.

MECODIUM EMARGINATUM (Swartz) Copeland comb. nov.

Hymenophyllum emarginatum SWARTZ, Schrad. Journ. (1801) 101; Synopsis 148, 377; COPELAND, Hymen. (1937) 118, pl. 58.

MALAY ISLANDS; NEW CALEDONIA.

MECODIUM JAVANICUM (Spr.) Copeland comb. nov.

Hymenophyllum javanicum SPR., Syst. Veg. IV (1827) 132; COPELAND, Hymen. (1937) 120, pl. 59.

Ceylon to New Caledonia and Eastern Australia.

MECODIUM PRODUCTOIDES (J. W. Moore) Copeland comb. nov.

Hymenophyllum productoides J. W. MOORE, Bishop Mus. Bull. 102 (1933) 5.

SOCIETY ISLANDS.

MECODIUM FIMBRIATUM (J. Sm.) Copeland comb. nov.

Hymenophyllum fimbriatum J. SM., Hooker's Journ. Bot. 3 (1841) 418, Species Fil. I (1844) 102, pl. 360; COPELAND, Hymen. (1937) 122, pl. 60.

PHILIPPINES.

MECODIUM RIUKIUENSE (Christ) Copeland comb. nov.

Hymenophyllum riukiuense CHRIST, Ann. Cons. Jard. Bot. Geneve 4 (1900) 208; COPELAND, Hymen. (1937) 123, pl. 61.

LOOCHOO ISLANDS.

MECODIUM CORRUGATUM (Christ) Copeland comb. nov.

Hymenophyllum corrugatum CHRIST, Bull. Boiss. II 3 (1903) 508; COPELAND, Hymen. (1937) 124.

Western China.

MECODIUM FLABELLATUM (La Bill.) Copeland comb. nov.

Hymenophyllum flabellatum LA BILL., Nov. Holl. Pl. 2 (1806) 101, pl. 250, fig. 1; COPELAND, Hymen. (1937) 125, pl. 62.

New Zealand to Queensland and Tahiti.

MECODIUM RUFESCENS (Kirk) Copeland comb. nov.

Hymenophyllum rufescens KIRK, Trans. N. Z. Inst. 11 (1879) 457, pl. 19*A*; COPELAND, Hymen. (1937) 126.

NEW ZEALAND.

MECODIUM LE RATII (Ros.) Copeland comb. nov.

Hymenophyllum Le Ratii ROSENSTOCK, Fedde's Repert. 9 (1910) 71; COPELAND, Hymen. (1937) 127, pl. 63.

NEW CALEDONIA.

MECODIUM RARUM (R. Br.) Copeland comb. nov.

Hymenophyllum rarum R. BROWN, Fl. N. Holl. (1810) 159; COPELAND, Hymen. (1937) 128, pl. 64.

NEW ZEALAND; AUSTRALIA.

MECODIUM INVOLUCRATUM Copeland.

Hymenophyllum involucratum COPELAND, Univ. Calif. Publ. Bot. 12 (1931) 375; Hymen. (1937) 129, pl. 65.

RAROTONGA.

MECODIUM WALLERI (M. and B.) Copeland comb. nov.

Hymenophyllum Walleri MAIDEN and BETCHE, Proc. Linn. Soc. N. S. Wales 35 (1910) 802; COPELAND, Hymen. (1937) 130, pl. 66.

QUEENSLAND.

MECODIUM MNIOIDES (Baker) Copeland comb. nov.

Hymenophyllum mnioides BAKER, Syn. Fil. (1873) 57; COPELAND, Hymen. (1937) 131, pl. 67.

NEW CALEDONIA.

MECODIUM MONTANUM (Kirk) Copeland comb. nov.

Hymenophyllum montanum KIRK, Trans. N. Z. Inst. 10 (1877) 394, pl. 21*B*; COPELAND, Hymen. (1937) 121, pl. 68.

NEW ZEALAND.

MECODIUM INTRICATUM (van den Bosch) Copeland comb. nov.

Hymenophyllum intricatum VAN DEN BOSCH, Ned. Kr. Arch. 53 (1863) 168; COPELAND, Hymen. (1937) 132.

TASMANIA.

MECODIUM FUMARIOIDES (Willdenow) Copeland comb. nov.

Hymenophyllum fumarioides WILLDENOW, Sp. Plant. 5 (1810) 526; COPELAND, Hymen. (1937) 132.

South Africa and East African Islands.

MECODIUM HUMBERTII (C. Christ) Copeland comb. nov.

Hymenophyllum Humbertii C. CHRIST, Arch. Bot. 2 (1928) 209; Dansk Bot. Arkiv. 7 (1932) 10, pl. 2, figs. 6–8; COPELAND, Hymen. (1937) 136.

MADAGASCAR.

MECODIUM VERONICOIDES (C. Chr.) Copeland comb. nov.

Hymenophyllum veronicoides C. CHR., in Bonaparte, Notes Pterid. 12 (1920) 20; Pterid. Madag. 9, pl. 2, figs. 9–12; COPELAND, Hymen. (1937) 135.

MADAGASCAR.

The preceding nine species constitute a well-defined group.

MECODIUM IMBRICATUM (Blume) Copeland comb. nov.

Hymenophyllum imbricatum BLUME, Enum. (1828) 220; COPELAND, Hymen. (1937) 137, pls. 70, 71.

MALAYA; POLYNESIA.

MECODIUM TREUBII (Raciborski) Copeland comb. nov.

Hymenophyllum Treubii RACIBORSKI, Pterid. Buit. (1898) 15; COPELAND, Hymen. (1937) 140, pl. 72.

JAVA; NEW GUINEA; PERAK?

MECODIUM JUNGHUHNII (van den Bosch) Copeland comb. nov.

Hymenophyllum Junghuhnii VAN DEN BOSCH, Pl. Jungh. I (1856) 570, Hymen. Javan. 60, pl. 49; COPELAND, Hymen. (1937) 143, pl. 73.

JAVA; SUMATRA; BORNEO.

MECODIUM LONGIFOLIUM (v. A. v. Rosenburgh) Copeland comb. nov.

Hymenophyllum longifolium VAN A. V. ROSENBURGH, Bull. Jard. Bot. Buit. (16) II (1914) 17; COPELAND, Hymen. (1937) 142, pl. 74.

CELEBES; PAPUA; JAVA?

MECODIUM SALAKENSE (Raciborski) Copeland comb. nov.

Hymenophyllum salakense RACIBORSKI, Pterid. Buit. (1898) 18; COPELAND, Hymen. (1937) 143, pl. 75.

JAVA; SUMATRA; BORNEO?

MECODIUM BADIUM (H. and G.) Copeland comb. nov.

Hymenophyllum badium HOOKER and GREVILLE, Icones Fil. (1828) pl. 76; COPELAND, Hymen. (1937) 144, pl. 76.

India to Formosa and Celebes.

MECODIUM CRISPATUM (Wall.) Copeland comb. nov.

Hymenophyllum crispatum Wallich in HOOKER and GREVILLE, Icones Fil. (1828) pl. 77; COPELAND, Hymen. (1937) 148, pl. 77.

India to the Philippines.

MECODIUM CRISPATO-ALATUM (Hayata) Copeland comb. nov.

Hymenophyllum crispato-alatum HAYATA, Icones pl. Formosa 5 (1915) 256; COPELAND, Hymen. (1937) 149, pl. 79.

FORMOSA.

MECODIUM FLEXILE (Makino) Copeland comb. nov.

Hymenophyllum flexile MAKINO, Bot. Mag. Tokyo 13 (1899) 45; COPELAND, Hymen. (1937) 150, pl. 80.

JAPAN.

MECODIUM OPACUM Copeland.

Hymenophyllum opacum COPELAND, Hymen. (1937) 151, pl. 81.

NEW GUINEA.

The preceding ten species are a natural group, with American relatives.

MECODIUM WRIGHTII (van den Bosch) Copeland comb. nov.

Hymenophyllum Wrightii VAN DEN BOSCH, Synopsis (1859) 51 [20]; COPELAND, Hymen. (1937) 152, pl. 82.

JAPAN.

MECODIUM EXSERTUM (Wall.) Copeland comb. nov.

Hymenophyllum exsertum WALLICH in Hooker, Spec. Fil. I (1844) 109, pl. 38*A*; COPELAND, Hymen. (1937) 153, pl. 83.

INDIA; CHINA; SIAM.

[20] The page citation is that of the reprint; to get the pagination in Ned. Kr. Arch. 4, add 340.

MECODIUM FLEXUOSUM (A. Cunn.) Copeland comb. nov.

Hymenophyllum flexuosum A. Cunningham, HOOKER, Comp. Bot. Mag. 2 (1836) 369; COPELAND, Hymen. (1937) 154, pl. 84.

NEW ZEALAND.

MECODIUM PULCHERRIMUM (Colenso) Copeland comb. nov.

Hymenophyllum pulcherrimum COLENSO, Tasm. Journ. Nat. Sci. 2 (1844) 185; COPELAND, Hymen. (1937) 156.

NEW ZEALAND.

MECODIUM VILLOSUM (Colenso) Copeland comb. nov.

Hymenophyllum villosum COLENSO, Tasm. Journ. Nat. Sci. 2 (1844) 185; COPELAND, Hymen. (1937) 157.

NEW ZEALAND.

MECODIUM AUSTRALE (Wildenow) Copeland comb. nov.

Hymenophyllum australe WILDENOW, Spec. Pl. 5 (1810) 527; COPELAND, Hymen. (1937) 158, pl. 85.

TASMANIA; NEW ZEALAND; VICTORIA?

MECODIUM DEMISSUM (Forster) Copeland comb. nov.

Trichomanes demissum FORSTER, Prod. (1786) 85.
Hymenophyllum demissum Swartz, COPELAND, Hymen. (1937) 159, pl. 86.

NEW ZEALAND.

MECODIUM DILATATUM (Forster) Copeland comb. nov.

Trichomanes dilatatum FORSTER, Prod. (1786) 85.
Hymenophyllum dilatatum Swartz, COPELAND, Hymen. (1937) 160, pl. 87.

NEW ZEALAND.

MECODIUM SCABRUM (A. Rich.) Copeland comb. nov.

Hymenophyllum scabrum A. RICHARD, Fl. Nouv. Zel. (1832) 90; COPELAND, Hymen. (1937) 161, pl. 87.

NEW ZEALAND.

MECODIUM CUNEATUM (Kunze) Copeland comb. nov.

Hymenophyllum cuneatum KUNZE, Anal. (1837) 50.

CHILE; JUAN FERNANDEZ. *H. Darwini* (Hooker) v. d. Bosch must belong here.

MECODIUM TRIANAE (Hieron.) Copeland comb. nov.

Hymenophyllum Trianae HIERON., Bot. Jahrb. 34 (1904) 429.

From Bolivia to Colombia.

MECODIUM MULTIFLORUM (Ros.) Copeland comb. nov.

Hymenophyllum multiflorum ROSENSTOCK, Meded. Rijks Herb. Leyden No. 19 (1913) 3.

BOLIVIA.

MECODIUM FERAX (van den Bosch) Copeland comb. nov.

Hymenophyllum ferax VAN DEN BOSCH, Synopsis (1859) 52.

ECUADOR; VENEZUELA.

MECODIUM MICROCARPUM (Desv.) Copeland comb. nov.

Hymenophyllum microcarpum DESVAUX, Prod. (1827) 333.

Tropical America.

MECODIUM MACROTHECUM (Fée) Copeland comb. nov.

Hymenophyllum macrothecum FÉE, 11 Mém. (1866) 115, pl. 31, fig. 2.

WEST INDIES.

MECODIUM MYRIOCARPUM (Hooker) Copeland comb. nov.

Hymenophyllum myriocarpum HOOKER, Sp. Fil. I (1844) 106, pl. 37*D*.

From Bolivia to Mexico.

MECODIUM ANDINUM (van den Bosch) Copeland comb. nov.

Hymenophyllum andinum VAN DEN BOSCH, Synopsis (1859) 57.

ECUADOR.

MECODIUM NIGRICANS (Presl) Copeland comb. nov.

Sphaerocionium nigricans PRESL, Linnæa 18 (1844) 536.

Tropical America.

MECODIUM CONTEXTUM (Ros.) Copeland comb. nov.

Hymenophyllum contextum ROSENSTOCK, Fedde's Repert. 22 (1925) 3.

COSTA RICA.

MECODIUM CONSTRICTUM (Christ) Copeland comb. nov.

Hymenophyllum constrictum CHRIST, Bull. Boiss. II 4 (1904) 939.

COSTA RICA.

MECODIUM PROTRUSUM (Hooker) Copeland comb. nov.

Hymenophyllum protrusum HOOKER, Sp. Fil. I (1844) 104, pl. 37*B*.

CENTRAL AMERICA; BOLIVIA.

MECODIUM COSTARICANUM (van den Bosch) Copeland comb. nov.

Hymenophyllum costaricanum VAN DEN BOSCH, Ned. Kr. Arch. 53 (1866) 161.

From Costa Rica to Bolivia.

MECODIUM SILIQUOSUM (Christ) Copeland comb. nov.

Hymenophyllum siliquosum CHRIST, Bull. Boiss. II 4 (1904) 939.

COSTA RICA.

MECODIUM CONTORTUM (van den Bosch) Copeland comb. nov.

Hymenophyllum contortum VAN DEN BOSCH, Ned. Kr. Arch. 53 (1863) 170.

From Costa Rica to Bolivia.

MECODIUM RENIFORME (Hooker) Copeland comb. nov.

Hymenophyllum reniforme HOOKER, Sp. Fil. I (1844) 110, pl. 38*C*.

PERU; ECUADOR.

MECODIUM DENDRITIS (Ros.) Copeland comb. nov.

Hymenophyllum Dendritis ROSENSTOCK, Fedde's Repert. 6 (1909) 308.

BOLIVIA.

MECODIUM TABLAZIENSE (Christ) Copeland comb. nov.

Hymenophyllum tablaziense CHRIST, Bull. Soc. Bot. Geneve II 1 (1909) 216.

COSTA RICA.

MECODIUM ALFREDII (Ros.) Copeland comb. nov.

Hymenophyllum Alfredii ROSENSTOCK, Fedde's Repert. 22 (1925) 4.

COSTA RICA.

MECODIUM ABRUPTUM (Hooker) Copeland comb. nov.

Hymenophyllum abruptum HOOKER, Sp. Fil. I (1844) 88, pl. 31*B*.

Tropical America.

MECODIUM UNDULATUM (Swartz) Copeland comb. nov.

Trichomanes undulatum SWARTZ, Prod. Fl. Ind. Occ. (1788) 137.

Tropical America.

MECODIUM FENDLERIANUM (Sturm) Copeland comb. nov.

Hymenophyllum fendlerianum STURM, Fl. Bras. I[2] (1859) 291.

Tropical America.

MECODIUM AXILLARE (Swartz) Copeland comb. nov.

Hymenophyllum axillare SWARTZ, Schrad. Journ. (1801) 101.

WEST INDIES; VENEZUELA.

MECODIUM ASPLENIOIDES (Swartz) Copeland comb. nov.

Trichomanes asplenioides SWARTZ, Prod. Fil. Ind. Occ. (1788) 136.

Tropical America.

MECODIUM CAUDICULATUM (Mart.) Copeland comb. nov.

Hymenophyllum caudiculatum MARTIUS, Ic. Cr. Bras. (1834) 102, pl. 67.

Patagonia to Brazil and Peru.

2. Genus CRASPEDOPHYLLUM (Presl) Copeland gen. nov.

Hymenophyllum, § *Craspedophyllum* PRESL, Hymen. (1843) 125.[21]
Pachyloma VAN DEN BOSCH, Eerste Bijdrage (1861) 318, *non* De Candolle.

Frons simplex bilobaque, glabra indusioque marginata. Laciniae integrae. Sorus terminalis sessilis. Indusium bipartitum, integrum. Species novohollandica, mihi solummodo ex icone nota, verosimiliter genus proprium efficiens.—PRESL, loc. cit.

Type, *C. marginatum* (Hooker & Greville) Copeland comb. nov.

CRASPEDOPHYLLUM MARGINATUM (Hooker & Greville) Copeland comb. nov.

Hymenophyllum marginatum HOOKER and GREVILLE, Ic. Fil. (1828) pl. 34; COPELAND, Hymen. (1937) 163, pl. 89.

A monotypic genus, probably related to *Mecodium*, known from New South Wales and Tasmania; well characterized by the black contents of the obliquely placed marginal cells; internal walls wavy-thickened; involucre valvate to the base; receptacle cylindric, included.

3. Genus HEMICYATHEON (Domin) Copeland gen. nov.

Hymenophyllum subgenus *Hemicyatheon* DOMIN, Bibl. Bot. 20 Heft 85 (1913) 20.

Pinnulis (segmentis) ultimis integris vel spinuloso-denticulatis; indusiis infundibuliformibus parte inferiore connatis sed supra profunde (usque ad medium vel duos partes tertias bilabiatis et campanulato patentibus; receptaculo longe exserto.—DOMIN, loc. cit.

Genus et Mecodio et Meringio subsimile, frondibus remotis majusculis tripinnatifidis, parietibus cellularum incrassatis, soris magnis pantotactis, involucris deorsum urceolatis sursum bivalvibus, receptaculo extruso.

Typus, H. Baileyanum Domin, loc. cit., sub Hymenophyllo.

A genus that I recognize as such because it consists of two species, certainly nearly related, of which one would be aber-

[21] As to this work, I cite the original pagination in Abh. Böhm. Ges. Wiss. V 3 (1843); to get the page numbers of the reprint, cited in Christensen's Index, subtract 92.

rant in *Mecodium* but wholly out of place in *Meringium*, the other aberrant in *Meringium* and wholly misplaced in *Mecodium*. They are alike in general aspect, which would not bar them from either large genus. The walls are less, and less regularly, thickened than in typical *Meringium*, so that the walls, and thus the texture, are intermediate, and would be unusual in either *Meringium* or *Mecodium*. The involucre is also intermediate, cleft as in *Meringium* but with less cuneate base; while unusual there, it can be matched in *Mecodium*. The receptacle is meringioid, but slender. I do not consider *Mecodium* and *Meringium* nearly related, but, far enough back, they did have a common ancestry. *Hemicyatheon* may date back that far; or may share the characteristics of the two because of more recent hybridization; or the combination of apparent affinities may be fortuitous.

Range: New Caledonia and Queensland.

SPECIES OF HEMICYATHEON

HEMICYATHEON BAILEYANUM (Domin) Copeland comb. nov.

Hymenophyllum Baileyanum DOMIN, Bibl. Bot. 20 Heft 85 (1913) 20; COPELAND, Hymen. (1937) 75, pl. 36.

QUEENSLAND.

HEMICYATHEON DEPLANCHEI (Mett.) Copeland comb. nov.

Hymenophyllum Deplanchei METTENIUS, Linnæa 35 (1868) 393; COPELAND, Hymen. (1937) 76, pl. 36.

NEW CALEDONIA.

4. Genus SPHAEROCIONIUM Presl

Sphaerocionium PRESL, Hymen. (1843) 125.
Dermatophlebium PRESL, Epim. Bot. (1849) 258.

Costa teres, prominula. Venae pinnatae, alternae, distantes, simplices ramosaeque, steriles venulisque conformibus apice libero desinentes. Sorus in lacinia frondis terminalis, compresso-planus, sessilis. Indusium bifidum, laciniis ovato-orbiculatis obtusis adpressis, demum patentibus. Receptaculum indusio brevius, inferne cylindricum nudum, apice globoso-incrassatum et capsuliferum. Capsulae lenticulares, oblique stipitatae.—PRESL, loc. cit.

Epiphytica, rhizomate repente, radicibus praedito; frondibus remotis, majusculis, pinnatim dissectis, margine costisque (rarius superficie) setis simplicibus vel saepius stellatis obsitis; chromatophoris minutis multis; soris pantotactis, involucro plerumque profunde fisso, receptaculo incluso.

Tropical America, Florida to Chile, with a few scattered Old World species.

A large genus, distinguished from *Mecodium* by its pubescence, and from *Leptocionium* by the included receptacle. There is closer apparent affinity to *Microtrichomanes;* if this be real, the latter may be regarded as a daughter genus.

Presl based his genus essentially on a single character, a receptacle with a comparatively slender sterile base, and a globose sporangium-bearing head. On this basis he included naked species immediately related to several minor groups in *Mecodium.* The fact that it was thus evidently unnatural is probably responsible for the failure of his successors to recognize it at all. Characterized with emphasis on the pubescence, it is a natural genus, typified by *S. hirsutum,* which must be regarded as the type of Presl's genus. Correcting the long abuse of the term *Euhymenophyllum* and applying it properly to a group with toothed margin, Christensen, in the Third Supplement to the Index, has taken up *Sphaerocionium* as the subgeneric name for all species of *Hymenophyllum* with entire margin. As I construe it, it is the group segregated by Prantl [22] as "Sect. 4. Pilosa." In the Synopsis of van den Bosch this is the group of *Hymenophyllum* with "Frons vestita," species 97–133.

The hairs in a majority of the species are restricted to the axes and margins. When they have long basal cells at the top of which they branch, they cover the surface with a dense felt, even though none originate there. Marginal hairs are regularly placed, as shown by Prantl. The cell from which one springs may or may not be differentiated evidently. Its differentiation may involve the adjacent cells, the hair then being borne on a projection of the margin, a tooth. In a few cases such teeth have been confused with those of *Meringium,* but they are not homologous. Even when the teeth of *Meringium* are prolonged into short hairs, these are rows of cells, and not bristlelike, as are all the simple hairs of *Sphaerocionium.* Stellate hairs usually branch from the end of a stalk cell, but in a few species the stalk cell is wanting and they branch from the base. Throughout the genus the ultimate branches and the simple setæ are alike in being nonseptate (above the base or basal cell), and sharp and stiff. There is no sharp line between branched hairs, hairs stellate from the base, paired setæ, and simple, solitary setæ. In a few species they are mixed. Sometimes the hairs on the rachis are mostly branched, those on the margin mostly simple,

[22] Hymen. 55.

and on some species (as *S. valvatum*) an occasional hair is forked or branched. A branched hair may have a single branch, having a septum, and usually being bent, at the distal end of the stalk cell.

It should be possible to break so large a genus into natural groups, but I do not know these plants intimately enough to do this with any confidence to the genus as a whole. It is not evident that the character of the receptacle can be used in this way, although I include here species with slender receptacles. The involucre, typically cleft nearly to the base, but sometimes with an evident immersed tube, seems likewise to lack significance. It is only as short lips and an elongate involucre are found together, and branched hairs disappear, in a group of apparently related species, reduced and dichotomous rather than pinnate in architecture, that these characters become evidently diagnostic for a group. And then, because the verbal definition of *Sphaerocionium* (in distinction to hairy plants of *Trichomanes*) would become very different otherwise, I feel constrained to recognize a smaller, related genus, *Microtrichomanes*. Generic status (as *Apteropteris*) is given also to one single species hitherto called *Trichomanes*, and *Hymenophyllum Malingii*, because it is isolated among all ferns by vegetative peculiarity; its hairs are those of *Sphaerocionium*.

SPECIES OF SPHAEROCIONIUM

With secondary lamellæ present on the axes (*Dermatophlebium*):

SPHAEROCIONIUM SERICEUM (Sw.) Presl.

Cuba to Bolivia and Brazil.

SPHAEROCIONIUM TOMENTOSUM (Kunze) Presl.

ANDES.

SPHAEROCIONIUM PLUMOSUM (Kaulf.) Copeland comb. nov.

Hymenophyllum plumosum KAULFUSS, Enum. (1824) 267.
Sphaerocionium aureum PRESL.

BRAZIL; COSTA RICA.

SPHAEROCIONUM PYRAMIDATUM (Desv.) Copeland comb. nov.

Hymenophyllum pyramidatum DESVAUX, Prod. (1827) 332.

ANDES.

H. fusugasugense Karsten, Colombia, belongs here. Without secondary lamellæ.

With branched hairs on axes, margin, and surface:

SPHAEROCIONIUM HIRSUTUM (Sw.) Presl.

The type of the genus; Cuba and Mexico to Chile.

SPHAEROCIONIUM RADDIANUM (K. Müller) Copeland comb. nov.

Hymenophyllum raddianum K. MÜLLER, Bot. Zeit. 12 (1854) 723.

BRAZIL.

SPHAEROCIONIUM INTERRUPTUM (Kze.) Presl.

Tropical America.

SPHAEROCIONIUM LANATUM (Fée) Copeland comb. nov.

Hymenophyllum lanatum FÉE, 11 Mém. (1866) 116, pl. 31, fig. 3.

WEST INDIES.

SPHAEROCIONIUM RUFUM (Fée) Copeland comb. nov.

Hymenophyllum rufum FÉE, Crypt. Vasc. Brazil 1 (1869) 198, pl. 70, fig. 4.

BRAZIL.

SPHAEROCIONIUM SPECTABILE (Mett.) Copeland comb. nov.

Hymenophyllum spectabile METTENIUS ex KUHN, Linnæa 35 (1868) 392.

BOLIVIA.

SPHAEROCIONIUM BUCHTIENII (Ros.) Copeland comb. nov.

Hymenophyllum Buchtienii ROSENSTOCK, Fedde's Repert. 5 (1908) 229.

BOLIVIA.

SPHAEROCIONIUM HEMIPTERON (Ros.) Copeland comb. nov.

Hymenophyllum hemipteron ROSENSTOCK, Fedde's Repert. 22 (1925) 4.

COSTA RICA.

SPHAEROCIONIUM PALMENSE (Ros.) Copeland comb. nov.

Hymenophyllum palmense ROSENSTOCK, Fedde's Repert. 22 (1925) 5.

COSTA RICA.

SPHAEROCIONIUM WERCKLEI (Christ) Copeland comb. nov.

Hymenophyllum Wercklei CHRIST, Bull. Boiss. II 4 (1904) 940.

COSTA RICA.

SPHAEROCIONIUM HYGROMETRICUM (Poiret) Copeland comb. nov.

Trichomanes hygrometricum POIRET, Enc. 8 (1808) 79.
Sphaerocionium elasticum (Bory) PRESL.

East African Islands.

SPHAEROCIONIUM SPLENDIDUM (v. d. B.) Copeland comb. nov.

Hymenophyllum splendidum VAN DEN BOSCH, Ned. Kr. Arch 5 * (1863) 192; COPELAND, Hymen. (1937) 174.

WEST AFRICA.

Here seem to belong also:

With branched hairs on axes and margin; surface naked:

HYMENOPHYLLUM AERUGINOSUM (Poiret) Carm.

TRISTAN D'ACUNHA.

HYMENOPHYLLUM LINDENI Hooker.

VENEZUELA; ECUADOR.

SPHAEROCIONIUM CILIATUM (Sw.) Presl.

Tropical America to East African Islands.

SPHAEROCIONIUM LINEARE (Sw.) Presl.

WEST INDIES.

SPHAEROCIONIUM CRUEGERI (K. Müller) Copeland comb. nov.

Hymenophyllum Cruegeri K. MÜLLER, Bot. Zeit. (1854) 722.

West Indies to Brazil.

SPHAEROCIONIUM ANTILLENSE (Jenman) Copeland comb. nov.

Hymenophyllum antillense JENMAN, Bull. Dept. Jam. No. 18 (1890) 6.

JAMAICA; HISPANIOLA.

SPHAEROCIONIUM ELEGANS (Spr.) Copeland comb. nov.

Hymenophyllum elegans SPR., Syst. Veg. IV (1827) 133.

BRAZIL; COSTA RICA.

SPHAEROCIONIUM HIRTELLUM (Sw.) Presl.

WEST INDIES; MEXICO; CENTRAL AMERICA.

SPHAEROCIONIUM DIVERSILOBUM Presl.

HISPANIOLA.

HYMENOPHYLLUM TRAPEZOIDALE Liebm.

MEXICO. This and the preceding species may be merely freaks.

SPHAEROCIONIUM ELEGANTULUM (v. d. B.) Copeland comb. nov.

Hymenophyllum elegantulum VAN DEN BOSCH, Synopsis 68.
Hymenophyllum pulchellum HOOKER, Sp. Fil. I, pl. 33*A*.

Colombia to Bolivia.

SPHAEROCIONIUM RUIZIANUM Kl.

VENEZUELA; PERU.

SPHAEROCIONIUM TRICHOPHYLLUM (H. B. K.) Copeland comb. nov.

Hymenophyllum trichophyllum H. B. K., Nov. Gen. et Sp. I (1815) 27.

BRAZIL; ANDES.

SPHAEROCIONIUM SAMPAIOANUM (Brade et Ros.) Copeland comb. nov.

Hymenophyllum Sampaioanum BRADE et ROSENSTOCK, Bol. Mus. Rio de Janeiro 1 (1931) 136, pl. 1, fig. 2; pl. 3; *Hymenophyllum Sampaii* in herb.

BRAZIL.

Here seem to belong:

HYMENOPHYLLUM ADIANTOIDES van den Bosch.

PERU.

HYMENOPHYLLUM CRISPATULUM van den Bosch.

PERU.

HYMENOPHYLLUM SPRUCEI Baker.

PERU.

SPHAEROCIONIUM FERRUGINEUM (Colla) Copeland comb. nov.

Hymenophyllum ferrugineum COLLA, Mem. Ac. Torino 39 (1836) 30.
Hymenophyllum subtilissimum Kze.

Chile to New Zealand.

SPHAEROCIONIUM LANCEOLATUM (Hooker and Arnott) Copeland comb. nov.

Hymenophyllum lanceolatum HOOKER and ARNOTT, Bot. Beechey's Voy. (1832) 109.

HAWAII.

SPHAEROCIONIUM OBTUSUM (Hooker and Arnott) Copeland comb. nov.

Hymenophyllum obtusum HOOKER and ARNOTT, Bot. Beechey's Voy. (1832) 109.

HAWAII.

SPHAEROCIONIUM LYALLII (Hooker) Copeland comb. nov.

Hymenophyllum Lyallii HOOKER f., Fl. N. Zealand II (1854) 16.
Trichomanes Lyallii HOOKER, Syn. Fil. (1867) 77; COPELAND, Trich. (1933) 163, pl. 7, fig. 7; pl. 11, fig. 4.

NEW ZEALAND; NEW SOUTH WALES.

SPHAEROCIONIUM PILOSISSIMUM (C. Chr.) Copeland comb. nov.

Hymenophyllum pilosissimum C. CHR., Gardens' Bull. S. S. 7 (1934) 213.

BORNEO; PHILIPPINES; NEW GUINEA.

SPHAEROCIONIUM MARLOTHII (Brause) Copeland comb. nov.

Hymenophyllum Marlothii BRAUSE, Fedde's Repert. 11 (1912) 122.

SOUTH AFRICA.

SPHAEROCIONIUM CAPILLARE (Desv.) Copeland comb. nov.

Hymenophyllum capillare DESVAUX, Prod. (1827) 333.
Sphaerocionium pendulum (Bory) Presl.

Africa and Islands.

SPHAEROCIONIUM POOLII (Baker) Copeland comb. nov.

Hymenophyllum Poolii BAKER, Journ. Linn. Soc. **15** (1876) 413; Icones Pl. 1609.

MADAGASCAR.

With unbranched setæ:

SPHAEROCIONIUM VALVATUM (H. and G.) Copeland comb. nov.

Hymenophyllum valvatum HOOKER and GREVILLE, Icones Fil. (1831) pl. 219.

West Indies to Bolivia.

SPHAEROCIONUM ELEGANTISSIMUM (Fée) Copeland comb. nov.

Hymenophyllum elegantissimum FÉE, 11 Mém. (1866) 118, pl. 29, fig. 2.

WEST INDIES.

SPHAEROCIONIUM MICROCARPUM (Desv.) Copeland comb. nov.

Hymenophyllum microcarpum DESVAUX, Prod. (1827) 33.

Tropical America.

SPHAEROCIONIUM DURANDII (Christ) Copeland comb. nov.

Hymenophyllum Durandii CHRIST, Bull. Boiss. **4** (1896) 657.

COSTA RICA.

SPHAEROCIONIUM SUBRIGIDUM (Christ) Copeland comb. nov.

Hymenophyllum subrigidum CHRIST, Bull. Boiss. II **5** (1905) 260.

COSTA RICA.

SPHAEROCIONIUM SEMIGLABRUM (Res.) Copeland comb. nov.

Hymenophyllum semiglabrum ROSENSTOCK, Fedde's Repert. **9** (1910) 67.

COSTA RICA.

Here seems to belong:

HYMENOPHYLLUM FRANCAVILLEI van den Bosch.

WEST INDIES.

SPHAEROCIONIUM SUBOBTUSUM (Ros.) Copeland comb. nov.

Hymenophyllum subobtusum ROSENSTOCK, Fedde's Repert. **9** (1910–1911) 71; COPELAND, Hymen. (1937) 173.

NEW CALEDONIA.

5. Genus APTEROPTERIS Copeland gen. nov.

Hymenophyllum subgen. *Apteropteris* COPELAND, Hymen. (1937) 176.

Lamina vera omnino carente, filamentis brevibus celluarum axibus frondis ubique excurrentibus pilis stellatis dense obtectis substituta, segmentis frondis deinde crasse filiformibus haud applanatis.—COPELAND, loc. cit.

Species unica: *Apteropteris Malingii* (Hooker) Copeland.

APTEROPTERIS MALINGII (Hooker) Copeland comb. nov.

Trichomanes Malingii HOOKER, Garden Ferns (1862) pl. 64.

Hymenophyllum Malingii METTENIUS, Hymen. 423, pl. 1, fig. 32; GIESENHAGEN, Flora (1890) 442, pl. 4, fig. 25; COPELAND, Hymen. (1937) 176.

Epiphytic, in New Zealand, usually on *Libocedrus Bidwillii,* in Tasmania on *Athrotaxis selaginoides.* The illustrations of Mettenius and Giesenhagen show the structure perfectly. The best description is by Holloway,[23] who calls it "certainly the most peculiar species of the New Zealand family both in its frond structure and in its distribution."

The stellate hairs are unmistakable evidence of affinity to *Sphaerocionium.*

6. Genus MICROTRICHOMANES (Mettenius) Copeland gen. nov.

Trichomanes, Gruppe *Micro-trichomanes* METTENIUS, Hymen. (1864) 413.

Gonocormus, § *Microtrichomanes* PRANTL, Hymen. 51.

Folia disticha . . ., dichotome v. subpinnatim partita, . . . striis nulis . . . Folium non proliferum, margine saepe ciliatum; indusii tubus latetudinem limbi vix superans; paleae rectae.—PRANTL, loc. cit.

Typice epiphytica, rhizomate filiforme late repente et intricato, radicibus praedito; frondibus parvis, repetiter dichotomis rarissime simplicibus, rhache vera ita carente, costis ubique alatis, margine aut minute setiferis aut nudis; parietibus cellularum tenuibus; soris in apices segmentorum immersis, involucro obconico vel campanulato, non bilabiato, receptaculo gracile modo exserto, sporangiis majusculis.

Typus, M. digitatum (Swartz sub Trichomane).

A small genus of the Old World Tropics, related to *Sphaerocionium* and probably derived from it.

Range: Malaya to Tahiti and Madagascar.

Dealing with a group presumably derived, by reduction, from ferns with more amply developed fronds, it must be observed, as in other such cases, that reduction is likely to result in convergent evolution, whereby species of diverse ancestry have be-

[23] Trans. N. Z. Inst. 54 (1923) 596, pls. 66, 76.

come similar. I may be misled in this manner into including in *Microtrichomanes* some species which do not belong here. So far as marginal setæ are present, they present sufficient evidence of affinity to *Sphaerocionium;* and the gap between *S. Lyallii* and *M. palmatifidum* is too narrow to leave reasonable doubt on the subject. They would be treated as congeneric, if the considerable number of species to which they are related in opposite directions did not make convenient an intergeneric boundary between them. As to the species without setæ, they seem to be related to those which bear setæ; but setæ are structures not usually lost in the course of reduction of the fronds.

The relation of *Microtrichomanes* and the still more reduced genera, *Didymoglossum* and *Microgonium,* invites study. Between *Microtrichomanes* and *Gonocormus,* which are united by Prantl, there is no near affinity.

SPECIES OF MICROTRICHOMANES

MICROTRICHOMANES PALMATIFIDUM (K. Müll.) **Copeland comb. nov.**

Trichomanes palmatifidum K. MÜLLER, Bot. Zeit. 12 (1854) 732; VAN DEN BOSCH, Hymen. Javan. 20, pl. 14; COPELAND, Trich. (1933) 162, pl. 7, fig. 6; pl. 11, fig. 1.

JAVA; SUMATRA; BORNEO; MALAY PENINSULA.

MICROTRICHOMANES RIDLEYI Copeland.

Trichomanes Ridleyi COPELAND, Trich. (1933) 162, pl. 11, figs. 2, 3.

PAHANG.

MICROTRICHOMANES DIGITATUM (Sw.) **Copeland comb. nov.**

Trichomanes digitatum SWARTZ, Syn. Fil. (1806) 370; COPELAND, Trich. (1933) 159, pl. 7, figs. 3, 4.

East African Islands; Malaya to Samoa? Christensen[24] would restrict this name to the form found in Madagascar and the Seychelles, recognizing *T. flabellatum* v. d. Bosch, described from Java, as distinct. Three Philippine forms might be distinguished, but probably blend. The following two species are still more aberrant.

MICROTRICHOMANES DICHOTOMUM (Kze.) **Copeland comb. nov.**

Trichomanes dichotomum KUNZE, Bot. Zeit. 6 (1848) 285; VAN DEN BOSCH, Hymen. Javan. 22, pl. 16; COPELAND, Trich. (1933) 160, pl. 7, fig. 5.

JAVA.

[24] Pterid. Madag., p. 3.

MICROTRICHOMANES TÆNIATUM Copeland.

Trichomanes tæniatum COPELAND, Bishop Mus. Bull. **93** (1932) 6, pl. 2; Trich. (1933) 161, pl. 10.

SOCIETY ISLANDS; SOLOMON ISLANDS.

MICROTRICHOMANES NITIDULUM (v. d. B.) Copeland comb. nov.

Trichomanes nitidulum VAN DEN BOSCH, Pl. Jungh. (1856) 547; Hymen. Javan. 21, pl. 15; COPELAND, Trich. (1933) 155, pl. 7, fig. 1.

JAVA; SUMATRA; CEYLON; TONKIN; NEW SOUTH WALES. This and the species to follow are without setæ.

MICROTRICHOMANES PARVULUM (Poiret) Copeland comb. nov.

Trichomanes parvulum POIRET, Lam., Enc. **8** (1808) 64, not of most subsequent authors nor Copeland, Trich. (1933) 145.
Trichomanes sibthorpioides Bory, COPELAND, Trich. (1933) 154, pl. 8.
Hymenophyllum sibthorpioides Mettenius, C. CHRISTENSEN, Pterid. Madag. 11, pl. 2, figs. 15–18.

East African Islands. The evidence suggested several times by Christensen, and summarized in Pterid. Madag., p. 3, seems to leave little doubt that the original *T. parvulum* is the species later described by Bory as *T. sibthorpioides*, removed to *Hymenophyllum* by Mettenius, and equally out of place there.

MICROTRICHOMANES FRANCII (Christ) Copeland comb. nov.

Trichomanes Francii CHRIST, Bull. Boissier II **7** (1907) 648; COPELAND, Trich. (1933) 156, pl. 7, fig. 2.

NEW CALEDONIA.

MICROTRICHOMANES VITIENSE (Baker) Copeland comb. nov.

Trichomanes vitiense BAKER, Journ. Linn. Soc. Bot. **9** (1866) 338, pl. 8, fig. 2; DOMIN, Bibl. Bot. 20: 10, pl. 3, fig. 3; COPELAND, Trich. (1933) 157, pl. 9, figs. 1, 2.

FIJI; SAMOA; QUEENSLAND. The fronds are forked, or reduced to simple.

7. Genus HYMENOPHYLLUM Smith

Hymenophyllum SMITH, Mém. Acad. Turin **5** (1793) 418.

Sorus marginalis receptaculo cylindraceo insertus. Indusium bivalve sorum includens.—SMITH, loc. cit.

Genus cosmopolitanum filicum terrestrium et epiphyticarum, rhizomate repente, frondibus mediocribus vel parvis pinnatim dissectis, marginibus serrulatis nudis, involucris profunde bivalvibus, receptaculo cylindrico interdum supra basin leviter incrassato, aut incluso aut involucro tantum longiore, sporangiis magnis sessilibus.

Type, *H. tunbridgense* (L.) Smith.

A genus of perhaps 25 very similar species, notable for their occurrence in temperate lands, though not wanting in the Tropics. Its near affinity is to *Meringium*, from which it is distinguished by the more deeply cleft involucre, the shorter receptacle, the absence of peculiarly (pitted) thickened cell walls, and usually smaller size. There are species in the far South, perhaps primitive, which share the characteristics of the two genera; and there are very reduced species there and elsewhere which, in the course of reduction, have lost their clear generic criteria. However, *Meringium* in its full development is so different that it seems clearly expedient to maintain both genera.

SPECIES OF HYMENOPHYLLUM

HYMENOPHYLLUM TUNBRIDGENSE (L.) Smith.

Scotland to Italy; Atlantic Islands, South Africa; South America.

HYMENOPHYLLUM BARBATUM Baker.

Japan to India.

HYMENOPHYLLUM SIMONSIANUM Hooker.

India to Formosa.

HYMENOPHYLLUM CUPRESSIFORME Lab.

AUSTRALIA.

HYMENOPHYLLUM GRACILESCENS Domin.

AUSTRALIA.

HYMENOPHYLLUM REVOLUTUM Colenso.

NEW ZEALAND.

HYMENOPHYLLUM RUGOSUM C. Christ & Skottsberg.

JUAN FERNANDEZ.

HYMENOPHYLLUM FALKIANDICUM Baker.

ANTARCTIC AMERICA.

HYMENOPHYLLUM PELTATUM Desv.

All southern lands, to Norway.

HYMENOPHYLLUM ANTARCTICUM Presl.

AUSTRALIA.

HYMENOPHYLLUM AFFINE Brack.

FIJI.

HYMENOPHYLLUM PERFISSUM Copeland.

BORNEO.

HYMENOPHYLLUM ASPERULUM Kunze.

ANDES.

HYMENOPHYLLUM HERZOGII Ros.

BOLIVIA.

Dwarfs which may be reduced representatives of either *Hymenophyllum* or *Meringium* are *H. pumilum* Moore, *H. Pumilio* Ros., and *H. minimum* Rich.

H. Levingei Clarke, of the Himalayas, described as bearing both hairs and paleæ, is otherwise in this genus, but is not to be placed with confidence until so remarkable a peculiarity is verified.

H. pectinatum Cav., Antarctic America, belongs in this rather than in any other genus, but is an isolated species, like so many others of the far South.

8. Genus MERINGIUM Presl

Meringium PRESL, Hymen. (1843) 116, pl. 8*B*.

Typice epiphyticae, frondibus remotis mediocribus pinnatim decompositis, marginibus serrulatis vel rarius integris, parietibus cellularum saepe valde incrassatis et grosse vittatis, soris paratactis, involucris deorsum obconicis sursum bivalvibus, receptaculo praelongo gracile, sporangiis sessilibus magnis.

Type, *Meringium meyenianum* Presl.

A genus of 60 or more recognized species, of the Tropics and South Temperate Zone, best developed in the Malay region, with several American species, and but one known in Africa; distinguished from *Hymenophyllum* by the closed lower part of the involucre and the long-exserted receptacle; also, in general, by larger and coarser fronds, with thick and coarsely pitted walls—like those of *Selenodesmium.* From India to Polynesia it is a common and homogeneous group. The New Zealand species are less distinct from *Hymenophyllum* in the development of the walls.

Presl overlooked the affinity to *Hymenophyllum,* compared his type with *Didymoglossum*, and with the group of *Trichomanes rigidum,* and described and pictured the sorus as "basi bibracteatus." As nobody has since seen the bracts, his plant was long unrecognized and supposed to be some *Trichomanes;* while the group it typifies came to be known by the name of another of his genera, really distinct, *Leptocionium.* He also gave generic names, *Myrmecostylum* and *Ptychophyllum,* to two other South Chilean plants, certainly related to *Meringium,* which I include in the latter. I believe, though, that since migration from a common home farther south the evolution of the American and Oriental groups has been independent.

There is a group of ill-defined species, ranging from Madagascar to the Philippines, which, with some loss of stature, have more or less completely lost the marginal teeth. *M. macroglossum* and *M. pachydermicum* seem always to be entire. *M. edentulum* is almost so. *M. holochilum* is serrulate, with sparse teeth. Although these entire species have been assigned to most diverse groups—several of them even to *Trichomanes*—there is no question whatever as to their affinity. They complicate a complete diagnosis of *Meringium,* but it is impracticable to separate them from it.

SPECIES OF MERINGIUM

MERINGIUM MEYENIANUM Presl.

Hymenophyllum meyenianum COPELAND, Hymen. (1937) 25, pl. 8.

PHILIPPINES; NEW GUINEA.

MERINGIUM BAKERI Copeland.

Hymenophyllum Bakeri COPELAND, Sarawak Mus. Journ. **2** (1917) 309; Hymen. (1937) 29.

Southern Philippines to Sumatra.

MERINGIUM KLABATENSE (Christ) Copeland comb. nov.

Hymenophyllum klabatense CHRIST, Verh. Nat. Ges. Basel **11** (1894) 4; COPELAND, Hymen. (1937) 30.

CELEBES; MINDANAO.

MERINGIUM VITTATUM Copeland.

Hymenophyllum vittatum COPELAND, Hymen. (1937) 31, pl. 9, figs. 1–3.

LUZON.

MERINGIUM BICOLANUM Copeland.

Hymenophyllum bicolanum COPELAND, Hymen. (1937) 31, pl. 10.

LUZON.

MERINGIUM CAMPANULATUM (Christ) Copeland comb. nov.

Hymenophyllum campanulatum CHRIST, Philip. Journ. Sci. § C 2 (1907) 155; COPELAND, Hymen. (1937) 32, pl. 11.

NEGROS (Philippines).

MERINGIUM BONTOCENSE Copeland.

Hymenophyllum bontocense COPELAND, Hymen. (1937) 33, pl. 12.

LUZON.

MERINGIUM MERRILLII (Christ) Copeland comb. nov.

Hymenophyllum Merrillii CHRIST, Philip. Journ. Sci. § C 2 (1907) 154; COPELAND, Hymen. (1937) 33, pl. 13.

LUZON.

MERINGIUM RAMOSII Copeland.

Hymenophyllum Ramosii COPELAND, Hymen. (1937) 34, pl. 9, figs. 4–6.

MINDANAO.

MERINGIUM HOLOCHILUM (v. d. B.) Copeland comb. nov.

Didymoglossum holochilum VAN DEN BOSCH, Pl. Jungh. I (1856) 561.
Hymenophyllum holochilum C. Chr., COPELAND, Hymen. (1937) 34, pl. 14.

Java to Papua and Malay Peninsula.

Apparent relatives of *M. holochilum* are *Hymenophyllum rufifolium* v. A. v. Rosenburgh, *H. rufifrons* v. A. v. R., *H. Elberti* Rosenstock, *H. brevidens* v. A. v. R., *H. torricellianum* v. A. v. R., *H. ellipticosorum* v. A. v. R., *H. nutantifolium* v. A. v. R., *H. pedicularifolium* Cesati, and *H. cincinnatum* Gepp.

MERINGIUM EDENTULUM (v. d. B.) Copeland comb. nov.

Leptocionium edentulum VAN DEN BOSCH, Ned. Kr. Arch. 53 (1863) 148.
Hymenophyllum edentulum C. Christ, COPELAND, Hymen. (1937) 24, pl. 7.

ASSAM; LUZON; BORNEO.

MERINGIUM PACHYDERMICUM (Cesati) Copeland comb. nov.

Hymenophyllum pachydermicum CESATI, Atti. Accad. Napoli 8 (1876) 8; COPELAND, Hymen. (1937) 20, pl. 5.

Philippines to Sumatra.

MERINGIUM PENANGIANUM (M. and C.) Copeland comb. nov.

Hymenophyllum penangianum MATTHEW and CHRIST, Journ. Linn. Soc. Bot. 39 (1909) 214; COPELAND, Hymen. (1937) 19, pl. 4.

BORNEO; MALAY PENINSULA.

MERINGIUM MACROGLOSSUM (v. d. B.) Copeland comb. nov.

Hymenophyllum macroglossum VAN DEN BOSCH, Ned. Kr. Arch. 5^{3} (1863) 156; COPELAND, Hymen. (1937) 19, pl. 3.

CEYLON.

MERINGIUM TENELLUM (Jacq.) Copeland comb. nov.

Adiantum tenellum JACQ., Coll. Bot. III (1789) 287, pl. 21, fig. 3.
Hymenophyllum ricciaefolium Bory, COPELAND, Hymen. (1937) 17, pl. 1.

East African Islands.

MERINGIUM POLLENIANUM (Ros.) Copeland comb. nov.

Hymenophyllum pollenianum ROSENSTOCK, Meded. Rijks Herb. Leyden No. 11 (1912) 1; COPELAND, Hymen. (1937) 18, pl. 2.

MADAGASCAR.

MERINGIUM PULCHRUM Copeland.

Hymenophyllum pulchrum COPELAND, Hymen. (1937) 22, pl. 6.

Southern Philippines.

Apparently in the same group as the preceding seven species, with margins entire or nearly so, are *H. batuense* Ros., Batu Island, and *H. Hallieri* Ros., Borneo.

MERINGIUM BRACHYGLOSSUM (A. Br.) Copeland comb. nov.

Hymenophyllum brachyglossum A. BR., Bot. Zeit. 5 (1847) 227; COPELAND, Hymen. (1937) 40.

JAVA.

MERINGIUM DENTICULATUM (Sw.) Copeland comb. nov.

Hymenophyllum denticulatum SWARTZ, Schrad. Journ. (1801) 100, Synopsis (1806) 148, 375; COPELAND, Hymen. (1937) 41, pl. 15.

Ceylon to Fiji.

MERINGIUM HOSEI Copeland.

Hymenophyllum Hosei COPELAND, Philip. Journ. Sci. § C 12 (1917) 46; Hymen. (1937) 45, pl. 16.

BORNEO.

This transfer precludes that of the same specific name for the earlier *Trichomanes Hosei* which is *Meringium penangianum;* the purpose being to avoid a new specific name for *H. Hosei.*

MERINGIUM ACANTHOIDES (v. d. B.) Copeland comb. nov.

Didymoglossum acanthoides VAN DEN BOSCH, Pl. Jungh. I (1856) 16.
Hymenophyllum acanthoides Rosenstock, COPELAND, Hymen. (1937) 45, pl. 17.

Java to Luzon; FORMOSA; NEW GUINEA.

MERINGIUM CARDUNCULUS (C. Chr.) Copeland comb. nov.

Hymenophyllum Carduncul us C. CHRISTENSEN, Mitt. Inst. Bot. Hamburg 7 (1928) 144; COPELAND, Hymen. (1937) 47.

BORNEO.

MERINGIUM KERIANUM (Watts) Copeland comb. nov.

Hymenophyllum kerianum WATTS, Proc. Linn. Soc. N. S. Wales **39** (1915) 767; COPELAND, Hymen. (1937) 48.

QUEENSLAND.

MERINGIUM MACROSORUM (v. A. v. R.) Copeland comb. nov.

Hymenophyllum macrosorum v. A. v. ROSENBURGH, Bull. Jard. Bot. Buit. **16** (1914) 18; COPELAND, Hymen. (1937) 48.

SUMATRA.

MERINGIUM LOBBII (Moore) Copeland comb. nov.

Hymenophyllum Lobbii MOORE in van den Bosch, Ned. Kr. Arch. **5**^{2} (1863) 176; COPELAND, Hymen. (1937) 49.

BORNEO.

MERINGIUM BLANDUM (Racib.) Copeland comb. nov.

Hymenophyllum blandum RACIBORSKI, Pterid. Buit. (1898) 20; COPELAND, Hymen. (1937) 50, pl. 18.

Java to Luzon.

MERINGIUM REDUCTUM Copeland.

Hymenophyllum reductum COPELAND, Hymen. (1937) 53, pl. 20.

PHILIPPINES.

MERINGIUM ROSENSTOCKII (Brause) Copeland comb. nov.

Hymenophyllum Rosenstockii BRAUSE, Bot. Jahrb. **56** (1920) 43; COPELAND, Hymen. (1937) 53, pl. 21, figs. 1, 2.

NEW GUINEA.

Hymenophyllum Hertericanum Brause may belong here; I have not seen the sorus.

MERINGIUM DIMIDIATUM (Mett.) Copeland comb. nov.

Hymenophyllum dimidiatum METTENIUS, Linnæa **35** (1868) 393; COPELAND, Hymen. (1937) 54.

NEW CALEDONIA.

MERINGIUM OVATUM Copeland.

Hymenophyllum ovatum COPELAND, Philip. Journ. Sci. § C **6** (1911) 70; Hymen. (1937) 56, pl. 22.

PAPUA.

MERINGIUM RUBELLUM (Ros.) Copeland comb. nov.

Hymenophyllum rubellum ROSENSTOCK, Nova Guinea **8** (1912) 716; COPELAND, Hymen. (1937) 56.

NEW GUINEA.

MERINGIUM FIRMUM (v. A. v. R.) Copeland comb. nov.

Hymenophyllum firmum v. A. v. ROSENBURGH, Nova Guinea 14 (1924) 28; COPELAND, Hymen. (1937) 57.

NEW GUINEA.

MERINGIUM GORGONEUM Copeland.

Hymenophyllum gorgoneum COPELAND, Hymen. (1937) 60, pl. 26.

SOLOMON ISLANDS.

MERINGIUM MACGILLIVRAYI (Baker) Copeland comb. nov.

Trichomanes Macgillivrayi BAKER, Ann. Bot. 5 (1891) 195.
Hymenophyllum Macgillivrayi COPELAND, Hymen. (1937) 60, pl. 25.

FIJI.

MERINGIUM FEEJEENSE (Brack.) Copeland comb. nov.

Hymenophyllum feejeense BRACKENRIDGE, U. S. Expl. Exped. 16 (1854) 266, pl. 37; COPELAND, Hymen. (1937) 61, pl. 27.

FIJI.

MERINGIUM PRAETERVISUM (Christ) Copeland comb. nov.

Hymenophyllum praetervisum CHRIST, Bot. Jahrb. 23 (1896) 338; COPELAND, Hymen. (1937) 62, pl. 28.

SAMOA.

Hymenophyllum minimum Richard, *H. pumilum* Moore, and *H. pumilio* Ros., are exceedingly reduced species, which may belong here.

MERINGIUM MULTIFIDUM (Forster) Copeland comb. nov.

Trichomanes multifidum FORSTER, Prod. (1786) 85.
Hymenophyllum multifidum Swartz, COPELAND, Hymen. (1937) 65, pl. 30, figs. 1–3.

NEW ZEALAND.

MERINGIUM BIVALVE (Forster) Copeland comb. nov.

Trichomanes bivalve FORSTER, Prod. (1786) 84.
Hymenophyllum bivalve Swartz, COPELAND, Hymen. (1937) 66, pl. 30, figs. 4–6.

New Zealand to Queensland.

The preceding two species have the sori and aspect of *Meringium*, and are therefore included in it; but the structure is rather that of *Hymenophyllum*. They may represent an evolutionary stage prior to the typical differentiation of the two genera.

MERINGIUM TRIANGULARE (Baker) Copeland comb. nov.

Hymenophyllum triangulare BAKER, Syn. Fil. (1873) 69; COPELAND, Hymen. (1937) 67.

AFRICA.

MERINGIUM TORTUOSUM (H. and G.) Copeland comb. nov.

Hymenophyllum tortuosum HOOKER and GREVILLE, Icones Fil. (1829) pl. 129.

Myrmecostylum tortuosum PRESL, Hymen. 119, pl. 10*A*.

ANTARCTIC AMERICA.

MERINGIUM PLICATUM (Kaulf.) Copeland comb. nov.

Hymenophyllum plicatum KAULFUSS, Enum. (1824) 268.

Ptychophyllum plicatum PRESL, Hymen. 120, pl. 11*E*.

ANTARCTIC AMERICA.

The two preceding species are the types of Presl's cited genera. To me they seem to be very typical *Meringium*, conforming in wall structure, margin, and involucre, and, so far as my poor fruiting material shows, in receptacle. The more or less overfull and therefore ruffled or crisped lamina of *M. plicatum* is no novelty in the genus. Presl described and figured one valve of the involucre as cleft to the base. I have seen such a monstrosity, very rarely, in Philippine species, and do not find it in the material in hand of *M. plicatum*.

H. quadrifidum Philippi is described as having a 4-valved involucre. If this is a fixed character, not a remarkable abnormality, the subject will best be regarded, as he suggested, as constituting a genus *Tetralasma*. I have now (May, 1938), by the kindness of Mr. Gualterio Looser, a photograph of part of the original collection of this plant, and am sure that the quadrifid involucre is not a constant peculiarity. The species appears to be *M. magellanicum*.

MERINGIUM MAGELLANICUM (Desv.) Copeland comb. nov.

Didymoglossum magellanicum DESVAUX, Prod. (1827) 331.

ANTARCTIC AMERICA, southern Brazil. Typical *Meringium*, throughout its range.

MERINGIUM SECUNDUM (H. and G.) Copeland comb. nov.

Hymenophyllum secundum HOOKER and GREVILLE, Icones Fil. (1829) Pl. 133.

ANTARCTIC AMERICA. The internal walls are somewhat reticulate-thickened.

MERINGIUM FUCOIDES (Sw.) Copeland comb. nov.

Trichomanes fucoides SWARTZ, Prod. Fl. Ind. Occ. (1788) 136.

Tropical America. Internal walls feebly reticulate-thickened.

H. dentatum Cav., southern Chile, has the margin and involucre of *Meringium*, but is otherwise too distinct for easy inclusion. Neither does it go naturally into any other genus. In its sharing of the characteristics of the modern genera it impresses me as more generalized than *M. multifidum*, in that it seems related to *Mecodium*, which is not in general by any means as close to *Meringium* as is *Hymenophyllum*.

9. Genus AMPHIPTERUM Presl

Amphipterum PRESL, Epim. Bot. (1852) 258.

Altior evolutionis gradus est ille, si raches costaque venaeque ala foliacea libera bilaterali serrata in pagina superiori frondis instructae sunt.—Talem organisationem exhibet inter Trichomanoideas Amphipterum fuscum (Trichomanes fuscum Blume, . . .—PRESL, loc. cit.

Genus Meringio derivatum, venis aut inferne aut utraque facie alis vel cristis accessoriis praeditis distinguendum; margine aut serrulata aut integra; soris magnis segmenta axillaria abbreviata tertiaria (vel sursum secondaria) terminantibus, involucro vix ad mediam longitudinem bilabiato, deorsum cristato vel laminato, receptaculo valde extruso.

As in the case of some other genera for which I use Presl's names, he left them really *nomina nuda*, except as the citation of a species serves perfectly for their identification. In the case of *Amphipterum*, in contrast to *Mecodium*, what little he wrote to characterize it is approximately correct. The accessory wings are the sole distinction from *Meringium*. There are several species of *Sphaerocionium* with similar structures, and they probably constitute a natural group; I do not set this group up as a genus, because such a genus would shade into *Sphaerocionium*, and its recognition would not facilitate the definition or recognition of the parent genus. *Amphipterum* is clear-cut; that is, there is no known species with incipient or occasional accessory wings. And its recognition facilitates that of *Meringium*, because two of its species have entire margins. It is true that species with entire margin remain in *Meringium;* these are not near relatives of *Amphipterum*, and cannot be set off generically because they intergrade in this respect with the parent.

Four species are known to me, ranging from Sumatra to Papua.

SPECIES OF AMPHIPTERUM

AMPHIPTERUM FUSCUM (Blume) Presl.

Trichomanes fuscum BLUME.

Hymenophyllum fuscum VAN DEN BOSCH, Hymen. Javan. 62 pl. 51, 52*B;* COPELAND, Hymen. (1937) 69, pl. 31.

JAVA; SUMATRA.

AMPHIPTERUM LEDERMANNI (Brause) Copeland comb. nov.

Hymenophyllum Ledermanni BRAUSE, Bot. Jahrb. **50** (1920) 41; COPELAND, Hymen. (1937) 70, pl. 32.

NEW GUINEA. *H. cernuum* Gepp may provide the correct specific name of this species.

AMPHIPTERUM GELUENSE (Ros.) Copeland comb. nov.

Hymenophyllum geluense ROSENSTOCK, Fedde's Repert. **5** (1908) 372; COPELAND, Hymen. (1937) 72, pl. 33.

NEW GUINEA.

AMPHIPTERUM LAMINATUM Copeland.

Hymenophyllum laminatum COPELAND, Philip. Journn. Sci. § C **6** (1911) 70; Hymen. (1937) 73, pl. 34.

PAPUA.

10. Genus MYRIODON Copeland gen. nov.

Hymenophyllum subgenus *Myriodon*, COPELAND, Hymen. (1937) 73.

Lamina normale continua omnino carente, dentibus longitudinalibus ad rhachin costasque ubique et irregulariter affixis substituta, involucro medio fisso ubique dentifero, receptaculo extruso.—COPELAND, loc. cit.

Type, *M. odontophyllum* Copeland.

A genus of a single known species, derived from *Meringium* and more particularly related to *M. denticulatum.* The frond looks so like the exceedingly crisped one of *M. acanthoides* that Brause described this as a variety of that species. But less superficial examination shows that instead of a crisped lamina it has no continuous lamina whatever, no particle of green tissue containing a vein, being thus almost unique among ferns. Its assimilating tissue consists of aphlebiate teeth, as that of *Apteropteris,* consists of filaments.

SPECIES OF MYRIODON

MYRIODON ODONTOPHYLLUM Copeland.

Hymenophyllum odontophyllum COPELAND, Hymen. (1937) 73, pl. 35.

NEW GUINEA.

11. Genus BUESIA (Morton) Copeland gen. nov.

Hymenophyllum subgenus *Buesia* MORTON, Bot. Gaz. **93** (1932) 336.

Filix pendula, rhizomatibus longe repentibus; stipites et rhaches paleis pluri-cellularibus basi cellulis 2- vel 3-seriatis planis instructi; rhaches primariae secundariaeque flexuosissimae; laminae elongatae pinnatae, pinnis tripinnatipartitis; segmenta ultima serrata; sori in lobulis intimis contractis abbreviatis dispositi; indusium bifidum margine undulatum; receptaculum subglobosum crassum.

Species typica: *Hymenophyllum mirificum* Morton.—MORTON, loc. cit.

Genus Meringio affine, alis axium majorum in paleas dissolutis, margine serrulato, soris paratactis involucris profunde bivalvibus, receptaculo breve crasso.

I follow Morton's suggestion and treat this as a genus, although it is not very distinct from *Meringium* as here, perhaps too broadly, construed. The same pealealike structures occur on *Meringium plicatum,* are reported on *Hymenophyllum Levingii,* and completely replace the usual lamina of *Myriodon.*

SPECIES OF BUESIA

BUESIA MIRIFICA (Morton) Copeland comb. nov.

Hymenophyllum mirificum MORTON, Bot. Gaz. 93 (1932) 336, fig. 1.

PERU.

BUESIA SODIROI (C. Christ) Copeland comb. nov. Plate 2.

Hymenophyllum Sodiroi C. CHRIST, Index (1905) 368; *H. pendulum* (SODIRO non Bory).

ECUADOR.

Buesia Sodiroi is a stouter and less finely dissected species with huge sori. I conclude from Morton's description of *H. mirificum* that besides the paleæ in the natural position of fragments of the wing, they are found scattered (sparsim), but on the frond given me by the National Herbarium they seem all to originate in the plane of the lamina. This is true of most of them on *B. Sodiroi,* but a few are unmistakably inserted out of this plane; which is less startling because they are inserted in all planes on the axes of *Myriodon.* Having seen these structures on *B. Sodiroi,* I can interpret the description and figure of another species, not seen, and confidently call it:

BUESIA JAMESONI (Hooker) Copeland comb. nov.

Hymenophyllum Jamesoni HOOKER, Spec. Fil. I (1844) 96, pl. 35*A*.

ECUADOR. Except that the fertile segments are not constricted below them, the sori are exactly those of *B. Sodiroi.*

12. Genus LEPTOCIONIUM Presl

Leptocionium PRESL, Hymen. (1843) 118, 11 *D*.

Venae pinnatae, simplices, prominulae, libere desinentes. Sorus terminalis, sessilis. Indusium usque fere ad basim bipartitum suborbiculatum, laciniis planis appressis margine aequaliter serrato-ciliatis. Receptaculum cylindricum, obtusum, undique capsuliferum, junius indusio aequilongum, adultum duplo longius nudum cicatriculis oblongis spiralibus notatum. Capsulae lenticulares, sessiles.

Genus inter Trichomanoideas et Hymenophylloideas intermedium, priorum receptaculum, posteriorum indusium possidens.—PRESL, loc. cit.

A single species, *L. dicranotrichum* Presl, of southern Chile. (Plate 3.)

Actually, the margin is entire, as Presl drew it. Margin and surface bear many very short setæ, which are mostly geminate. *Leptocionium* has the sorus of *Meringium,* and the margin and setæ of *Sphaerocionium,* the setæ short and simple, commonly pinnate.

Not knowing or appreciating Presl's *Meringium,* which has page priority, van den Bosch adopted Presl's name *Leptocionium* for all Hymenophyllaceæ with toothed margins, and the use of the name in this sense, as a subgenus, has been usual since his time, but is corrected in the third Supplement to Christensen's Index.

13. Genus SERPYLLOPSIS van den Bosch

Serpyllopsis VAN DEN BOSCH (Synopsis p. 37, nomen), Versl. Akad. Wetens. Amsterdam 11 (1861) 318.

Frons pinnata, pinnae simplices integrae vena simplici percursae, sori laterales, receptaculum incrassatum teres.—VAN DEN BOSCH, loc. cit.

Christensen amplified the generic description, emphasizing: "1) the indefinite growth of the leaves, and 2) the pubescence of thick red hairs along the rachis and midribs of pinnæ beneath."[25]

The type species, and the only species named as in the genus, is *S. caespitosa* (Gaud.) C. Chr.[26] (Plate 4), *S. antarctica* v. d. Bosch.

Range: Antarctic America, Falkland Islands, Juan Fernandez. Christensen[27] recognized three varieties, besides the typical form. Of these, two have specific names in *Hymenophyllum: H. densifolium* Philippi, with deeply bilabiate involucre with obscurely dentate lips; and *H. Dusenii* Christ, the involucre with entire, truncate mouth, but with few and spatulate pinnæ and evident, filiform stipe. The typical form has subsessile fronds and pinnæ with broadly rounded bases, and the involucre very shallowly bilabiate with dentate lips. Christensen and Skottsberg[28] described still another variety, *fernandeziana,* with deeply immersed and broadly winged involucres cleft halfway down, and dentate lips crested on the back.

[25] Arkiv. f. Bot. 10 ^{2} (1910) 28.
[26] Archiv f. Bot. 10 ^{2} (1910) 29.
[27] Loc. cit.
[28] Pterid. of Juan Fernandez (1920) 5.

Aside from the fructification, there is a strong but perhaps superficial resemblance to *Hymenophyllum rarum*, and the far southern occurrence of both makes their affinity a reasonable conjecture. Even if this were established, it would remain expedient to maintain *Serpyllopsis* as a genus, whether with one or with three or more known species.

14. Genus HYMENOGLOSSUM Presl

Hymenoglosum PRESL, Hymenophyllaceae (1843) 127.

Costa utrinque teres, prominula flexuosa. Venae oppositae, suboppositae alternaeque, angulo acuto exorientes, parallelae, utrinque prominulae, simplicissimae, in dentes frondis marginatae excurrentes, ante marginem obtuse desinentes. Sori in dentibus frandis apicales.

Rhizoma repens, filiforme . . . Frondes glaberrimae.

Species. Hymenoglossum cruentum (Hymenophyllum cruentum Cav.).
—PRESL, loc. cit.

Range: Chile, Juan Fernandez.

The genus was retained by van den Bosch[29] and by Christensen and Skottsberg,[30] was unknown to Prantl, and is included in *Hymenophyllum* by other authors, including Christensen. In that genus it is isolated by characters of form and structure. As to form, the fronds are simple and large, about 10 cm long and broadly lanceolate; no other species in the family resembles it. The veins are simple, remote, parallel. The margin varies from subentire (sterile) to obtusely serrate, with a sorus at the end of each tooth, half-immersed and cleft halfway down, the lips entire, receptacle included. Anatomical characters are a broad marginal band two cells thick, and a thickened line around each parenchyma cell next to the outside wall.[31] (Plate 5.)

There is no evident particular affinity to any other species or group.

15. Genus CARDIOMANES Presl

Cardiomanes PRESL, Hymen. (1843) 104.

Costa nulla. Venae pedato-flabellatae, crebrae, furcatae, steriles ante marginem frondis apice obtuso desinentes. Sorus intramarginalis, immersus. Indusium campanulatum, ore integrum. Capsulae lenticulares, receptaculo clavato obtuso demum exserto undique affixae.—PRESL, loc. cit.

Terrestre, rhizomate valido, late repente; stipitibus remotis, erectis; fronde simplice, reniforme, majuscula, coriacea, stratis

[29] Synopsis 45, Bijdrage.

[30] Pteridophyta of Juan Fernandez. Nat. Hist. Juan Fernandez 2 (1920) 6.

[31] Mettenius, Hymen. (1864) pl. 2, fig. 33.

ca. IV cellularum composita, venis flabellato-dichotomis; soris marginalibus, involucris cylindricis immersis, receptaculo exserto.

A single species (Plate 6), perhaps the most isolated in the family, endemic in New Zealand.

CARDIOMANES RENIFORME (Forster) Presl.

16. Genus VANDENBOSCHIA Copeland gen. nov.

Trichomanes auctorum omnium, partim.
Trichomanes, § *Eutrichomanes* PRESL, VAN DEN BOSCH, PRANTL, *partim.*

Typice epiphyticae, rhizomate elongato scandente, frondibus remotis, pinnatim dissectis; parietibus cellularum tenuibus, ubique conformibus; soris pantotactis, involucris infundibuliformibus ore non bilabiatis, receptaculis gracilibus protrusis, sporangiis parvis. Species typica: V. radicans (Swartz sub Trichomane).

Range: That of the family.

This is the most nearly cosmopolitan genus in the family. Among those which have been included in *Trichomanes*, it is the least differentiated; on this ground I regard it as most nearly primitive. A considerable number of the genera of more limited geographic range are evidently derived from it. Thus, *Cephalomanes* in the Orient can be derived approximately from the Oriental *V. auriculata;* while *Trichomanes,* an American genus, is traced back approximately through the American *T. rupestre* to *Vandenboschia;* the two lines of distinct origin being superficially so parallel in evolution that Prantl combined parts of them in one small genus, *Lacostea.* Other probable derivatives of *Vandenboschia* are the pantropic *Selenodesmium* (prior to dispersal from the Antarctic), the American *Davalliopsis* and *Didymoglossum,* and the Oriental *Crepidopteris, Crepidomanes, Callistopteris, Nesopteris,* and *Pleuromanes.*

The failure of this very well-known group to bear any distinctive and valid name is explained under *Trichomanes,* as due to the misapplication of that name to this group.

SPECIES OF VANDENBOSCHIA

VANDENBOSCHIA PHILIPPIANA (Sturm) Copeland comb. nov.

Trichomanes Philippianum STURM, Enum. Pl. r. vasc. Chil. (1858) 38; VAN DEN BOSCH, Goddijn, Meded. Rijk's Herb. Leyden No. 17 (1913) 24, fig. 13; CHRISTENSEN and SKOTTSBERG, Pterid. Juan Fernandez (1920) 2, fig. 1.

JUAN FERNANDEZ.

This is the most generalized species of the old genus *Trichomanes.* The fronds are either remote or clustered, and our limited material indicates the absence of sharp distinction between rhizome and stipe. This strongly suggests *Gonocormus,* to which van den Bosch, as far as I can see, did not refer it. (His number, 8*a*,[32] places it with *T. dichotomum,* a *Microtrichomanes.*) The involucre is variable in form, but sufficiently like that of *V. pyxidifera.* The very large cells suggest *Macroglena.* The stipellate walls of the marginal cells, and sometimes the submarginal, are altogether peculiar. This species may constitute a genus; but I prefer to let the most generalized number of the group stand at the bottom of the least specialized, and in that sense most primitive, genus.

VANDENBOSCHIA INGAE (C. Chr.) Copeland comb. nov.

Trichomanes Ingae C. CHR., Christensen and Skottsberg, Pterid. Juan Fernandez (1920) 3, fig. 2.

JUAN FERNANDEZ.

Here probably belongs *T. pyxidiferum* var. *marchionicum* E. Brown.

VANDENBOSCHIA COLENSOI (Hooker) Copeland comb. nov.

Trichomanes Colensoi HOOKER, f. Icones Pl. 10 (1854) 979; HOLLOWAY, Trans. N. Z. Inst. 54 (1923) pl. 73; COPELAND, Trich. (1933) 137, pl. 3.

NEW ZEALAND.

VANDENBOSCHIA FALLAX (Christ) Copeland comb. nov.

Trichomanes fallax CHRIST, Ann. Mus. Congo V 3 (1909) 24; CHRISTENSEN, Dansk Bot. Arkiv. 7 (1932) 5, pl. 1, figs. 1, 2.

WEST AFRICA; MADAGASCAR.

VANDENBOSCHIA DRAYTONIANA (Brack.) Copeland comb. nov.

Trichomanes draytonianum BRACKENRIDGE, U. S. Expl. Exped. 16 (1854) 252, pl. 36, fig. 3; COPELAND, Trich. (1933) 134, pl. 1, figs. 4–7.

HAWAII.

Trichomanes Wildii Bailey seems to belong here.

VANDENBOSCHIA STENOSIPHON (Christ) Copeland comb. nov.

Trichomanes stenosiphon CHRIST, Fedde's Repert. 5 (1898) 10; COPELAND, Trich. (1933) 133, pl. 1, fig. 2.

KOREA.

[32] Ned. Kr. Arch. 5[2] (1861) 141.

VANDENBOSCHIA PARVA Copeland.

Trichomanes parvum COPELAND, Trich. (1933) 134, pl. 1, fig. 3.

FORMOSA.

VANDENBOSCHIA SCHMIDIANA (Zenker) Copeland comb. nov.

Trichomanes Schmidianum ZENKER, Taschner, Dissert. (1843) 34, pl. 1, figs. 1, 3, 5; COPELAND, Trich. (1933) 135, pl. 2, fig. 1.

INDIA.

VANDENBOSCHIA PYXIDIFERA (Linn.) Copeland comb. nov.

Trichomanes pyxidiferum LINNÆUS, Sp. Pl. (1753) 1098; SLOSSON, Bull. Torrey Bot. Club 42 (1915) 651.

American Tropics; tropical (?) and South Africa.

I cannot distinguish *T. brasiliense* Desv. from this species. Several other related "species" are unknown to me.

VANDENBOSCHIA HYMENOPHYLLOIDES (v. d. B.) Copeland comb. nov.

Trichomanes hymenophylloides VAN DEN BOSCH, Ned. Kruid. Arch. 5[3] (1863) 209; SLOSSON, loc. cit.

Tropical America.

T. borbonicum van den Bosch, of the East African Islands is, *teste* Christensen, very nearly this species.

VANDENBOSCHIA DIAPHANA (H. B. K.) Copeland comb. nov.

Trichomanes diaphanum H. B. K., Nov. Gen. et Sp. I (1825) 25.

Tropical South America.

VANDENBOSCHIA HERZOGII (Ros.) Copeland comb. nov.

Trichomanes Herzogii ROSENSTOCK, Meded. Rijks Herb. Leyden No. 19 (1913) 5.

BOLIVIA.

VANDENBOSCHIA SERRATIFOLIA (Ros.) Copeland comb. nov.

Trichomanes serratifolium ROSENSTOCK, Hedw. 46 (1906) 77.

BRAZIL.

VANDENBOSCHIA TENERA (Spr.) Copeland comb. nov.

Trichomanes tenerum SPR., Syst. Veg. IV (1827) 129.

Mexico to Uruguay.

VANDENBOSCHIA CAPILLACEA (Linn.) Copeland comb. nov.

Trichomanes capillaceum LINNÆUS, Sp. Pl. (1753) 1099.

Tropical America.

This and the preceding species are Prantl's section *Leptomanes*. *T. angustatum* Carm., of Tristan d'Acunha, unknown to me, may belong here, may be *Macroglena*, or may be neither.

VANDENBOSCHIA EXSECTA (Kze.) Copeland comb. nov.

Trichomanes exsectum KUNZE, Anal. (1837) 47, pl. 29, fig. 2.

SOUTHERN CHILE; JUAN FERNANDEZ.

Like so many far-southern species this is rather isolated in character. Both the lamina and the tube of the involucre are peculiarly marginate.

VANDENBOSCHIA RADICANS (Sw.) Copeland comb. nov.

Trichomanes radicans SWARTZ, Schrad. Journ. (1801) 97, Synopsis 143; COPELAND, Trich. (1933) 213, pl. 35, figs. 1, 2.

Tropical America and West Africa, north to Kentucky, Britain, India, and Japan, wanting or nearly so in Malaya and in Polynesia. In my treatise on *Trichomanes* I have reduced to this many supposed Oriental species. Many described American species have been treated in the same way by others. *T. speciosum* Willd., of the Canaries, is a local form probably worthy of specific recognition.

VANDENBOSCHIA SCANDENS (Linn.) Copeland comb. nov.

Trichomanes scandens LINNÆUS, Sp. Pl. (1753) 1098.

WEST INDIES.

TRICHOMANES GIGANTEUM Bory.

Bourbon; perhaps local here and in Madagascar; but the name has been given to specimens from Sumatra to Fiji.

VANDENBOSCHIA APHLEBIOIDES (Christ) Copeland comb. nov.

Trichomanes aphlebioides CHRIST, C. Chr., Index (1906) 635; HOLTTUM, Journ. Mal. Br. Roy. As. Soc. 6 (1928) 18, pl. 4; COPELAND, Trich. (1933) 219, pl. 38, figs. 5–8.

Sumatra to Fiji.

VANDENBOSCHIA MAXIMA (Blume) Copeland comb. nov.

Trichomanes maximum BLUME, Enum. (1828) 228; VAN DEN BOSCH, Hymen. Javan. 25, pl. 18; COPELAND, Trich. (1933) 217, pl. 38, figs. 1–4.

Malaya to Tahiti.

VANDENBOSCHIA JOHNSTONENSIS (Bailey) Copeland comb. nov.

Trichomanes johnstonense BAILEY, Proc. Royal Soc. Queensland 1 (1884) 14, lithograms, pl. 26.

QUEENSLAND; PHILIPPINES.

VANDENBOSCHIA DAVALLIOIDES (Gaud.) Copeland comb. nov.

Trichomanes davallioides GAUDICHAUD, Freycinet, Voy. Bot. (1826) 378; COPELAND, Trich. (1933) 215, pl. 36.

HAWAII.

VANDENBOSCHIA CYRTOTHECA (Hilleb.) Copeland comb. nov.

Trichomanes cyrtotheca HILLEBRAND, Fl. Haw. (1888) 636; COPELAND, Trich. (1933) 216, pl. 35, figs. 3, 4; pl. 37.

HAWAII.

VANDENBOSCHIA AURICULATA (Blume) Copeland comb. nov.

Trichomanes auriculatum BLUME, Enum. (1828) 225; COPELAND, Trich. (1933) 223.

Cephalomanes auriculatum VAN DEN BOSCH, Hymen. Javan. 34, pl. 25.

Malaya to Japan and Papua.

17. Genus POLYPHLEBIUM Copeland nom. nov.

Phlebiophyllum VAN DEN BOSCH, Versl. Akad. Wet. Amsterdam 11 (1861) 321, *non Phlebophyllum* Nees (1832).

Epiphyticum, rhizomate scandente intricato filiforme; frondibus remotis, pendentibus, mediocribus, pinnatifidis vel pinnatis, pinnis plerisque linearibus, rarius lanceolatis pinnatifidisque, membranaceis, costis pinnatim ramosis venulis dichotomis; soris axillaribus, involucro elongato-urceolato, ore expanso, receptaculo gracile longissimo.

An isolated, monotypic genus; the only plant in the family with very thin leaves in which the veins branch freely in undivided segments of the frond. What affinity it has is presumably to the group of *V. pyxidifera.*

Range: New Zealand to Tasmania and Queensland.

SPECIES OF POLYPHLEBIUM

POLYPHLEBIUM VENOSUM (R. Br.) Copeland comb. nov. Plate 7.

Trichomanes venosum R. BROWN, Prod. Fl. N. Holland (1810) 159; COPELAND, Trich. (1933) 138.

18. Genus PLEUROMANES Presl

Pleuromanes PRESL, Epim. Bot. (1849) 258.

Leucomanes PRESL, ibid.

Craspedoneuron VAN DEN BOSCH, Synopsis (1859) 21, as section; Hymen. Javan. (1861) 12, as genus.

Typice epiphytica, rhizomate filiforme late repente et intricato, molliter piloso; stipitibus remotis gracillimis; frondibus pendentibus glaucis, majusculis, bi-tripinnatifidis, segmentis linearibus margine incrassato, strato sclerenchymatico costam circumdante dilatato, parte mediale segmenti ideo crassa et opaca, molliter pilosa; soris axillaribus, involucris urceolatis ore aut truncato aut subexpanso, receptaculo filiforme valde protruso.

A small, well-marked genus, derived from *Vandenboschia latifrons*, a relative of *V. pyxidifera.* In my paper on Trichomanes

I treated *T. latifrons* as a member of the daughter group; but, as a matter of convenient verbal definition, it is necessary to leave it in the parent genus. As to the margin, cf. Copeland, Hymen. (1937) pl. 10, and Mettenius, pl. 1, fig. 23.

Range: Ceylon and Luzon to Tahiti. *V. latifrons* is found from the Himalayas to Formosa and Luzon.

SPECIES OF PLEUROMANES

PLEUROMANES ACUTUM Presl.

Trichomanes acutum PRESL, Hymen. 134; COPELAND, Trich. (1933) 140.

LUZON. The type species.

PLEUROMANES PALLIDUM (Blume) Presl.

Trichomanes pallidum BLUME, Enum. 225; COPELAND, Trich. (1933) 141.

The range of the genus.

19. Genus GONOCORMUS van den Bosch

Gonocormus VAN DEN BOSCH, Hymen. Javan. (1861) 7; Eerste Bijdrage (1861) 321.

Rhizomate et stipite vix vel tantum distinguendis, tenuibus, obscuris, rigidis, apice stipitis typice prolifera; frondibus minutis, venatione flabellata, margine inciso, parietibus non vittatis; involucris immersis tubiformi-campanulatis ore conspicue dilatatis, receptaculo exserto.

A well-defined genus of exceedingly ill-defined species, ranging from Africa across Polynesia and to Japan.

The first publication of the generic name was not accompanied by a diagnosis, but it is authenticated by described species of which the first is *G. minutus* (*Trichomanes minutum* Bl.). A diagnosis was published in the same year. I have discussed this group in sufficient detail in my treatise on Trichomanes.[33] The Marquesan specimen, *Mumford and Adamson 361*, which [34] I regarded as *T. parvulum*, is *T. latilabiatum* E. Brown.[35] Christensen [36] believes that *T. parvulum* Poir. is really the plant since called *T.* (or *Hymenophyllum*) *sibthorpioides*, and suggests that the widespread species of *Gonocormus* would better be called *T.*

[33] 142 ff.

[34] This issue, p. 106.

[35] Bishop Mus. Bull. **89** (1931) 8, fig. 3.

[36] Pterid. Madagascar (1932) 3.

saxifragoides Presl. An older name is *T. minutum* Blume, from which I do not consider *T. saxifragoides* genetically distinct.

If species are to be distinguished in *Gonocormus,* they may be:

G. minutus (Blume) v. d. Bosch, using this name for what has been called *T. parvulum;* the range of the genus.

G. diffusus (Blume) v. d. Bosch.

G. prolifer (Blume) Prantl, exemplifying the genus in its most characteristic development.

G. Teysmanni v. d. Bosch.

GONOCORMUS ALAGENSIS (Christ) Copeland comb. nov.

Trichomanes alagense CHRIST, Philip. Journ. Sci. § C 3 (1908) 270; COPELAND, Trich. (1933) 152, pl. 6, figs. 4–7.

PHILIPPINES. More distinct than are most of these species.

GONOCORMUS LATILABIATUS (E. Brown) Copeland comb. nov.

Trichomanes latilabiatum E. BROWN, Bishop Mus. Bull. No. 89 (1931) 8, fig. 3.

MARQUESAS.

20. Genus CREPIDOPTERIS Copeland nom. nov.

Trichomanes, § *Crepidium* PRESL, Hymen. (1843) 115, *non Crepidium* Blume (1825).

Crepidomanes VAN DEN BOSCH, Hymen. Javan. (1861) 16, *non* Presl.

Aut epiphyticae aut terrestres, rhizomate gracile late repente, frondibus remotis minusculis, typice bipinnatifidis, rhachi alata, venulis spuriis nullis; cellulis marginalibus 1- vel 2-seriatis valde elongatis parietibus varie incrassatis, cellulis aliis isodiametricis parietibus tenuibus; soris segmenta acropetalia infima occupantibus, involucris infundibuliformibus alatis ore patente, receptaculo protruso.

Typus: C. humilis (Forster sub Trichomane).

A small, well-defined genus of the Malay-Polynesian region, regarded as a relative of the group of *Vandenboschia pyxidifera* for want of other evident affinity; probably not nearly related to *Crepidomanes* with which it has been confused. The longitudinally elongate marginal cells are a convenient diagnostic characteristic, but the genus is recognizable at sight by a combination of characters—small size, thinness, narrowly elliptic form, degree of dissection, position of sori—which are not individually diagnostic. If two rows of cells are elongate, the inner row may be double in thickness (two cells deep).

SPECIES OF CREPIDOPTERIS

CREPIDOPTERIS HUMILIS (Forster) Copeland comb. nov.

Trichomanes humile FORSTER, Prod. (1786) 12; COPELAND, Trich. (1933) 164, pl. 12.

Sumatra to Tahiti, not to New Zealand.

CREPIDOPTERIS GRACILLIMA Copeland.

Trichomanes gracillimum COPELAND, Trich. (1933) 168, pl. 13.

LUZON.

CREPIDOPTERIS ENDLICHERIANA (Presl) Copeland comb. nov.

Trichomanes endlicherianum PRESL, Epim. Bot. (1849–51) 10, pl. 5*A*; COPELAND, Trich. (1933) 168, pls. 14, 15.

New Zealand to Norfolk, Fiji, and Tahiti.

CREPIDOPTERIS WERNERI (Rosenst.) Copeland comb. nov.

Trichomanes Werneri ROSENSTOCK, Fedde's Repert. 5 (1908) 35; COPELAND, Trich. (1933) 170, pl. 16.

NEW GUINEA.

CREPIDOPTERIS VIEILLARDII (v. d. B.) Copeland comb. nov.

Trichomanes Vieillardii VAN DEN BOSCH, Ann. Sc. Nat. IV 15 (1861) 90; COPELAND, Trich. (1933) 171, pl. 17.

NEW CALEDONIA.

21. Genus CREPIDOMANES Presl

Crepidomanes PRESL, Epim. Bot. (1851) 258.
Taschneria PRESL, ibid.; COPELAND (as group), Trich. (1933) 174.

Cellulae parenchymatis magnae, seriales, rotundato-hexagonoideae, lateribus crassiusculis. Venae venulaeque distantes, simplices, costis conformes. Venula inframarginalis tenuis, continua. Reliqua ut in Eutrichomane.—PRESL, loc. cit. (etiam p. 17).

Epiphytica rarius terrestria, rhizomate filiforme late repente, piloso, radicibus saepe vel semper carentibus; frondibus mediocribus pinnatim dissectis (vel reductis digitatis), axibus plerisque alatis, segmentis angustis monophlebiis, margine integro nudo, striis sclerenchymaticis aut intramarginalibus aut irregulariter dispersis nunquam carentibus; soris typice axillaribus (paratactis), involucro obconico, vel campanulato, vel infundibuliforme, alato, ore bifido (rarissime symmetrice evoluto), receptaculo exserto.

An Old World genus of a dozen or more species ranging from the East African Islands to Japan and Polynesia. The striæ afford a convenient and sure diagnostic character, and the mouth of the involucre is bilabiate with the single exception of *C. Christii.* This combination of characters has been regarded as sufficient to establish affinity to *Didymoglossum,* with which this group was combined by van den Bosch. Prantl then restricted the application of the name *Didymoglossum* to this group, and renamed the real *Didymoglossum* as *Hemiphlebium.* Actually it is not *Didymoglossum,* but *Microgonium,* which has immediate affinity to *Crepidomanes.* Because *Microgonium* is evidently a group of reduced species, *Crepidomanes* is likely to have been the parent genus. I have thought [37] that *Crepidomanes* was "presumably derived from the group of *T. pyxidiferum,*" but am now as ready to share van den Bosch's view that it represents a coördinate evolutionary line, with some ultimate affinity to *Didymoglossum.* I do not believe, however, that the bilabiate mouth of the involucre betrays any real near affinity to *Hymenophyllum.*

The species are locally variable, and dwarfing is common. The series of dwarfs of various species converges with reduction, until the more extreme dwarfs of diverse origin tend to become indistinguishable. *T. Lenormandi,* which I list under *Microgonium,* is evidently a very reduced *Crepidomanes.*

SPECIES OF CREPIDOMANES

CHEPIDOMANES INTRAMARGINALE (H. and G.) Copeland comb. nov.

Trichomanes intramarginale Hooker and Greville, COPELAND, Trich. (1933) 189, pl. 23, figs. 1–3.

CEYLON; INDIA. The type species of the genus.

CREPIDOMANES BIPUNCTATUM (Poiret) Copeland comb. nov.

Trichomanes bipunctatum POIRET, Lam., Enc. 8 (1808) 69; COPELAND, Trich. (1933) 177, pl. 18, figs. 1–4.

Madagascar to Tahiti, with a gap in Malaya.

CREPIDOMANES BILABIATUM (Nees and Blume) Copeland comb. nov.

Trichomanes bilabiatum NEES and BLUME, Nova Acta 11 (1823) 123, pl. 13, fig. 2; COPELAND, Trich. (1933) 179, pl. 18, figs. 5, 6.

JAVA; SUMATRA.

CREPIDOMANES RUPICOLUM (Racib.) Copeland comb. nov.

Trichomanes rupicolum RACIBORSKI, Pterid. Buitenzorg (1898) 24; COPELAND, Trich. (1933) 181, pl. 19, fig. 2.

JAVA.

[37] Trich. (1933) 174.

CREPIDOMANES BREVIPES (Presl.) Copeland comb. nov.

Didymoglossum brevipes PRESL, Hymen. (1843) 139.
Trichomanes brevipes BAKER, Syn. Fil. 84; COPELAND, Trich. (1933) 182, pl. 20.

PHILIPPINES; GUAM; BORNEO.

CREPIDOMANES CHRISTII Copeland.

Trichomanes Christii COPELAND, Philip. Journ. Sci. 1 (1906) Suppl. 251; Trich. (1933) 185, pl. 21.

Philippines to Sumatra.

CREPIDOMANES VENULOSUM (Rosenst.) Copeland comb. nov.

Trichomanes bipunctatum var. *venulosa* ROSENSTOCK, Hedwigia 56 (1915) 350.
Trichomanes venulosum COPELAND, Trich. (1933) 186, pl. 22, figs. 1, 2.

NEW GUINEA.

CREPIDOMANES NYMANI (Christ) Copeland comb. nov.

Trichomanes Nymani Christ, SCHUM. and LAUT., Flora Südsee Nachtr. (1905) 36; COPELAND, Trich. (1933) 187, pl. 19, fig. 4.

NEW GUINEA.

CREPIDOMANES PERVENULOSUM (v. A. v. R.) Copeland comb. nov.

Trichomanes pervenulosum v. A. v. ROSENBURGH, Philip. Journ. Sci. § C 11 (1916) 103, pl. 5, fig. 2; COPELAND, Trich. (1933) 188, pl. 19; pl. 20, fig. 3.

AMBOINA.

CREPIDOMANES LATEMARGINALE (Eaton) Copeland comb. nov.

Trichomanes latemarginale EATON, Proc. Am. Acad. 4 (1859) 111; COPELAND, Trich. (1933) 189, pl. 24.

India to Formosa.

CREPIDOMANES MEGISTOSTOMUM Copeland.

Trichomanes megistostomum COPELAND, Trich. (1933) 191, pl. 23, figs. 4–6.

SIAM.

CREPIDOMANES LATEALATUM (v. d. B.) Copeland comb. nov.

Trichomanes latealatum VAN DEN BOSCH, Ned. Kruid. Arch. 5[2] (1863) 138; COPELAND, Trich. (1933) 192, pls. 25, 26.

INDIA.

There may be a considerable number of additional species in the Indo-Sino-Japanese region. More than a dozen have been named. I have seen authentic material of half of them and, comparing type collections only, would deem them distinct enough. Among most plants this would be a satisfactory test of specific identity. In this particular group, however, the characteristics embodied in the descriptions are subject to such wide variation, that I prefer not to risk encumbering synonymy with new combinations of names until the examination of many collections may show that the several supposed species do not too freely overlap as they vary. The examination of very many collections has shown that a number of "species" described from the Philippines and Java, apparently distinct if the types only are compared, are forms of the fairly protean *C. brevipes* and *C. bilabiatum.*

22. Genus MICROGONIUM Presl

Microgonium PRESL, Hymen. (1843) 111; VAN DEN BOSCH, Hymen. Javan. 5.
Hemiphlebium § *Microgonium* PRANTL, Hymen. 48.

Typice epiphytica, rhizomate filiforme, intricato, velutino, radicibus saepe vel semper carentibus; frondibus remotis, minimis, integris vel lobatis, margine nudo, venatione flabellata vel pinnata, venulis spuriis praeditis, vernatione planis; soris epitactis marginalibus, involucro elongato, ore expanso vix bilabiato, receptaculo extruso.

Range: Old World Tropics, one species apparently American.

Evidently derived, by reduction, from *Crepidomanes.*

SPECIES OF MICROGONIUM (SUBMARGINAL STRAND PRESENT)

MICROGONIUM BIMARGINATUM van den Bosch.

Microgonium bimarginatum VAN DEN BOSCH, Hymen, Javan (1861) 7.
Trichomanes bimarginatum VAN DEN BOSCH (1861); COPELAND, Trich. (1933) 208, pl. 33, figs. 1–4.

Malaya to Ceylon and Samoa.

MICROGONIUM MINDORENSE (Christ) Copeland comb. nov.

Trichomanes mindorense CHRIST, Philip. Journ. Sci. § C 3 (1908) 270; COPELAND, Trich. (1933) 209, pl. 34, figs. 1, 2.

MINDORO.

MICROGONIUM CRASPEDONEURUM Copeland.

Trichomanes craspedoneurum COPELAND, Philip. Journ. Sci. § C 7 (1912) 53; Trich. (1933) 208, pl. 33, figs. 5–7.

LUZON.

MICROGONIUM CUSPIDATUM (Willd.) Presl.

Microgonium cuspidatum (Willd.) PRESL, Hymen. 111, pl. 6*A*, the type of the genus.
Trichomanes cuspidatum WILLDENOW, Copeland, Trich. (1933) 210, pl. 32, figs. 6, 7.

East African Islands.

MICROGONIUM EROSUM (Willd.) Presl.

Trichomanes erosum WILLDENOW, Copeland, Trich. (1933) 210, pl. 34, figs. 3–6.

AFRICA.

Trichomanes lenormandi v. d. Bosch, of the Comores and Madagascar, belongs here by the original description; and *T. pygmaeum* C. Chr. clearly does so by definition.[38] But Christensen suspects that they are one species. And *T. Lenormandi* in its larger forms would better be regarded as a reduced *Crepidomanes.*

Related to this, but without any marginal vein, are *T. fulgens* C. Chr. and *T. Kirkii* Hooker, of the same region.

MICROGONIUM HOOKERI Presl.

Microgonium hookeri PRESL (1848).
Trichomanes hookeri PRESL, Hymen. 108, *non Didymoglossum hookeri* PRESL, ibid. 115.
Microgonium berteroanum PRESL, ibid. 112 *nomen,* 138, pl. 6*B.*

Cuba to Guiana. Submarginal strand absent.

MICROGONIUM SUBLIMBATUM (K. Müller) van den Bosch.

Microgonium sublimbatum (K. Müller) VAN DEN BOSCH, Hymen. Javan. 6, pl. 2.
Trichomanes sublimbatum K. MÜLLER, Copeland, Trich. (1933) 198, pl. 28, figs. 1, 2.

Assam to Papua.

MICROGONIUM HENZAIANUM (Parish) Copeland comb. nov.

Trichomanes henzaianum PARISH in Hooker, Second Cent. Ferns (1860) pl. 1; COPELAND, Trich. (1933) 198, pl. 28, figs. 3, 4.
Microgonium henzariense VAN DEN BOSCH.

MOULMEIN (or Tenasserim).

The involucre is obconic, but the false veins leave little doubt that this is a *Microgonium.*

MICROGONIUM MOTLEYI van den Bosch.

Microgonium motleyi VAN DEN BOSCH, Hymen. Javan. 5, pl. 1.
Trichomanes motleyi VAN DEN BOSCH, Copeland, Trich. (1933) 201, pl. 30, figs. 1–4.

BORNEO; MALAY PENINSULA; further range doubtful.

[38] Bonaparte, Notes Pterid. 12 : 13, pl. 10; Pterid. Madag. 2: figs.

MICROGONIUM BECCARIANUM (Cesati) Copeland comb. nov.

Trichomanes beccarianum CESATI, Atti Accad. Napoli 7 pt. 8 (1876) 8, pl. 1, fig. 2; COPELAND, Trich. (1933) 200, pl. 29.

Ceylon to Formosa and the Solomon Islands.

The key, p. 197, of my treatise on Trichomanes, is in error as to this species, but the latter is correctly distinguished from *T. cultratum* in the text.[39]

MICROGONIUM CULTRATUM (Baker) Copeland comb. nov.

Trichomanes cultratum BAKER, Journ. Bot. 17 (1879) 293; COPELAND, Trich. (1933) 202, pl. 30, figs. 5–7.

FIJI; QUEENSLAND.

MICROGONIUM OMPHALODES Viellard.

Microgonium omphalodes VIELLARD.

Trichomanes omphalodes C. Chr., COPELAND, Trich. (1933) 203, pl. 31, figs. 1–6.

Trichomanes peltatum BAKER (non Poiret) Journ. Linn. Soc. 9 (1866) 336, pl. 80; GIESENHAGEN, Hymen., figs. 14–26.

Java to Tahiti.

Hymenophyllum parvifolium Baker, Moulmein, was described by both Baker and Kuhn as having striæ, but no veins except the costæ. It may be a very small *M. henzaianum.*

Trichomanes Hildebrandtii Kuhn, from the Comores, apparently collected only once, and scantily, is superficially very like *M. omphalodes;* it is larger, but *M. omphalodes* is variable in size. I have specimens of *M. omphalodes* more than 25 mm in diameter, although 10 mm is a commoner size. The known range being from Tahiti to Java, extension to the African islands would not be surprising. However, Giesenhagen[40] has found, beside minor differences, that the lamina of *T. Hildebrandtii* is several cells thick, with the chlorophyll confined to the upper superficial layer. It is, of course, no *Trichomanes,* in my use of that name; but, without a specimen, I do not know whether or not it is a *Microgonium.*

In my treatises on Trichomanes and on Hymenophyllum I have had repeatedly to emphasize the fact that simplification in form, and eventually in structure, is a natural concomitant of reduction in size; and that, in the course of simplification, the characteristics which indicate affinity and ancestry may more

[39] Pages 202, 203. [40] Hymen. 449–452, figs. 1, 5.

or less completely disappear, with the result that reduced plants of diverse ancestry may be very much alike.

In *Didymoglossum* and *Microgonium* we are dealing with plants as reduced as we know in the family; and must recognize the fact that so far as the group of characters which have commonly served for specific diagnosis are concerned, descendants of almost any larger plants of the old genus *Trichomanes*, reduced to this point, might be regarded as conspecific. *Trichomanes muscoides* has been construed broadly and variously enough to illustrate this fact. Recognizing the difficulty of detecting real affinity among such reduced plants, I intended first to combine them, as *Didymoglossum,* and avow lack of confidence in the unity of such a genus. In particular the Oriental species have looked like derivatives of *Crepidomanes* (*Taschneria*), which is confined to the Old World, and I have hesitated to regard a pantropic group as derived from one of limited range and, therefore, presumably younger.

Study of the available American material, representing the generally accepted species, has now shown that they have a common significant character, in the possession of marginal setæ, which are wanting on all species of the Malay-Polynesian region. On the strength of this distinction, already emphasized by Prantl,[41] I now regard the Oriental group, without setæ, as genetically distinct, and related to *Crepidomanes,* which has much the same range. *Microgonium Hookeri* is the only species falling outside this geographic range, and I may be in error in including it; it may be a very aberrant member of *Didymoglossum.* However, the expanded, nonbilabiate involucre of *D. Petersii* arouses no doubt as to its affinity, any more than does the symmetrically expanded mouth of *Crepidomanes Christii,* in a genus otherwise characterized by somewhat bilabiate mouths.

23. Genus CALLISTOPTERIS Copeland gen. nov.

Epiphyticae, rhizomate valido adscendente; stipitibus caespitosis, teretibus, setosis; frondibus magnis, basi plus minus angustatis, quadripinnatifidis segmentis linearibus tenuiter membranaceis; parietibus tenuibus; involucris immersis, obconicis, ore truncato vel subbilabiato, receptaculo exserto.

Typus: C. apiifolia (Presl sub Trichomane).

[41] Hymen. 46.

A small, well-marked group, the showiest in the family.
Range: Malaya across Polynesia.

SPECIES OF CALLISTOPTERIS

CALLISTOPTERIS APIIFOLIA (Presl) Copeland comb. nov.

Trichomanes apiifolium PRESL, Hymen. (1843) 108, 136; VAN DEN BOSCH, Hymen. Javan. 26, pl. 19; COPELAND, Trich. (1933) 227, pl. 42, fig. 1.

Sumatra to Samoa.

CALLISTOPTERIS BAUERIANA (Endl.) Copeland comb. nov.

Trichomanes bauerianum ENDLICHER, Prod. Fl. Norfolk (1833) 17; COPELAND, Trich. (1933) 229, pl. 42, fig. 2.

NORFOLK; LORD HOWE ISLAND.

CALLISTOPTERIS POLYANTHA (Hooker) Copeland comb. nov.

Hymenophyllum polyanthum HOOKER, Nightingale, Oceanic Sketches (1835) 132.

Trichomanes polyanthum Hooker, COPELAND, Trich. (1933) 230, pl. 42, fig. 3.

Trichomanes societense[42] J. W. MOORE, Bishop Mus. Bull. 102 (1933) 5.

SOCIETY ISLANDS.

CALLISTOPTERIS BALDWINII (Eaton) Copeland comb. nov.

Hymenophyllum Baldwinii EATON, Bull. Torr. Bot. Club 6 (1879) 293.

Trichomanes Baldwinii COPELAND, Trich. (1933) 230, pl. 42, figs. 4–8.

HAWAII.

24. Genus NESOPTERIS Copeland gen. nov.

Terrestres, rhizomate valido suberecto, stipitibus caespitosis, longis, sursum anguste alatis ala decidua; frondibus magnis, quadripinnatifidis, basi vix angustatis, segmentis linearibus, costis pilis minutis clavatis obsitis; cellulis parvis, parietibus tenuibus rectis, involucris cylindricis alatis, receptaculis exsertis.

Typus: N. grandis (Copel. sub Trichomane).

A small, well-marked genus, superficially somewhat like *Selenodesmium,* with larger, less rigid, more finely dissected fronds, and very different structure. More like *Callistopteris,* from which it differs in the firmer texture, in habitat, pubescence, and

[42] This name is proposed on the ground that "*polyanthum*" is an orthographic variant of "*polyanthus*" which I do not believe. The Greek equivalent of "polyanthus" is "polyanthes." If Swartz had used that word, it would invalidate Hooker's specific name. Swartz made up his word; I am not sure what it is, but take it to be a noun used as an adjective. And a noun and an adjective are not orthographic variants.

shape of involucre. The three seem to be phyletically distinct, probably independently related to (derived from) the group of *Vandenboschia radicans*. *V. maxima* represents more definitely the source of *Nesopteris*.

Range: Loochoo and Java to Samoa; unknown on the continent, and hence named the island fern.

SPECIES OF NESOPTERIS

NESOPTERIS GRANDIS Copeland.

Trichomanes grande COPELAND, Philip. Journ. Sci. § C **6** (1911) 70; Trich. (1933) 224, pl. 40. figs. 1–4.
Trichomanes preslianum NAKAI, Bot. Mag. Tokyo **40** (1926) 261.

PHILIPPINES; JAVA.

NESOPTERIS THYSANOSTOMA (Makino) Copeland comb. nov.

Trichomanes thysanostomum MAKINO, Bot. Mag. Tokyo **12** (1898) 193 *nomen;* **13** (1899) 46.
Trichomanes blepharistomum COPELAND, Trich. (1933) 225, pl. 41.

LOOCHOO; LUZON.

NESOPTERIS INTERMEDIA (v. d. B.) Copeland comb. nov.

Trichomanes intermedium VAN DEN BOSCH, Ned. Kruid. Arch. **5** (1861) 179; Journ. Bot. Neerl. **1** (1861) 361; COPELAND, Trich. (1933) 226, pl. 40, fig. 5.

PAPUA; POLYNESIA.

NESOPTERIS SUPERBA (Backhouse) Copeland comb. nov.

Trichomanes superbum BACKHOUSE, Moore, Gard. Chron. (1862) 44; COPELAND, Trich. (1933) 221, pl. 39.

BORNEO.

25. Genus CEPHALOMANES Presl

Cephalomanes PRESL, Hymen. (1843) 109, pl. 5.

Venae pinnatim exorientes, creberrimae, prominulae, uni- bifurcatae, venulisque sterilibus apice obtuso liberae. Sorus in dentibus frondis obliteratis terminalis, pedicellatus. Indusium cylindraceum, limbo patente integro. Receptaculum indusio dimidio duplove longius, rectum, rigidulum, cylindricum, apice in globum incrassatum, basi capsuliferum. Capsulae sessiles, lenticulares.

Species. Cephalomanes atrovirens.—PRESL, loc. cit.

Terrestre, rhizomate valido adscendente vel erecto, radicibus validis obscuris sustenso; stipitibus dense fasciculatis, setosis, rigidis; fronde plerumque lanceolata, simplice pinnata, obscura, rigidula, venis crassis saepe in dentes vel lacinias ultra marginem protensis; cellulis magnis, parietibus in proportione tenuibus, undulatis; involucris cylindricis (rarius obconicis) rigidis, receptaculo crasso longe exserto.

A small and very natural genus of the Oriental Tropics, derived from the group of *Vandenboschia radicans*. *V. auriculata*, which I leave in the latter group, but which van den Bosch treated as *Cephalomanes*, illustrates the course of evolution of the daughter genus. The globose tip of the receptacle, responsible for the generic name, was illusory or very exceptional, although Presl depicted it for a second species, *C. oblongifolium*.[43]

Range: Malaya to India and across Polynesia.

SPECIES OF CEPHALOMANES

CEPHALOMANES JAVANICUM (Blume) van den Bosch.

Cephalomanes javanicum VAN DEN BOSCH, Hymen. Javan. 30, pl. 22.
Trichomanes javanicum Blume, COPELAND, Trich. (1933) 246, pl. 52, fig. 1.

Java to India (and Papua?).

CEPHALOMANES SINGAPORIANUM van den Bosch.

Cephalomanes singaporianum VAN DEN BOSCH, Synopsis (1859) 11.
Trichomanes singaporianum v. A. v. Rosenburgh, COPELAND, Trich. (1933) 247, pl. 52, fig. 5.

SINGAPORE; MALAY PENINSULA; BORNEO.

CEPHALOMANES SUMATRANUM (v. A. v. R.) Copeland comb. nov.

Trichomanes sumatranum v. A. v. ROSENBURGH, Bull. Dept. Agr. Ind. Neerl. No. 18 (1908) 4; COPELAND, Trich. (1933) 248, pl. 52, fig. 4.

SUMATRA; BORNEO; ANNAM.

CEPHALOMANES OBLONGIFOLIUM Presl.

Cephalomanes oblongifolium PRESL, Epim. Bot. 19, pl. 10.
Trichomanes asplenioides PRESL, Hymen. (1843) 129, *non* Swartz; KUNZE, Farnkr. 218, pl. 89; COPELAND, Trich. (1933) 249, pl. 52, fig. 2; pl. 55, fig. 10.

PHILIPPINES; AMBOINA; BORNEO; FORMOSA; SOLOMON ISLANDS.

CEPHALOMANES ATROVIRENS Presl.

Cephalomanes atrovirens PRESL, Hymen. (1843) 110, pl. 5, the generic type.
Trichomanes atrovirens Kunze, COPELAND, Trich. (1933) 251, pl. 52, fig. 3; pl. 55, fig. 2.

PHILIPPINES; NEW GUINEA; QUEENSLAND.

CEPHALOMANES DENSINERVIUM Copeland.

Trichomanes densinervium COPELAND, Philip. Journ. Sci. § C 6 (1911) 71; Trich. (1933) 253, pl. 53, fig. 1.

NEW GUINEA.

[43] Epim. Bot., pl. 10.

CEPHALOMANES KINGII Copeland.

Trichomanes Kingii COPELAND, Philip. Journ. Sci. § C 6 (1911) 72; Trich. (1933) 253, pl. 53, fig. 2.

NEW GUINEA.

CEPHALOMANES ACROSORUM Copeland.

Trichomanes acrosorum COPELAND, Philip. Journ. Sci. § C 6 (1911) 72; Trich. (1933) 254, pl. 53, fig. 3.

NEW GUINEA.

CEPHALOMANES BORYANUM (Kunze) van den Bosch.

Cephalomanes boryanum VAN DEN BOSCH, Synopsis (1859) 11.
Trichomanes boryanum KUNZE, Farnkr. 237, pl. 97; COPELAND, Trich. (1933) 254, pl. 52, fig. 4.

POLYNESIA.

Cephalomanes madagascariense van den Bosch, Synopsis 11, is a doubtful species; cf. Christensen, Pterid. Madagascar (1932) 5.

Trichomanes Foersteri Rosenstock, of Sumatra, is unknown to me.

Trichomanes crassum Copel.[44] is certainly *Cephalomanes*, but, being known sterile only, may be suspected of being hybrid or monstrous. LEYTE (Philippines).

26. Genus TRICHOMANES Linnæus

Trichomanes LINNÆUS, Sp. Plant. (1753) 1097.
Trichomanes § *Achomanes* PRESL, Hymen. (1843) 105.
Ragatelus PRESL, Hymen. (1843) 108.
Neurophyllum PRESL, Hymen. (1843) 110, *non* Torrey et Gray.
Odontomanes PRESL, Epim. Bot. (1849) 16.
Neuromanes TREVISAN (1851); VAN DEN BOSCH, Synopsis 7.
Ptilophyllum VAN DEN BOSCH (1861); PRANTL, *partim; non* Morris *nec aliorum.*
Lacostea VAN DEN BOSCH (1861); PRANTL, *pro parte minore.*

Although the era of our botanic nomenclature began with the publication of Linnæus' Species Plantarum in 1753, genera are not defined in that work. For Linnæan generic definitions and, therefore, for the typification of his genera, we must go to earlier works of the same author.[45] In the case of *Trichomanes* it is

[44] Trich. (1933) 256, pl. 54; pl. 55, fig. 3.

[45] The latest rule sends us to the next subsequent edition of the "Genera," but, to interpret the definition found there, we must still go back to the first edition, where the same definition is amplified by references which fix the type.

defined in the Corollarium Genera Plantarum (and, *teste* Underwood, in *Hortus Cliffortianus,* also dated 1937): "Calyx turbinatus, solitarius, erectus, ex ipso margine folii. Stylus setaceus capsulam terminans." No species is mentioned, but reference is made to Plumier[46] for an illustration. This is *Trichomanes crispum.* As Linnæus's generic concept finds its first expression here, and no other species is mentioned or referred to, this species must be accepted as the type species of the genus.

The genus typified by this species may be a small but natural one, pinnatifid or simply pinnate, mostly bearing long, soft hairs, with rather close veins tending to be parallel, restricted to the American Tropics, being then Presl's section *Achomanes,* van den Bosch's and Prantl's genus *Ptilophyllum;* or it can be a much larger, still natural, genus, including a number of such more or less definable groups, and found in all moist tropical and most warm-temperate regions. I use it in the former sense and diagnose it accordingly:

Typically terrestrial American ferns; fronds typically uniform, pinnatifid to pinnate in plan, false veinlets rarely present, and then between and parallel to the veins, lamina one cell thick except immediately along veins; involucre obconic to cylindric, the mouth truncate to expanded, but not valvate or bilabiate, receptacle slender and protruding; sporangia rather small, and with a limited number of wall cells.

That *T. crispum* is not congeneric with *T. scandens* L., *T. radicans* Sw., and *T. pyxidiferum* L. has been the belief of nearly every author who undertook to break the huge group called *Trichomanes* in the general treatises on ferns into smaller, natural genera. By the principles of the typification of genera now generally accepted, van den Bosch and Prantl erred in keeping the name for the larger, more primitive, cosmopolitan group of *T. radicans,* and introducing a new name, *Ptilophyllum,* for *Trichomanes* as properly typified. To this extent they had justification, that they left in *Trichomanes* the larger number of species. If, however, they had observed any rule at all, they would have adopted, for the group including *T. crispum,* Presl's name *Ragatelus,* based on the nearly related *T. crinitum,* in spite of the fact that Presl erected the genus on an erroneous figure and without seeing the plant. Presl based *Cephalomanes* on an equally baseless or imaginary character; but van den Bosch re-

[46] Fil. 86.

tained that genus and quoted Linnæus in justification: "Nomen genericum dignum alio, licet aptiore, permutare non licet." [47]

To place some limit on the number of new binomials which have to result from the typification of the genus by *T. crispum,* I have construed it as broadly as I could—except as it might include *Feea. Odontomanes* might, about as reasonably as *Feea,* be given generic status; the group is natural and definable, but its affinity to *T. crispum* is reasonably clear. And, if one would give generic status to every definable and apparently natural group, *Neuromanes* could be recognized, along with *Odontomanes.*

The reduction of *Ptilophyllum* and *Lacostea* to one genus is a somewhat different proposition. Van den Bosch and Prantl, who are responsible for both, were careful students of these ferns. Prantl laid particular stress on the system of branching and the position of the sori. Subordinating all other considerations to these, he divided the great group which might be called *Trichomanes,* after the elimination of such more clearly distinct, smaller, related groups as *Didymoglossum* (in the sense of Desvaux), into *Ptilophyllum, Lacostea,* and *Trichomanes,* the latter including *T. pyxidiferum* and *T. radicans.* Prantl's criteria are useful in some groups of ferns, but not here. *Lacostea* was to be characterized by anadromic venation and paratact sori, in distinction to *Ptilophyllum,* and limited dissection of the frond, in distinction to *Trichomanes.* He included in it *T. javanicum,* not knowing *T. asplenioides* Presl (properly *Cephalomanes oblongifolium*), which even until Christensen has been reduced to *T. javanicum,* although its sori are epitact. Among American species both van den Bosch and Presl placed *T. alatum* (as *P. ptilodes*) in *Ptilophyllum,* although to me it seems clearly to be close to *Lacostea* (*T. pedicellatum*); and also to *T. luschnatianum* (*T. rupestre*) which they left in *Trichomanes.* At this point, though, we come to what I regard as a likely genetic connection between my *Trichomanes* and that of Prantl, so that one has reasonable freedom of choice as to where he will leave *T. rupestre.*

Another character of generic value in many cases is the elongation of the rhizome, commonly correlated with the remoteness of the leaves, and with their arrangement, as distichous or polystichous. However good a generic character in many or

[47] Synopsis 10.

most groups, it is not even a specific character in others—*T. meifolium,* for example. In *Trichomanes* it will not serve even for natural subgeneric grouping. In the family in general the elongate rhizome is primitive. Regarding *Vandenboschia* as ancestral to *Trichomanes,* I suggest *T. ruprestre* as a primitive element in *Trichomanes,* as shown by both the slender, elongate rhizome and the dissection of the frond. But it does not appear that all species with clustered fronds, or all species with elongate rhizomes, constitute a natural group. Both types of rhizome appear even in *Feea,* derived from a *Trichomanes* group in which most of the species have the fronds clustered on a suberect rhizome.

Another feature of generic value in many cases, but not here, is hairyness, as hairs may be absent on the lamina, or present and of particular form. Most species of section *Ptilophyllum* bear long, weak hairs. This character is unstable also in *Vandenboschia* and *Feea.*

Range: Tropical America, extending a little beyond the Tropics.

SPECIES OF TRICHOMANES

Fronds bipinnatifid: Approximately *Lacostea* van den Bosch.

TRICHOMANES RUPESTRE (Raddi) van den Bosch.

Tropical South America.

T. venustum Desv. is a more divided form, from Central America.

TRICHOMANES ANKERSII Parker.

Trinidad to Brazil.

TRICHOMANES TANAICUM Hooker.

BRAZIL.

TRICHOMANES PEDICELLATUM Desvaux.

Tropical America (BRAZIL).

The three preceding species are *Lacostea;* the following three, called *Ptilophyllum,* seem to me to be as near to *Lacostea.*

TRICHOMANES ALATUM Swartz.

West Indies to Brazil. Stipes usually tufted, rarely subremote.

TRICHOMANES FIMBRIATUM Backhouse.

TRINIDAD; GUIANA.

TRICHOMANES ARBUSCULA Desvaux.

West Indies to Brazil and Peru.

TRICHOMANES ANADROMUM Rosenstock.

COSTA RICA.

Trichomanes bicorne Hooker is a more divided relative of *T. alatum,* from the Amazon; and *T. amazonicum* Christ is described as a local relative with less divided fertile fronds.

Fronds pinnate or pinnatifid, veins free: *Ptilophyllum* van den Bosch.

TRICHOMANES POLYPODIOIDES Linn.

Cuba and Mexico to Uruguay. Rhizome elongate.

TRICHOMANES CRINITUM Swartz.

Jamaica and Costa Rica to Ecuador.

TRICHOMANES CRISPUM Linnæus. Plate 8.

Cuba to Ecuador and Brazil. The type of the genus.

TRICHOMANES ACCEDENS Presl.

West Indies across Brazil.

TRICHOMANES SELLOWIANUM Presl.

Tropical America (BRAZIL).

TRICHOMANES CRISTATUM Kaulfuss.

Tropical America (BRAZIL).

TRICHOMANES GALEOTTII Fournier.

MEXICO; HONDURAS; CUBA.

TRICHOMANES PELLUCENS Kunze.

Tropical America (BRAZIL).

TRICHOMANES PILOSUM Raddi.

Guiana across Brazil.

TRICHOMANES LAXUM Kl.

Tropical America (BRAZIL).

TRICHOMANES LINDIGII Fournier.

COLOMBIA; BRAZIL.

TRICHOMANES LUDOVICIANUM Ros.

COSTA RICA.

Frond pinnate, veins cross-connected by false veinlets: *Neuromanes* Trev.

TRICHOMANES PINNATUM Hedwig.

Cuba and Mexico to Brazil.

TRICHOMANES VITTARIA D. C.

GUIANA; AMAZON.

Fertile frond simple. Frond pinnate, veinlets anastomosing: *Odontomanes* Presl.

TRICHOMANES HOSTMANNIANUM (Kl.) Kunze.

GUIANA; AMAZON.

I have enumerated, with one exception, only the species in hand; and suppose that all American species which have been referred to *Ptilophyllum* as genus or subgenus are correctly placed there. The Oriental species so referred by van Alderwerelt do not belong here. Prantl was likewise wrong, in principle as well as in form, in referring to *Lacostea* the Oriental *Cephalomanes.* The latter presents a most interesting example of evolution parallel in form to that of *Trichomanes,* the two originating independently in *Vandenboschia.*

27. Genus FEEA Bory

Feea BORY, Dict. Class. d'Hist. Nat. **6** (1824) 446; PRESL, Hymen., (1843) 102; VAN DEN BOSCH, Synopsis, 6.

Hymenostachys BORY, Dict. Class. d'Hist. Nat. **6** (1824) 588; **8** (1825) 462; PRESL, Hymen. (1843) 103.

Homoeotes PRESL, Abh. böhm. Ges. Wiss. V 5 (1848) 331 (not seen).

Trichomanes subgenus *Feea* et *Hymenostachys* HOOKER, Sp. Fil. **1** (1846) 114.

Trichomanes § *Feea,* HOOKER and BAKER, Syn. Fil. 71.

Ptilophyllum § *Homoeotes* et *Feea,* PRANTL, Hymen., 48.

Genus Trichomane (ex affinitate T. crispi) derivatum, terrestre, rhizomate aut brevi-repente aut suberecto et radicibus validis sustenso, stipitibus subremotis vel caespitosis; frondibus dimorphis, sterilibus lanceolatis profunde pinnatisectis (deorsum rarius pinnatis) segmentis integris, fertilibus linearibus; aliter Trichomane conforme.

Tropical America, from the Amazon basin to the Caribbean, one species extending into Central America and one into the West Indies.

SPECIES OF FEEA

FEEA HETEROPHYLLA (H. B. W.) Copeland comb. nov.

Trichomanes heterophyllum H. B. W. in Willdenow, Sp. Pl. **5** (1810) 503.

Homoeotes heterophylla PRESL.

Feea Humboldtii VAN DEN BOSCH, Ned. Kr. Arch. 4 (1859) 347.
Feea spruceana VAN DEN BOSCH, ibid.

Amazon basin, Guiana.

FEEA DIVERSIFRONS (Bory) Copeland comb. nov.

Hymenostachys diversifrons BORY, Dict. Class. d'Hist. Nat. 8 (1825) 462.
Feea Boryi VAN DEN BOSCH.

Guiana to southern Mexico and Bolivia.

FEEA TROLLII (Bergdolt) Copeland comb. nov.

Trichomanes Trollii BERGDOLT, Flora 127 (1933) 264, text figs.

BOLIVIA; GUIANA?

FEEA BOTRYOIDES (Kaulfuss) van den Bosch.

Trichomanes botryoides KAULFUSS.
Feea nana BORY, the type of the genus.

GUIANA; PANAMA; PERU.

FEEA OSMUNDOIDES (DC.) Copeland comb. nov. Plate 9.

Trichomanes osmundoides DC., in Poiret (Lam.) Enc. 8 (1808) 65.
Feea polypodina BORY, Dict. Class. d'Hist. Nat. 6 (1824) 446.
Feea spicata PRESL, Abh. böhm. Ges. V 5 (1848) 330.

Guiana to West Indies and Ecuador.

There remains *Trichomanes platyrachis* Domin, of Jamaica, which I have not seen. As it has been found but once, in a thoroughly collected locality, it seems likely to be an aberrant individual specimen of *F. osmundoides*.

These five species seem, with a sufficient measure of probability, all to be derived from the immediate group of *Trichomanes crispum;* as that species is construed in Species Filicum, they may all be derived from it. On the assumption that they represent a natural derived group, I treat them as one genus; but it must be conceded that this assumption is not as well grounded as is that of their common descent from a single group. That is, they may represent two, or even three, independent derived lines, from a common source.

Feea heterophylla, Presl's genus *Homoeotes*, has a somewhat elongate rhizome with seriate, not clustered, stipes. The fertile frond is pinnatifid, with numerous, closely placed, short, truncate segments, each (except near the apex of the frond) bearing several sori, which collectively form a border on the frond. Goebel[48] has clearly established its affinity to "*T. cris-*

[48] Flora 124 (1930) 381–388.

pum." I have several of the *Luetzelburg* specimens, and so know exactly what his *T. heterophyllum* is, but cannot so definitely locate his *T. crispum.* It was like *T. heterophyllum* in pubescence. As to the length of the rhizome, Goebel is silent. Broadly construed, *T. crispum* includes forms variable in pubescence and in the character of the rhizome—18 species of various authors, according to Synopsis Filicum, 25 by this time.[49]

Feea diversifrons (Bory's genus *Hymenostachys*) and *F. Trollii* have entire fertile fronds, the marginal sori sunk in the lamina. The pubescence is comparatively scant and uniform, distinct from that of *F. heterophylla,* but within the range of *T. crispum s. lat.* The rhizome is short and the fronds tufted, as in the typical *T. crispum.* This pair of species is treated in most detail by Bergdolt.[50]

Feea botryoides and *F. osmundoides* (Bory's genus *Feea*) have the lamina elided between the sori which stand side by side on an almost wingless rachis. The fronds are tufted on a suberect rhizome.

The fact that the plants I combine in a genus *Feea* show affinity to at least two groups of plants, whether or not the latter are well regarded as belonging in a single species, is not proof that my *Feea* is diphyletic or polyphyletic (except in the sense in which every human family becomes more so by amphimixis with each generation). Because dimorphism is a rare phenomenon in Hymenophyllaceæ, it seems probable that as a genetic change (or mutation), the nearly related plants which exhibit it result from one such occurrence. The difference in rhizome and in pubescence may be the result of parallel evolution—which Bergson might have expected to happen. More probably, in my own present view, they are due to hybridization.

Some species of *Feea* have conspicuous peculiarities not found in *T. crispum* or its immediate group. Thus *F. diversifolia* has the lamina of the fertile frond several cells thick. I treat this as an important generic characteristic of *Davalliopsis,* and as one such character of *Cardiomanes* and *Hymenoglossum,* but as of minor significance or utility in the cases of *Mecodium dilatatum* and its relatives. In the case of *F. diversifolia,* it looks like an almost inevitable mechanical consequence of the congestion of the sori. Other *Feea* species show a tendency to be more

[49] Maxon, Pterid. of Porto Rico (1926) 501.
[50] Flora 127 (1933) 251.

than one cell thick.[51] Striæ (false veinlets) occur in some species. *F. diversifolia* has veins excurrent from the costa, as in the group of *T. pinnatum.*

F. diversifrons and *F. Trollii* have anastomosing veins, a feature as unique in this family as is the dimorphism.

We have then a choice of three courses:

1. To leave these ferns in *Trichomanes.* Its ancestry is there, and there is some dimorphism at two other places in this parent genus.

2. To recognize two or three genera, here combined as *Feea.*

3. To treat the group of five species as one genus. I have chosen this course because it seems to give expression most conveniently to the noteworthy common characteristics of this group of related species.

It may be noted here, though the subject is a *Trichomanes,* that Christ referred to "Sect. Feea" his *T. amazonicum*[52] described as distinguished from *T. bicorne* Hooker, found at the same place, by having the fertile fronds bipinnatifid, while the sterile fronds, like all fronds of *T. bicorne,* are tripinnatifid. Christ injected this foreign element into *Feea,* and then condemned the latter for not being a natural group.

The remaining dimorphous *Trichomanes* is *T. Vittaria,* derived from *T. pinnatum.* It is the type of Presl's genus *Neurophyllum,* this name being untenable for it. It was characterized essentialy by the venation, and included *T. pinnatum.* Trevisan and van den Bosch called this group *Neuromanes,* but its proper name, if it is treated as a genus, is probably *Odontomanes.*

28. Genus DIDYMOGLOSSUM Desvaux

Didymoglossum DESVAUX, Prod. (1827) 330.

Didymoglossum PRESL, Hymen. (1843) 114; VAN DEN BOSCH, Synopsis 39, *partim.*

Hemiphlebium PRESL, Hymen. (1843) 117; PRANTL, Hymen. 45; *non Didymoglossum* VAN DEN BOSCH, Hymen. Javan. 35; *nec.* Prantl *ut sect. Trichomanes,* Hymen. 52.

Sori marginales exserti; sporangia sessilia receptaculo communi cylindraceo inserta; involucrum urceolatum ore hiante biligulatum. Habitus Trichomanidis.—DESVAUX, loc. cit.

Typice epiphytica, radicibus (an semper?) carentibus, rhizomate filiforme, intricato, velutino; frondibus remotis, aut parvis

[51] Mettenius, Abh. d. Math.-plys. Classe d. k. Sächs. Ges. Wiss. 7 (1864) 461.

[52] Hedwigia 44 (1935) 359.

aut minimus, pinnatifidis vel saepius integris, margine setiferis, venulis aut pinnatim aut flabellatim insertis, venulis spuriis interspersis; soris marginalibus, involucro elongato, ore typice bilabiato, receptaculo extruso.

Range: Tropical and subtropical America, across Africa to Ceylon, on trees and rocks in wet places.

The false veinlets and bilabiate involucre suggest affinity to *Crepidomanes,* which, however, is probably very remote; the marginal hairs, to *Sphaerocionium.* I suspect more real affinity to *Trichomanes* (*Lacostea*).

SPECIES OF DIDYMOGLOSSUM

DIDYMOGLOSSUM ROBINSONII (Baker) Copeland comb. nov.

Trichomanes Robinsonii BAKER, Journ. Linn. Soc. 9 (1867) 339, pl. 8 B.

Trichomanes montanum Hooker *non* Salisb. and *T. quercifolium* Hook. and Grev., *non* Desv. are synonymous or nearly so.

NATAL; MADAGASCAR; Tropical America.

DIDYMOGLOSSUM KRAUSSII (Hook. and Grev.) Presl.

Cuba to Brazil.

DIDYMOGLOSSUM REPTANS (Sw.) Presl.

WEST INDIES; VENEZUELA; COLOMBIA.

DIDYMOGLOSSUM HYMENOIDES (Hedwig) Copeland comb. nov.

Trichomanes hymenoides HEDWIG, Fil. Gen. et Sp. (1799) pl. 4, fig. 3.
Trichomanes muscoides SWARTZ (1801).
Didymoglossum muscoides DESVAUX, the type of the genus.

Jamaica to Brazil.

DIDYMOGLOSSUM PUNCTATUM (Poiret) Desvaux.

Cuba to Brazil.

DIDYMOGLOSSUM SPHENOIDES (Kunze) Presl.

Florida to Brazil.

DIDYMOGLOSSUM PUSILLUM (Sw.) Desvaux.

Cuba to Venezuela; the type of *Hemiphlebium.*

DIDYMOGLOSSUM SOCIALE Fée.

BRAZIL.

DIDYMOGLOSSUM CORDIFOLIUM Fée.

WEST INDIES; GUIANA.

DIDYMOGLOSSUM FONTANUM (Lindm.) Copeland comb. nov.

Trichomanes fontanum LINDM., Arkiv. Bot. 1 (1903) 44.

BRAZIL.

DIDYMOGLOSSUM PABSTIANUM (K. Müller) van den Bosch.

BRAZIL.

DIDYMOGLOSSUM LINEOLATUM van den Bosch.

Florida to Colombia. Without unconnected veinlets. *Trichomanes Curtii* Rosenstock, of Costa Rica, is hardly distinct.

DIDYMOGLOSSUM PETERSII (Gray) Copeland comb. nov.

Trichomanes Petersii GRAY, Am. Journ. Sci. II 15 (1853) 326.

Georgia to Mississippi. The involucre is not bilabiate.

DIDYMOGLOSSUM LIBERIENSE Copeland.

Trichomanes liberiense COPELAND, Trich. (1933) 160, pl. 9, figs. 316.

LIBERIA.

DIDYMOGLOSSUM EXIGUUM (Beddome) Copeland comb. nov.

Hymenophyllum exiguum BEDDOME, Ferns Brit. India (1868), pl. 275.
Trichomanes exiguum Baker, COPELAND, Trich. (1933) 205, pl. 32, figs. 1, 2.

CEYLON.

DIDYMOGLOSSUM WALLII (Thwaites) Copeland comb. nov.

Trichomanes Wallii THWAITES, Trimen, Journ. Bot. 23 (1885) 274; COPELAND, Trich. (1933) 206, pl. 32, figs. 3–5.

CEYLON.

Trichomanes Giesenhagenii C. Chr., Comores, evidently belongs here.

Trichomanes Barklianum Baker, Mauritius, may belong here, but is without false veins, and the involucre is not bilabiate.

In spite of a general indisposition to creating new binomials for species not known to me personally, I do so for the following three, because the identity of the species seems to be well established by the comparative and comprehensive study of Lindman.[53]

DIDYMOGLOSSUM MELANOPUS (Baker) Copeland comb. nov.

Trichomanes melanopus BAKER, Syn. Fil. (1874) 465; LINDMAN, loc. cit. 28, figs. 11–14.

ECUADOR.

DIDYMOGLOSSUM MOSENII (Lindm.) Copeland comb. nov.

Trichomanes Mosenii LINDMAN, loc. cit., 46, figs. 25 *D, E;* fig. 27.

BRAZIL.

[53] Ark. för Bot. (1903) 7–55.

DIDYMOGLOSSUM MYRIONEURON (Lindm.) Copeland comb. nov.

Trichomanes myrioneuron LINDMAN, loc. cit., 48, figs. 25, *E–I*, 28, 29.

GUIANA; BRAZIL; COSTA RICA?

VENEZUELA.

T. goebelianum Gies., another "smallest of all ferns," the frond 2.5 to 3 mm long, is a *Didymoglossum* with aberrant involucre, obconic, half-immersed, with broad, unbordered lips.

29. Genus LECANIUM Presl [54]

Lecanium PRESL, Hymen. (1843) 103, pl. 1.

Costa nulla. Venae flabellatae, creberrimae, subparallelae, pluries furcatae, crassiores apice soriferae. Venulae tenuissimae in superiori parte frondis libere exorientes et squamas duas oppositas supramarginales pateraeformes patentes gerentes. Sorus intramarginalis, immersus. Indusium lineari-cylindricum, elongatum, limbo hypocraterimorpho patente crenulato. Capsulae receptaculo filiformi indusium longe excedenti undique affixae, sessiles, angulato-lenticulares, valde excentrice (pone marginem) affixae.

Species. Lecanium membranaceum (Trichomanes membranaceum L.).

—PRESL, loc. cit.

The genus was maintained by van den Bosch in his Bijdrage, and placed in his suborder Diploophyllaceæ. Prantl [55] treated it as a subgenus of his *Hemiphlebium*. All other authors have left it in *Trichomanes*.

[54] The validity of this name is challenged on two grounds: That *Achomanes* Necker is an older name, validly published, and appropriate; and that *Lecanium* Presl (1843) is invalidated by *Lecanium* Reinwardt (1825). As to the first: *Achomanes* Necker does seem to have been published properly under the Revised Statutes of 1930, for the first time since we had rules backed by the authority of a Congress. No species was ever named in the genus. It would have included several of the genera of later writers, and Presl, Hymenophyllaceae 107, made a competent election among these; he restricted it (with the status of a section) to that one group, explicitly included by Necker, which is typical *Trichomanes*, typified by *T. crispum*. The same rules which for the current decade validate Necker's publication of the genus thus make it an absolute synonym of *Trichomanes*.

As to *Lecanium* Reinwardt: Reinwardt in 1824 named a genus *Onychium*, typified by *O. carnosum*. His attention being called to the prior use of this name by Kaulfuss (1820), he immediately (Flora (1825) 3. Beilage, 48) suggested *Lecanium* as a substitute, and went on to suggest that *Lecanopteris* would be preferable, not being subject to confusion with *Lecanora*. The publication of both names, as synonyms, being thus avowedly tentative, both fall under Rule 40 of the Statutes of 1930. Blume (1828) validated *Lecanopteris*, as correctly shown by the citation in Christensen's Index; and *Lecanium* Reinwardt did not and does not legally exist.

[55] Page 76.

Fronds of more than one layer of parenchyma were first ascribed to this plant by Müller,[56] and this was agreed to by van den Bosch. As shown by Müller, by Mettenius,[57] and by Giesenhagen,[58] plural cell layers are not everywhere present. The adult plant[59] (Plate 10) is without roots, using metamorphosed shoots as substitutes.

Somewhat isolated in the foregoing respects, the genus is unique in its marginal scales, correctly described by Presl and figured by Müller, wrongly (as pelate) by Hooker,[60] inaccurately by Giesenhagen as spiral or snail-shaped, and most completely by Mettenius[61] and by Maxon,[62] "A pair of concave, cordate-orbicular, sessile, opposed, membranous squamules, these closely bordering the younger and smaller blades, deciduous in the larger ones." They are borne on the joint apices of two or more false veinlets, between each pair of true veinlets. They apparently serve (Giesenhagen) to hold water in the space they inclose, or eventually to maintain a measure of humidity about the thin and tender margin of the young fronds.

Range: The West Indies, and from Nicaragua to Bolivia and Venezuela.

30. Genus SELENODESMIUM Copeland gen. nov.

Trichomanes § *Selenodesmium* PRANTL, Hymen. (1873) 53.

Folia polysticha, lamina triangularis, petioli fasciculus sect. transv. semilunaris diarchus; paleae peltatae.—PRANTL, loc. cit.

Rhizomate valido, ad terram brevi-repente vel suberecto, stipitibus approximatis vel caespitosis, elongatis setis brevibus obscuris deciduis vestitis; frondibus basi acutis plus minus rigidis, pinnulis semidissectis parte mediale plerumque integra cum venis parallelis, venis deinde in segmenta monophlebia divergentibus: parietibus cellularum crassis conspicue vittatis, rarius undulatis; involucris cylindraceis ore haud bilabiato, receptaculo valde exserto.

A well-defined pantropic group of ill-defined species. The name probably refers to the "semilunar" cross section of the

[56] Bot. Zeit. 3 (1845) 577, pl. 4.
[57] Page 460, pl. 1, figs. 10, 11.
[58] Page 444, figs. 4, 8.
[59] Giesenhagen, 444, 445.
[60] Exotic Flora, pl. 76.
[61] Hymen. 469.
[62] Pterid. of Porto Rico, 498.

bundle of the stipe. *Trichomanes rigidum* Sw. is the type species, but the genus reaches its "more typical" development in the Malay-Polynesian region, where the remarkably thick and pitted walls and deltoid fronds are its best diagnostic characters. In America the fronds are less harsh and the walls more or less zigzag, as is true of young (and rare aberrant) Oriental specimens. The plants are strictly terrestrial and intolerant of desiccation. Stout proproots commonly support the stems of old plants above the surface of the ground. In spite of past confusion of the species, I see no evident affinity between this group and *Nesopteris*.

SPECIES OF SELENODESMIUM

SELENODESMIUM RIGIDUM (Sw.) Copeland comb. nov.

Trichomanes rigidum SWARTZ, Prod. (1788) 137.

Tropical America (JAMAICA).

SELENODESMIUM MANDIOCCANUM (Raddi) Copeland comb. nov.

Trichomanes mandioccanum RADDI, pl. Brasil. 1 (1825) 64.

BRAZIL; ? AFRICA.

SELENODESMIUM BATRACHOGLOSSUM Copeland.

Trichomanes batrachoglossum COPELAND, Trich. (1933) 244, pls. 50, 51, figs. 1, 2.

LIBERIA.

SELENODESMIUM CUPRESSOIDES (Desv.) Copeland comb. nov.

Trichomanes cupressoides DESVAUX, Prod. (1827) 330; COPELAND, Trich. (1933) 242, pl. 49.

East African Islands; ? AFRICA.

SELENODESMIUM STYLOSUM (Poir.) Copeland comb. nov.

Trichomanes stylosum POIRET, Lam. Enc. 8 (1808) 82; COPELAND, Trich. (1933) 243, pl. 51, figs. 3–5.

East African Islands.

SELENODESMIUM OBSCURUM (Blume) Copeland comb. nov.

Trichomanes obscurum BLUME, Enum. (1828) 227; VAN DEN BOSCH, Hymen. Javan. 23, pl. 17; COPELAND, Trich. (1933) 233, pls. 43, 44.

Java to India, Formosa, and Papua.

SELENODESMIUM EXTRAVAGANS Copeland.

Trichomanes extravagans COPELAND, Trich. (1933) 240, pl. 48.

LUZON.

SELENODESMIUM DENTATUM (v. d. B.) Copeland comb. nov.

Trichomanes dentatum VAN DEN BOSCH, Ned. Kruid. Arch. 51 (1861) 182; Journ. Bot. Neerl. 1 (1861) 363; COPELAND, Trich. (1933) 237, pls. 45, 46.

POLYNESIA.

SELENODESMIUM ELONGATUM (A. Cunn.) Copeland comb. nov.

Trichomanes elongatum A. CUNN., Comp. to Bot. Mag. 2 (1836) 368; HOOKER, Ic. Pl. pl. 701; COPELAND, Trich. (1933) 239, pl. 47, figs. 1, 2.

NEW ZEALAND; eastern Australia.

SELENODESMIUM LONGICOLLUM (v. d. B.) Copeland comb. nov.

Trichomanes longicollum VAN DEN BOSCH, Ann. Sc. Nat. IV 15 (1861) 90; COPELAND, Trich. (1933) 240, pl. 47, figs. 3–5.

NEW CALEDONIA.

31. Genus DAVALLIOPSIS van den Bosch

Davalliopsis VAN DEN BOSCH, Eerste Bijdrage (1861) 323.

Terrestris, rhizomate crasso adscendente, stipitibus caespitosis, elongatis, validis, sulcatis, fasciculis triangularibus; fronde egregie magna, tri-quadripinnatifida, basi acuta, lamina stratis tribus cellularum composita; involucro infundibuliforme ore expanso, receptaculo exserto.

Probably a single species, of tropical America.

DAVALLIOPSIS ELEGANS (Rich.) Copeland comb. nov. Plate 11.

Trichomanes elegans RICH., Act. Soc. Hist. Nat. Paris 1 (1792) 114.

Van den Bosch established this genus imperfectly, publishing no specific name under it; but his name fortunately was retained for subgeneric or section use by Prantl and Christensen.

The three-layered lamina [63] is the best diagnostic character of *Davalliopsis*. Such affinity as I see ground for suspecting is to *Selenodesmium;* but the wall structure of the latter is distinct, and the resemblance may be superficial.

Christensen says of *T. pachyphlebium* C. Chr. "Its nearest relative seems to be the American *T. elegans* Rich." [64] If it be indeed a *Davalliopsis*, it presents a case parallel to that of *Didymoglossum*, of possible Antarctic origin and escape by way of the Cape.

32. Genus MACROGLENA Copeland gen. nov.

Trichomanes, § *Macroglena* PRESL, Abh. böhm. Ges. Wiss. V 5 (1848) 333.

[63] Mettenius, pl. 4, figs. 1–4.

[64] Bonaparte, Notes Pterid. 12 (1920) 16, fig. 5; Pterid. Madag. 6.

Terrestres et epiphyticae, rhizomate valido, elongato vel breve, stipitibus remotis, confertis vel caespitosis; fronde majuscula pinnatim decomposita, axibus angustissime alatis segmentis deinde anguste linearibus vel setiformibus, rigidis; soris pantotactis, receptaculo cupuliforme vel rarius elongato, plerumque truncato nunquam bilabiato, receptaculo exserto.

Typus, M. meifolia (Bory sub Trichomane).

Range: Old World Tropics, south to New Zealand and Madagascar.

The extremely narrow (or eventually wanting) lamina, which is the conspicuous characteristic of this genus, is obviously not a primitive character, but may with confidence be regarded as the result of reduction. As has repeatedly to be noted, reduction is likely to result in similarity of plants of diverse ancestry. There are American species of *Vandenboschia* (*Leptomanes*) which are reduced in the same manner; these are distinguished from *Macroglena* by texture, and are not subject to confusion with it. But it may be that in the Orient or South, also, this kind of reduction has occurred in more than one line, and that thus I have been led to include here some species not nearly enough related to belong in one genus.

As I construe the genus, it includes *T. strictum* of New Zealand, and is old enough to be of direct Antarctic origin. I would rather believe that the Madagascar species are of Antarctic origin independent of *T. strictum;* and *T. angustatum* of Tristan d'Acunha, which I do not know, may survive as a third independent escape from Antarctica. Some species seem to be related to *Selenodesmium*, this being indicated by cell structure rather than by form of frond. I regard the two genera as cognate, rather than as derived one from the other.

Macroglena as a genus is unspecialized either as to the length of the rhizome or the structure of the cell walls—items usually characteristic of genera in this family. The type species has undifferentiated walls, but its stipes range from remote to congested.

SPECIES OF MACROGLENA

MACROGLENA MEIFOLIA (Bory) Copeland comb. nov.

Trichomanes meifolium Bory, WILLDENOW, Sp. Pl. 5 (1810) 509; KAULFUSS, Enum. 265, pl. 2; CHRISTENSEN, Pterid. Madagascar (1932) 7, pl. 1, figs. 18–20; COPELAND, Trich. (1933) 265.

Christensen regards this species as confined to Madagascar and Réunion. As I construe it, more broadly, including *T. Pluma* Hooker, it ranges also from Malaya to Samoa.

MACROGLENA PARVIFLORA (Poiret) Copeland comb. nov.

Trichomanes parviflorum Poiret, LAMARCK, Enc. 8 (1808) 83; CHRISTENSEN, Pterid. Madag. (1932) 7, pl. 1, figs. 10–13.

MASCARENES; farther range, to Polynesia, in doubt.

MACROGLENA ANGUSTIMARGINATA (Bonaparte) Copeland comb. nov.

Trichomanes angustimarginatum BONAPARTE, Notes Pterid. 16 (1925) 12; CHRISTENSEN, Pterid. Madag. (1932) 7, pl. 1, figs. 14–17.

MADAGASCAR.

MACROGLENA GEMMATA (J. Sm.) Copeland comb. nov.

Trichomanes gemmatum J. SM., Hooker's Journ. Bot. 3 (1841) 417; BAKER, Syn. Fil. (1867) 87; COPELAND, Trich. (1933) 269, pl. 61, fig. 2.

MALAY PENINSULA; BORNEO.

MACROGLENA SETACEA (v. d. B.) Copeland comb. nov.

Trichomanes setaceum VAN DEN BOSCH, Ned. Kr. Arch. 5^2 (1861) 176; COPELAND, Trich. (1933) 260, pl. 57, fig. 1.

MALAY PENINSULA; BORNEO; PHILIPPINES.

MACROGLENA COMPACTA (v. A. v. R.) Copeland comb. nov.

Trichomanes compactum v. A. v. ROSENBURGH, Nova Guinea 14 (1924) 57; COPELAND, Trich. (1933) 265, pl. 49.

NEW GUINEA.

MACROGLENA ASAE-GRAYI (v. d. B.) Copeland comb. nov.

Trichomanes Asae-Grayi VAN DEN BOSCH, Ned. Kr. Arch. 5^2 (1861) 180; COPELAND, Trich. (1933) 264, pl. 61, fig. 1.

FIJI; SAMOA; TAHITI.

MACROGLENA FLAVO-FUSCA (v. d. B.) Copeland comb. nov.

Trichomanes flavo-fuscum VAN DEN BOSCH, Ann. Sc. Nat. IV 15 (1861) 88; COPELAND, Trich. (1933) 264, pl. 58, fig. 2.

NEW CALEDONIA.

MACROGLENA SCHLECHTERI (Brause) Copeland comb. nov.

Trichomanes Schlechteri BRAUSE, Bot. Jahrb. 49 (1912) 10; COPELAND, Trich. (1933) 268, pl. 60.

NEW GUINEA.

MACROGLENA LAETA (v. d. B.) Copeland comb. nov.

Trichomanes laetum VAN DEN BOSCH, Ann. Sc. Nat. IV 15 (1861) 90; COPELAND, Trich. (1933) 261, pl. 57, fig. 2.

NEW CALEDONIA.

MACROGLENA CAUDATA (Brack.) Copeland comb. nov.

Trichomanes caudatum BRACKENRIDGE, U. S. Expl. Exped. 16 (1854) 256, pl. 36, fig. 5; COPELAND, Trich. (1933) 262, pl. 57, figs. 3–5; pl. 58, fig. 1.

Tahiti to Queensland.

MACROGLENA STRICTA (Menzies) Copeland comb. nov.

Trichomanes strictum MENZIES, Hooker and Greville, Ic. Fil. (1831) pl. 122; COPELAND, Trich. (1933) 259, pl. 56, figs. 3, 4.

NEW ZEALAND.

33. Genus ABRODICTYUM Presl

Abrodictyum PRESL, Hymen. (1843) 112, pl. 7.

Epiphyticum ad truncos filicum, rhizomate breve, parvo, stipitibus dense caespitosis, basi setosis, teretibus; fronde mediocre bipinnatifida vel subtripinnatifida anguste elliptica, pendente, segmentis linearibus; cellulis (marginalibus exceptis) transversim elongatis, et oblique longitudinaliter instructis, parietibus conspicue vittatis; involucro infundibuliforme limbo patente receptaculo setaceo valde elongato.

A single species, without particular evident affinity, common on tree-fern trunks in the Philippines, and reported from Celebes (Kjellberg and Christensen) and the Moluccas (van den Bosch).

Van den Bosch altered the name to *Habrodictyon.*

SPECIES OF ABRODICTYUM

ABRODICTYUM CUMINGII Presl.

A large majority of the species of the Hymenophyllaceæ are found in the moist Tropics. In this sense only, the statement of Sadebeck, is correct: "Das Centrum der geographischen Verbreitung ist in den Tropen." [65] The origin of the family, as it now exists, was Austral. Sadebeck notes that New Zealand is "fast ein zweites Centrum"; and both he and Christ, as others before them, note the wealth of these plants in Antarctic America. But these conditions seem to have been interpreted as evidence that ferns of tropic origin find there a sufficiently uniform humidity and temperature. Like the Gleicheniaceæ and *Blechnum,* as to both of which Diels notes how far south they "vordringen," the Hymenophyllaceæ present most perfect geographic evidence of Antarctic origin, and of migration into, not from, the Tropics.

The Hymenophyllaceæ constitute about one fourteenth of the world's fern species, and this proportion may rise to about one in twelve in the Tropics. This is the closest whole number for Borneo and Java. Eastward migration from the Malay

[65] Nat. Pflanzenfamilien. Teil I Abt. 4 (1902) 104.

region is always assumed to be responsible for the bulk of the fern population of Polynesia. In Fiji and the Society Islands the proportion of Hymenophyllaceæ rises slightly, to one in ten. Diversion of this migration to the northeast extended it to Hawaii; to the southeast (if it occurred), to New Zealand. This is the process pictured by "vordringen," and if the picture were correct, the composition of the fern floras of Hawaii and New Zealand should correspond reasonably to that of Malaya, for the climatic conditions of both permit the filmy ferns to thrive. Actually, they are one in eighteen of all Hawaiian [66] ferns and one in five in New Zealand. Going south in New Zealand, the proportion continues to rise, reaching one in three in the Stewart Islands.[67] Ten species of *Hymenophyllum* are reported (Cockayne, Holloway) even from the Auckland Islands, beyond 50° south latitude. In the Northern Hemisphere the climate of the wet side of southern New Zealand is duplicated, at the same latitude, from Portland to Sitka, but Hymenophyllaceæ are totally absent.

In far southern America, in the narrow strip west of the Andes, the climatic conditions of New Zealand are sufficiently duplicated, and there is a similar wealth of species of filmy ferns, although few species are common to New Zealand.[68] As this area, being continental, can be given only an arbitrary northern limit, I have not tried to determine the proportion of Hymenophyllaceæ to all ferns; but it will correspond roughly to southern New Zealand. Juan Fernandez is an outlying fragment of this region, and its Hymenophyllaceæ (Christensen and Skottsberg, 1920), are fifteen out of forty-nine ferns, not quite one in three. In the Falkland Islands they seem to be three out of five.

[66] The Hawaiian climate, as a whole, is less appropriate to these ferns than that of New Zealand, but there are sufficient areas that are perfectly suitable. Hawaiian Polypodiaceæ, as a whole, are obviously of Malayan origin. Of the eight Hymenophyllaceæ, only *Gonocormus minutus* and *Callistopteris Baldwinii* suggest possible Malayan origin; the others are endemic: *Vandenboschia davallioides* and *V. cyrtotheca*, apparently American in affinity; *V. draytoniana* and *Mecodium recurvum*, far southern; and two species of *Sphaerocionium*, Antarctic (New Zealand) rather than anything else.

[67] Holloway, Trans. N. Z. Inst. 55 (1924) 84.

[68] The exact number is a question of specific identity. *Hymenophyllum tunbridgense*, *H. peltatum*, and *Sphaerocionium aeruginosum* are represented by forms which have been regarded as specifically identical.

South Africa seems never to have been as near to Antarctica as New Zealand and America have been, and its present climate would not permit a rich hymenophyllaceous flora, if it ever had one. *Mecodium rarum, H. tunbridgense,* and *H. peltatum* are represented by identical, or very similar plants in New Zealand and South Africa. *Sphaerocionium Lyallii* and *S. Marlothii* are nearly related. *Didymoglossum Robinsonii,* first described under this specific name from Natal, is the most southern representative of its genus. If, by analogy with other genera, we impute direct Antarctic origin to *Didymoglossum,* it is the only genus (except, possibly, *Davalliopsis*) that seems to have escaped from Antarctica by this route only; and this will explain its unique present range—America, Africa, and eastward only as far as Ceylon. Nothing in the family in South Africa seems, with much probability, to have had a northern origin. Because of the paucity of species, this rather negative statement is all that is possible. The comparative absence of immigrants from Antarctica must be responsible for the paucity of the family in all Africa and its islands.[69] According to Kuhn's old figures the proportion to all ferns is one in eighteen. Even this low proportion is reached by including St. Helena and Tristan d'Acunha which may well have received their filmy ferns directly from Antarctica.

The inability of tropical Hymenophyllaceæ to migrate from the Tropics is attested by their paucity in the North—five species in the United States (three of which reach only to southern Florida), and three in Europe. The Japan region has more, but not nearly as many as have been described. This must be a recent element in the Japanese flora, or it should have reached America when the North Pacific climate was more favorable.

The diversity of far southern Hymenophyllaceæ presents evidence of Antarctic origin as conclusive as that of wealth of species. In the first place, every genus common to America and Malaya, unless it be *Microgonium,* occurs in New Zealand, and all others except *Selenodesmium* in South Chile. As to *Microgonium,* it is doubtful whether its one American species, *M. Hookeri,* really belongs in the genus. With the genera *Hymenophyllum, Meringium, Mecodium, Sphaerocionium, Vandenboschia,* and *Selenodesmium,* New Zealand has also *Crepidopteris*

[69] Fil. Africa (1868).

of wide range. I cannot now authenticate the statement in my treatise on Trichomanes,[70] that *T. bipunctatum*, a *Crepidomanes*, is in New Zealand; it is common in southern Polynesia, and thence in Madagascar. Besides these large genera, New Zealand has *Cardiomanes*, altogether isolated, *Polyphlebium*, related to *Vandenboschia*, and *Apteropteris*, probably derived from *Sphaerocionium*. *Diploophyllum* (with another name) may be added to this list if one choose to recognize it as a genus.

Antarctic America is still richer in peculiar species and genera. With its outlying islands it has *Serpyllopsis*, which has been referred to both *Trichomanes* and *Hymenophyllum*. *Hymenoglossum* is as isolated as *Cardiomanes*. *Leptocionium* shares the characteristics of *Meringium* and *Sphaerocionium*.

There survive then at least six genera restricted to the far South. Of the genera which either never were there or do not survive there, only *Didymoglossum* and *Microgonium* are on both sides of the Atlantic. *Didymoglossum* has a representative in Natal, which suggests Antarctic origin; it does not reach Malaya and Polynesia. *Microgonium* is doubtfully in America.

The genera which do not occur in the far South can be derived from those which survive there, in each hemisphere, locally, from the local representatives of the originally Antarctic genera, with the single possible exception of *Abrodictyum*, which may be derived from *Selenodesmium*, but is more isolated than any other tropical genus. With this single possible exception, then, the entire family consists of genera surviving in the far South, or of the descendants of these genera. The geographic evidence is conclusive.

Evidence that Antarctica could have been the source of the family still remains to be presented, since the Antarctic continent is not now a place where any fern survives. There is not much palæontological evidence on the subject, but two quotations may suffice as to the general fact. In the Glaciology of Wright and Priestly, a volume of the report of the British Antarctic Expedition, it is stated in italics: "Glacial conditions have been the exception and not the rule in Antarctica." [71] And "In the upper Oligocene or lower Miocene, once more a temperate to subtropical flora holds sway over some portion of the Antarctic Continent." [72] No approximately complete land con-

[70] Page 177. [71] (1922) 44. [72] Op. cit., 446.

nection is necessary for the dispersal of these plants. In the absence of fossils, the evidence of suitable climate is all that can be expected. If the Hymenophyllaceæ of today are the descendants of Oligocene migrants from Antarctica, the elapsed time must have sufficed, by its length, for their present dispersal and diversification; and, by its shortness, to account for their limited northern dispersal, and for the absence elsewhere of such very divergent or generalized (*Serpyllopsis*) genera as are found in the far South.

The pantropic genera are *Mecodium, Sphaerocionium, Hymenophyllum, Meringium, Vandenboschia,* and *Selenodesmium,* with which *Didymoglossum* may be included, although wanting in the far eastern region. These are all found now in the far South, where their surviving species are traces of the path of their migration to the Tropics. They were evidently differentiated as genera in Antarctica, and this cannot have occurred later than early Miocene. It may have been earlier, but not indefinitely earlier.

During the warm era which ended in the Miocene, these genera presumably became differentiated and were able to emigrate. The change at the end of that era did not drive them out, except as possibly subantarctic land became habitable under the influence of the Antarctic refrigeration. Directly, the Antarctic cold merely exterminated whatever was there, very likely including older, more primitive forms which, if they had survived would let us construct the trunk of the hymenophyllaceous genealogical tree, of which we now have only these main branches, some comparatively abortive branches represented by the small genera of the far South, and the more recent branches (of the main branches), represented by the tropical genera of limited distribution.

The still earlier history of the family is more a matter of speculation, unsupported, I suspect, by any fossil evidence whatever. Its locus may have been Antarctica from the time the phylum became identifiable. That there is no living representative which is unlikely to have had an Antarctic ancestor, creates a presumption against an original differentiation of the family in some other region.

Of course, the family had ancestors. These are homosporous leptosporangiate ferns, of the same general evolutionary status as Gleicheniaceæ and Schizaeaceœ, newer and "higher" than Osmundaceæ, less perfectly evolved so far as the characters of the family as a whole are concerned than the Polypodiaceæ, and probably older than most of the polypodiaceous genera.

The general structural simplicity of the fronds, reminiscent of the mosses, was once responsible for the opinion that the Hymenophyllaceæ were related to the mosses and were the most primitive ferns. The last exponent of this view was Prantl, who held it after it ceased to be reasonable. It is more curious and less reasonable to find Goebel supporting the same opinion as to the gametophyte, even in recent years. The protonema of "*Trichomanes*" is more like that of mosses than is the corresponding structure of "*Hymenophyllum,*" and he regards the branched, nonthalloid protonema as the phylogenetically oldest form of the hymenophyllaceous prothallium. However complete the apparent identity of the protonema of "*Trichomanes*" and a moss, it is not evidence of affinity unless the gametophyte has an ancestry distinct from that of the sporophyte, and to a group, the Musci, far aside from the accepted line of fern evolution. The protonema is the least primitive gametophyte in the family, just as the minute fronds of *Microgonium*, which Prantl regarded as the most primitive sporophytes, are really the least so.

The Hymenophyllaceæ had fern ancestors. Their evolution as a family was a phenomenon of reduction, on a scale for which there is no parallel among independent (holophytic) vascular plants. On the scale of one small genus we know similar reduction of the leaf tissue in *Leptopteris*. On the scale of one tissue we know aquatics which have lost their stomata. But no other considerable family has lost the tissue differentiation of the plant leaf. And this is a fairly successful family, judged by the area it occupies, and by its wealth of genera and species and individuals. It evidently fits well a set of conditions—high humidity, weak illumination, still air—common, especially in the Tropics. Except as man may destroy its environment by removing the forest, it is not at all a waning family. Its prosperity, with its simplified leaves, throws instructive light on the conditions responsible for the evolution of the ordinary leaf and its tissues.

Within the family reduction continues to be the most interesting phenomenon of general evolution. *Craspedophyllum, Microtrichomanes, Didymoglossum,* and *Microgonium* are genera in whose evolution reduction in size, correlated with inevitable simplification in form, has been the most conspicuous element. Without transgressing the generic limits I recognize, reduction of the same kind has been conspicuous in *Mecodium, Sphaerocionium, Meringium, Cephalomanes, Didymoglossum, Microtrichomanes,* and *Vandenboschia.* Very many species are exceedingly plastic in the same respect, a fact responsible for a very large number of sure synonyms, and for the difficulty of assigning limits to such species as *Vandenboschia radicans, Mecodium polyanthos,* all common species of *Crepidomanes,* and most species of *Gonocormus* and *Selenodesmium.*

The proposal of more than thirty genera, in a family where two have been imagined to suffice, will not be welcomed by those insufficiently acquainted with these plants to understand the propriety of any larger number. Really, there are very few of the thirty-three as to the propriety of which I recognize any question. *Hemicyatheon* and *Amphipterum* are maintained because any other course, conserving naturalness, involves worse inconvenience. *Apteropteris* and *Myriodon* are proposed because the plants are too bizarre to go well into the large genera to which they are related; each is in its way unique among vascular plants. *Meringium* could have been left in *Hymenophyllum;* but the separation seems natural, facilitates the picturing of their dispersal and subsequent evolution, and leaves both genera large enough for convenience.

One can easily go farther in the recognition of genera. My predecessors have divided *Trichomanes* and *Feea* more finely, and it will probably be done again. *Microgonium Hookeri* may belong in a genus by itself. *Trichomanes Hildebrandtii* and *Hymenophyllum Levingei,* both unknown to me, are described as peculiar enough perhaps to merit generic status. And a number of far southern species which I include in the cosmopolitan genera are at least very foreign elements there. Thus *Hymenophyllum pectinatum* may become a monotypic genus. *Diploophyllum* may again be separated from *Mecodium.* And *Hymenophyllum dentatum* is so far from at home in *Meringium* that I abstain from renaming it there, though it belongs nowhere else. *Hymenophyllum Rolandi-Principis* is a generic entity, but may better remain unnamed as such until its fruit may be discovered.

In each of the thirty-three adopted and named genera I have listed the species I know to belong there and believe to be good species. As to the Old World species this listing is almost complete. As a matter of convenience I conclude this treatise with an index of synonyms of *Trichomanes* and *Hyme-*

nophyllum, based on Christensen's Index Filicum and its supplements, and intended for use in connection therewith. In this index will be found many such entries as *Vandenboschia* sp., *Mecodium* sp., and *Sphaerocionium* sp. In such cases I abstain from a transfer of specific name because I do not personally know the species in question and, therefore, have no judgment as to the validity of the species, not because of doubt as to its genus. Experience with Oriental named species has shown a surprising proportion which seem to me not to be distinct, and this makes me fear that a general transfer of published names of American species would result in many undesirable synonyms.

INDEX OF SYNONYMS

HYMENOPHYLLUM

H. abruptum Hooker.	*Mecodium abruptum.*
H. acanthoides Ros.	*Meringium acanthoides.*
H. acrosorum v. d. B.	*Mecodium polyanthos.*
H. aculeatum Racib.	*Meringium denticulatum.*
H. aculeolatum v. d. B.	*Meringium* ?
H. adiantoides v. d. B.	*Sphaerocionium* sp.
H. aeruginosum Carm.	*Sphaerocionium* sp.
H. affine Brack.	id.
H. Alfredii Ros.	*Mecodium Alfredii.*
H. alpinum Col.	*Meringium multifidum.*
H. alveolatum C. Chr.	id.
H. amabile Morton.	*Sphaerocionium* sp.
H. andinum v. d. B.	*Mecodium andinum.*
H. angulosum Christ.	*Mecodium angulosum.*
H. angustifrons Christ.	*Sphaerocionium* sp.
H. angustum v. d. B.	*Sphaerocionium* sp.
H. anisopterum A. Peter.	*Sphaerocionium* sp.
H. antarcticum Presl.	id.
H. antillense Jenman.	*Sphaerocionium antillense.*
H. apiculatum Mett.	*Mecodium* sp.
H. Armstrongii Kirk.	*Microtrichomanes* ?
H. asperulum Kze.	id.
H. asplenioides Sw.	*Mecodium asplenioides.*
H. atrovirens Col.	*Mecodium australe* ?
H. australe Willd.	*Mecodium australe.*
H. axillare Sw.	*Mecodium axillare.*
H. Babindae Watts.	*Hymenophyllum antarcticum.*
H. badium H. and G.	*Mecodium badium.*
H. Balansae Fourn.	*Mecodium* sp.
H. baileyanum Domin.	*Hemicyatheon Baileyanum.*
H. Bakeri Copel.	*Meringium Bakeri.*
H. Baldwinii Eaton.	*Callistopteris Baldwinii.*
H. Balfourii Baker.	*Mecodium fumarioides.*

H. bamlerianum Ros.	*Mecodium imbricatum.*
H. barbatum Baker.	id.
H. batuense Ros.	*Meringium* sp.
H. bicolanum Copel.	*Meringium bicolanum.*
H. bismarckianum Christ.	*Mecodium* sp.
H. bivalve Sw.	*Meringium bivalve.*
H. blandum Racib.	*Meringium blandum.*
H. blumianum Spr.	*Mecodium polyanthos.*
H. bontocense Copel.	*Meringium bontocense.*
H. borneense Hooker.	*Microtrichomanes palmatifidum.*
H. Boschii Ros.	*Meringium holochilum.*
H. botryoides v. d. B.	*Mecodium* sp.
H. Boutonii Baker.	*Sphaerocionium* sp.
H. brachyglossum A. Br.	*Meringium brachyglossum.*
H. brachypus Sod.	id.
H. brasilianum Ros.	*Sphaerocionium* sp.
H. breve Ros.	*Mecodium* sp.
H. brevidens v. A. v. R.	*Meringium* sp.
H. brevistipes Liebm.	*Mecodium* sp.
H. Buchtienii Ros.	*Sphaerocionium Buchtienii.*
H. caespitosum Gaud.	*Serphyllopsis caespitosa.*
H. calodictyon v. d. B.	*Meringium* ?
H. campanulatum Christ.	*Meringium campanulatum.*
H. capillaceum Roxb.	*Mecodium* sp.
H. capillare Desv.	*Sphaerocionium capillare.*
H. Cardunculus C. Chr.	*Meringium Cardunculus.*
H. carnosum Christ.	*Mecodium* sp.
H. caudatellum Christ.	*Sphaerocionium* sp.
H. caudiculatum Mart.	*Mecodium caudiculatum.*
H. ceratophylloides Christ.	id. (?)
H. cernuum Gepp.	*Amphipterum* sp.
H. Cheesemani Baker.	*Microtrichomanes* ?
H. Chrysothrix Sturm.	*Sphaerocionium* sp.
H. ciliatum Sw.	*Sphaerocionium ciliatum.*
H. cincinnatum Gepp.	*Meringium* sp.
H. Clemensiae Copel.	*Meringium pachydermicum.*
H. compactum Bonap.	*Mecodium fumarioides.*
H. constrictum Christ.	*Mecodium constrictum.*
H. constrictum Hayata.	*Mecodium polyanthos.*
H. contextum Ros.	*Mecodium contextum.*
H. contortum v. d. B.	*Mecodium contortum.*
H. contractile Sod.	*Sphaerocionium* sp.
H. copelandianum v. A. v. R.	*Mecodium Reinwardtii.*
H. coreanum Nakai.	*Mecodium Wrightii.*
H. corrugatum Christ.	*Mecodium corrugatum.*
H. corticola Hooker.	*Microtrichomanes nitidulum.*
H. costaricanum v. d. B.	*Mecodium costaricanum.*
H. crispato-alatum Hayata.	*Mecodium crispato-alatum.*
H. crispatulum v. d. B.	*Spaerocionium* sp.

H. crispatum Wall.	*Mecodium crispatum.*
H. crispum H. B. K.	*Sphaerocionium* sp.
H. cristulatum Ros.	*Mecodium sanguinolentum.*
H. Cruegeri Müller.	*Sphaerocionium Cruegeri.*
H. cruentum Cav.	*Hymenoglossum cruentum.*
H. cubense Sturm.	*Sphaerocionium* sp.
H. cuneatum Kze.	*Mecodium cuneatum.*
H. cupressiforme Lab.	**id.**
H. Darwinii Hk. f.	*Mecodium* sp.
H. decurrens Sw.	*Sphaerocionium* sp.
H. dejectum Baker.	*Hymenophyllopsis dejecta.*
H. Delavayi Christ.	*Mecodium exsertum.*
H. delicatissimum Fée.	*Sphaerocionium Cruegeri.*
H. deltoideum C. Chr.	*Mecodium Humbertii.*
H. demissum Sw.	*Mecodium demissum.*
H. Dendritis Ros.	*Mecodium Dendritis.*
H. densifolium Phil.	*Serpyllopsis caespitosa.*
H. dentatum Cav.	*Meringium* ?
H. denticulatum Sw.	*Meringium denticulatum.*
H. Deplanchei Mett.	*Hemicyatheon Deplanchei.*
H. dichotomum Blume.	*Mecodium Reinwardtii.*
H. dichotomum Cav.	*Meringium denticulatum.*
H. dichotomum aliorum.	*Merigium plicatum.*
H. dicranotrichum.	*Leptocionium dicranotrichum.*
H. dilatatum Sw.	*Mecodium dilatatum.*
H. dimidiatum Mett.	*Meringium dimidiatum.*
H. dimorphum Christ.	*Sphaerocionium* sp.
H. dipteroneuron A. Br.	*Amphipterum fuscum.*
H. discosum Christ.	*Mecodium paniculiflorum.*
H. divaricatum v. d. B.	*Sphaerocionium* sp.
H. Durandii Christ.	*Sphaerocionium Durandii.*
H. Dusenii Christ.	*Serpyllopsis caespitosa.*
H. ectocarpon Fée.	?
H. edentulum C. Chr.	*Meringium edentulum.*
H. Elberti Ros.	*Meringium* sp.
H. elegans Spr.	*Sphaerocionium elegans.*
H. elegantissimum Fée.	*Sphaerocionium elegantissimum.*
H. elegantulum v. d. B.	*Sphaerocionium elegantulum.*
H. ellipticosorum v. A. v. R.	*Meringium* sp.
H. emarginatum Sw.	*Mecodium emarginatum.*
H. epiphyticum J. W. Moore.	*Mecodium polyanthos.*
H. erosum Blume.	*Mecodium javanicum.*
H. exiguum Bedd.	*Didymoglossum exiguum.*
H. eximium Kunze.	*Mecodium emarginatum.*
H. exsertum Wall.	*Mecodium exsertum.*
H. falklandicum Baker.	id.
H. farallonense Hieron.	*Mecodium* sp.
H. fastigiosum Christ.	*Hymenophyllum barbatum.*
H. fecundum v. d. B.	*Mecodium* sp.
H. feejeense Brack.	*Meringium feejeense.*

H. fendlerianum Sturm.	*Mecodium fendlerianum.*
H. ferax v. d. B.	*Mecodium ferax.*
H. ferrugineum Colla.	*Sphaerocionium ferrugineum.*
H. Filicula Bory.	*Crepidomanes bipunctatum.*
H. fimbriatum J. Sm.	*Mecodium fimbriatum.*
H. firmum v. A. v. R.	*Meringium firmum.*
H. flabellatum Lab.	*Mecodium flabellatum.*
H. flexile Makino.	*Mecodium flexile.*
H. flexuosum A. Cunn.	*Mecodium flexuosum.*
H. Foersteri Ros.	*Meringium* ?
H. formosum Brack.	*Mecodium imbricatum.*
H. Foxworthyi Copel.	*Pleuromanes pallidum.*
H. Francavillei v. d. B.	*Sphaerocionium* sp.
H. Frankliniae Col.	*Sphaerocionium ferrugineum.*
H. fraternum Harr.	*Mecodium fimbriatum.*
H. fuciforme Sw.	*Mecodium* ? (receptacle elongate.)
H. fucoides Sw.	*Meringium fucoides.*
H. Fuertesii Brause.	*Sphaerocionium* sp.
H. fujisanense Nakai.	*Mecodium polyanthos.*
H. fumarioides Willd.	*Mecodium fumarioides.*
H. Funckii v. d. B.	*Mecodium* sp.
H. fuscum v. d. B.	*Amphipterum fuscum.*
H. fusugasugense Karst.	*Sphaerocionium* sp.
H. Gardneri v. d. B.	*Mecodium exsertum.*
H. geluense Ros.	*Amphipterum geluense.*
H. Glaziovii Baker.	*Sphaerocionium* sp.
H. glebarium Christ.	?
H. Gollmeri v. d. B.	*Mecodium* sp.
H. gorgoneum Copel.	*Meringium gorgoneum.*
H. gracilescens Domin.	id.
H. gracilius Copel.	*Mecodium polyanthos.*
H. gratum Fée.	?
H. halconense Copel.	*Meringium pachydermicum.*
H. Hallieri Ros.	*Meringium* sp.
H. hamuliferum v. A. v. R.	*Meringium holochilum.*
H. helicoideum Sod.	*Mecodium* sp.
H. hemipteron Ros.	*Sphaerocionium hemipteron.*
H. Henryi Baker.	*Hymenophyllum barbatum.*
H. hertericanum Brause.	*Meringium* ?
H. Herzogii Ros.	id.
H. Hieronymi C. Chr.	*Meringium* sp.
H. himalaianum v. d. B.	*Mecodium polyanthos.*
H. hirsutum Sw.	*Sphaerocionium hirsutum.*
H. hirtellum Sw.	*Sphaerocionium hirtellum.*
H. holochilum C. Chr.	*Meringium holochilum.*
H. holotrichum A. Peter.	*Sphaerocionium* sp.
H. Hosei Copel.	*Meringium Hosei.*
H. Houstonii Jenman.	id. (?) (sterile.)
H. Humbertii C. Chr.	*Mecodium Humbertii.*
H. humboldtianum Fourn.	*Mecodium* sp.

H. hygrometricum Desv.	*Sphaerocionum hygrometricum.*
H. imbricatum Blume.	*Mecodium imbricatum.*
H. inaequale Desv.	*Mecodium inaequale.*
H. integrum v. d. B.	*Mecodium polyanthos.*
H. intercalatum Christ.	*Sphaerocionium* sp.
H. interruptum Kze.	*Sphaerocionium interruptum.*
H. intricatum v. d. B.	*Mecodium intricatum.*
H. involucratum Copel.	*Mecodium involucratum.*
H. Jamesoni Hooker.	*Buesia Jamesoni.*
H. japonicum Miq.	*Hymenophyllum barbatum.*
H. javanicum Spr.	*Mecodium javanicum.*
H. johorense Holttum.	*Microtrichomanes johorense.*
H. Junghuhnii v. d. B.	*Mecodium Junghuhnii.*
H. kaieteurum Jenman.	?
H. karstenianum Sturm.	*Sphaerocionium* sp.
H. kerianum Watts.	*Meringium kerianum.*
H. khasianum Baker.	*Hymenophyllum barbatum.*
H. klabatense Christ.	*Meringium klabatense.*
H. kohautianum Presl.	*Mecodium* sp.
H. Kuhnii C. Chr.	*Mecodium Kuhnii.*
H. Kurzii Prantl.	*Meringium holochilum.*
H. laciniosum Christ.	*Mecodium nigricans.*
H. laminatum Copel.	*Amphipterum laminatum.*
H. lanatum Fée.	*Sphaerocionium lanatum.*
H. lanceolatum H. and A.	*Sphaerocionium lanceolatum.*
H. latilobum Bonap.	*Mecodium badium.*
H. Ledermanni Brause.	*Amphipterum Ledermanni.*
H. Lehmanni Hieron.	*Mecodium* sp.
H. leptocarpum Copel.	*Meringium penangianum.*
H. leptodictyon K. Müller.	*Mecodium emarginatum.*
H. LeRatii Ros.	*Mecodium LeRatii.*
H. Levingei Clarke.	id. ?
H. L'Herminieri Mett.	*Mecodium* sp.
H. Limminghii v. d. B.	*Mecodium fumarioides.*
H. Lindeni Hooker.	*Sphaerocionium* sp.
H. Lindigii Mett.	*Sphaerocionium* sp.
H. lindsaeoides Baker.	*Sphenomeris odontolabia.*
H. lineare Sw.	*Sphaerocionium lineare.*
H. lingganum v. A. v. R.	*Meringium holochilum.*
H. Lobbii Moore.	*Meringium Lobbii.*
H. longifolium v. A. v. R.	*Mecodium longifolium.*
H. lophocarpum Col.	*Mecodium sanguinolentum.*
H. Lyallii Hooker f.	*Sphaerocionium Lyallii.*
H. Macgillivrayi Copel.	*Meringium Macgillivrayi.*
H. macrocarpum v. d. B.	*Mecodium badium.*
H. macroglossum v. d. B.	*Meringium macroglossum.*
H. macrosorum v. A. v. R.	*Meringium macrosorum.*
H. macrothecum Fée.	*Mecodium macrothecum.*
H. magellanicum Willd.	*Meringium magellanicum.*
H. Malingii Mett.	*Apteropteris Malingii.*

H. marginatum H. and G.	*Craspedophyllum marginatum.*
H. Marlothii Brause.	*Sphaerocionium Marlothii.*
H. Mazei Fourn.	*Mecodium* sp.
H. megalocarpum Col.	*Mecodium demissum.*
H. melanocheilos Col.	*Microtrichomanes* (?) *Armstrongii.*
H. Merrillii Christ.	*Meringium Merrillii.*
H. meyenianum Copel.	*Meringium meyenianum.*
H. micans Christ.	*Mecodium* sp.
H. micranthum v. d. B.	*Mecodium javanicum.*
H. microcarpum Desv.	*Sphaerocionium microcarpum.*
H. microchilum C. Chr.	*Mecodium polyanthos.*
H. microphyllum Mett.	*Mecodium* sp.
M. microsorum v. d. B.	*Mecodium polyanthos.*
H. millefolium Schl. and Cham.	*Mecodium* sp. (*polyanthos* ?)
H. minimum A. Rich.	id. ?
H. mirificum Morton.	*Buesia mirifica.*
H. mnioides Baker.	*Mecodium mnioides.*
H. modestum v. d. B.	*Mecodium emarginatum.*
H. montanum Kirk.	*Mecodium montanum.*
H. Moorei Baker.	*Hymenophyllum pumilum.*
H. multifidum Sw.	*Meringium multifidum.*
H. multiflorum Ros.	*Mecodium multiflorum.*
H. myriocarpum Hooker.	*Mecodium myriocarpum.*
H. nanum Sod.	id.
H. Neesii Hooker.	*Meringium denticulatum.*
H. nigrescens Liebm.	*Mecodium nigricans.*
H. nitens R. Br.	*Mecodium flabellatum.*
H. nitiduloides Copel.	*Mecodium nitiduloides.*
H. notabile Fée.	?
H. nutantifolium v. A. v. R.	*Meringium* sp.
H. obtusum H. and A.	*Sphaerocionium obtusum.*
H. odontophyllum Copel.	*Myriodon odontophyllus.*
H. oligocarpum Col.	*Meringium multifidum.*
H. oligosorum Makino.	*Mecodium Wrightii.*
H. omeiense Christ.	*Hymenophyllum barbatum.*
H. ooides Müller and Baker.	*Mecodium ooides.*
H. opacum Copel.	*Mecodium opacum.*
H. orbignyanum v. d. B.	*Sphaerocionium* sp.
H. osmundoides v. d. B.	*Mecodium polyanthos.*
H. ovatum Copel.	*Meringium ovatum.*
H. oxyodon Baker.	*Hymenophyllum barbatum.*
H. pachydermicum Cesati.	*Meringium pachydermicum.*
H. palmatum v. d. B.	*Microtrichomanes parvulum.*
H. palmense Ros.	*Sphaerocionium palmense.*
H. paniculiflorum Presl.	*Mecodium paniculiflorum.*
H. pannosum Christ.	*Sphaerocionium* sp.
H. pantotactum v. A. v. R.	*Mecodium polyanthos.*
H. parvifolium Baker.	*Microgonium* sp.
H. parallelocarpum Hayata.	*Mecodium polyanthos.*
H. parvulum C. Chr.	*Mecodium* sp.

H. parvum C. Chr.	*Mecodium fumarioides.*
H. paucicarpum Jenman.	*Mecodium* (*teste* Morton.)
H. pectinatum Cav.	id.
H. pedicularifolium Cesati.	*Meringium* sp.
H. peltatum Desv.	id.
H. penangianum Matthew and Christ.	*Meringium penangianum.*
H. pendulum Bory.	*Sphaerocionium capillare.*
H. perfissum Copel.	id.
H. perparvulum v. A. v. R.	*Meringium* sp.
H. physocarpum Christ.	*Mecodium thuidium.*
H. piliferum C. Chr.	?
H. pilosissimum C. Chr.	*Sphaerocionium pilosissimum.*
H. pilosum v. A. v. R.	*Meringium pachydermicum.*
H. pleiocarpum v. A. v. R.	*Mecodium crispatum.*
H. plicatum Kaulf.	*Meringium plicatum.*
H. plumosum Kaulf.	*Sphaerocionium plumosum.*
H. Poilanei Tard. and C. Chr.	id. (?)
H. pollenianum Ros.	*Meringium pollenianum.*
H. polyanthos Sw.	*Mecodium polyanthos.*
H. polyanthum Hooker.	*Callistopteris polyantha.*
H. polychilum Col.	*Mecodium demissum.*
H. polyodon Baker.	id. (?)
H. Poolii Baker.	*Sphaerocionium Poolii.*
H. praetervisum Christ.	*Meringium praetervisum.*
H. Preslii Ros.	(*nomen inconditum*)
H. prionema Kunze.	id.
H. procerum v. d. B.	*Sphaerocionium* sp.
H. productoides J. W. Moore.	*Mecodium productoides.*
H. productum Kze.	*Mecodium productum.*
H. protrusum Hooker.	*Mecodium protrusum.*
H. pseudo-tunbridgense Watts.	*Hymenophyllum affine.*
H. pulcherrimum Col.	*Mecodium pulcherrimum.*
H. pulchrum Copel.	*Meringium pulchrum.*
H. pumilio Ross.	id.
H. pumilum C. Moore.	id.
H. punctisorum Ros.	*Mecodium polyanthos.*
H. pusillum Col.	*Hymenophyllum revolutum.*
H. pycnocarpum v. d. B.	*Mecodium polyanthos.*
H. pygmaeum Col.	*Hymenophyllum revolutum.*
H. pyramidatum Desv.	*Sphaerocionium pyramidatum.*
H. pyriforme v. d. B.	*Meringium bivalve.*
H. quadrifidum Phil.	*Meringium magellanicum.*
H. raddianum K. Müller.	*Sphaerocionium raddianum.*
H. Ramosii Copel.	*Meringium Ramosii.*
H. rarum R. Br.	*Mecodium rarum.*
H. recurvum Gaud.	*Mecodium recurvum.*
H. reductum Copel.	*Meringium reductum.*
H. Reinwardtii v. d. B.	*Mecodium Reinwardtii.*
H. remotipinna Bonap.	*Mecodium veronioides.*

H. reniforme Hooker.	*Mecodium reniforme.*
H. retusilobum Hayata.	*Mecodium* sp.
H. revolutum Col.	id.
H. ricciaefolium Bory.	*Meringium tenellum.*
H. Rimbachii Sod.	*Mecodium* sp.
H. ringens Christ.	*Meringium* ?
H. riukiuense Christ.	*Mecodium riukiuense.*
H. Rolandi-Principis Ros.	*Gen. novum ined.*
H. Rosenstockii Brause.	*Meringium Rosenstockii.*
H. rubellum Ros.	*Meringium rubellum.*
H. rufescens Kirk.	*Mecodium rufescens.*
H. rufifolium v. A. v. R.	*Meringium* sp.
H. rufifrons v. A. v. R.	*Meringium* sp.
H. rufum Fée.	*Sphaerocionium rufum.*
H. rugosum C. Chr. and Skottsberg.	id.
H. ruizianum Kze.	*Sphaerocionium ruizianum.*
H. sabinifolium Baker.	*Meringium acanthoides.*
H. salakense Racib.	*Mecodium salakense.*
H. samoense Baker.	*Mecodium samoense.*
H. sampaioanum Brade et Ros.	*Sphaerocionium sampaioanum.*
H. sanguinolentum Sw.	*Mecodium sanguinolentum.*
H. scabrum A. Rich.	*Mecodium scabrum.*
H. secundum H. and G.	*Meringium secundum.*
H. semibivalve H. and G.	*Mecodium rarum.*
H. semifissum Copel.	*Meringium penangianum.*
H. semiglabrum Ros.	*Sphaerocionium semiglabrum.*
H. sericeum Sw.	*Sphaerocionium sericeum.*
H. Serra Presl.	*Meringium secundum.*
H. serrulatum C. Chr.	*Meringium meyenianum.*
H. seselifolium Presl.	id. ?
H. shirleyanum Domin.	*Mecodium samoense.*
H. sibthorpioides Mett.	*Microtrichomanes parvulum.*
H. siliquosum Christ.	*Mecodium siliquosum.*
H. Silveirae Christ.	*Sphaerocionium* sp.
H. simonsianum Hooker.	id.
H. Skottsbergii C. Chr.	*Mecodium* sp.
H. Smithii Hooker.	*Meringium meyenianum.*
H. Sodiroi C. Chr.	*Buesia Sodiroi.*
H. sororium v. d. B.	*Mecodium imbricatum.*
H. spectabile Mett.	*Sphaerocionium spectabile.*
H. sphaerocarpum v. d. B.	*Mecodium polyanthos.*
H. spicatum Christ.	id.
H. splendidum v. d. B.	*Sphaerocionium splendidum.*
H. Sprucei Baker.	*Sphaerocionium* sp.
H. Steerei C. Chr.	*Mecodium fimbriatum.*
H. streptophyllum Fourn.	*Mecodium* sp.
H. subdemissum Christ.	*Mecodium polyanthos.*
H. subdimidiatum Ros.	*Meringium* ?
H. subfirmum v. A. v. R.	*Meringium firmum.*
H. subflabellatum Cesati.	*Meringium Lobbii.*

H. subobtusum Ros.	*Sphaerocionium subobtusum.*
H. subrigidum Christ.	*Sphaerocionium subrigidum.*
H. subrotundum v. A. v. R.	*Meringium denticulatum.*
H. subtilissimum Kunze.	*Sphaerocionium ferrugineum.*
H. tablaziense Christ.	*Mecodium tablaziense.*
H. taliabense v. A. v. R.	*Meringium pachydermicum.*
H. tasmannicum v. d. B.	*Mecodium australe.*
H. tenellum Kuhn.	*Meringium tenellum.*
H. tenerrimum v. d. B.	*Sphaerocionium* sp.
H. tenerum v. d. B.	*Mecodium* sp.
H. Thomassetii C. H. Wright.	id.
H. thuidium Harr.	*Mecodium thuidium.*
H. todjambuense Kjellberg.	*Mecodium* sp.
H. tomentosum Kze.	*Sphaerocionium tomentosum.*
H. torquescens v. d. B.	id.
H. torricellianum v. A. v. R.	*Meringium* sp.
H. tortuosum H. and G.	*Meringium tortuosum.*
H. trapezoidale Liebm.	*Mecodium* sp.
H. Treubii Racib.	*Mecodium Treubii.*
H. Trianae Hieron.	*Mecodium Trianae.*
H. triangulare Baker.	*Meringium triangulare.*
H. trichocaulon Phil.	?
H. trichomanoides v. d. B.	*Mecodium* sp.
H. trichophyllum H. B. K.	*Sphaerocionium trichophyllum.*
H. truncatum Col.	*Meringium multifidum.*
H. tunbridgense (L.) Sw.	id.
H. Ulei Christ and Gies.	*Sphaerocionium* sp.
H. uncinatum Sim.	id.
H. undulatum Sw.	*Mecodium undulatum.*
H. unilaterale Bory.	*Hymenophyllum peltatum.*
H. Urbani Brause.	*Sphaerocionium* sp.
H. vacillans Christ.	?
H. valvatum H. and G.	*Sphaerocionium valvatum.*
H. veronicoides C. Chr.	*Mecodium veronicoides.*
H. villosum Col.	*Mecodium villosum.*
H. vincentinum Baker.	*Mecodium macrothecum.*
H. violaceum Meyen.	*Meringium meyenianum.*
H. viride Ros.	id. ?
H. vittatum Copel.	*Meringium vittatum.*
H. Walleri Maiden and Betche.	*Mecodium Walleri.*
H. Wercklei Christ.	*Sphaerocionium Wercklei.*
H. Wrightii v. d. B.	*Mecodium Wrightii.*
H. zeelandicum v. d. B.	*Hymenophyllum revolutum.*
H. zollingerianum Kunze.	*Amphipterum fuscum.*

TRICHOMANES

T. abrotanifolium v. d. B.	*Vandenboschia* sp.
T. accedens Ph.	id.
T. acrosorum Copel.	*Cephalomanes acrosorum.*
T. acutilobum Ching.	*Crepidomanes* sp.

T. acuto-obtusum Hayata.	*Crepidomanes Makinoi.*
T. acutum Presl.	*Pleuromanes acutum.*
T. adscendens Kze.	id.
T. africanum Christ.	*Vandenboschia* ?
T. alagense Christ.	*Gonocormus alagensis.*
T. alatum Sw.	id.
T. alternans Carr.	*Crepidopteris endlicheriana.*
T. amabile Nakai.	*Vandenboschia radicans.*
T. amazonicum Christ.	id.
T. anadromum Ros.	id.
T. angustatum Carm.	*Macroglena* ?
T. angustimarginatum Bonap.	*Macroglena angustimarginata.*
T. Ankersii Parker.	id.
T. aphlebioides Christ.	*Vandenboschia aphlebioides.*
T. apicilare Fourn.	*Crepidopteris* sp.
T. apiifolium Pr.	*Callistopteris apiifolia.*
T. arbuscula Desv.	id.
T. Asae-Grayi v. d. B.	*Macroglena Asae-Grayi.*
T. asplenioides Presl.	*Cephalomanes oblongifolium.*
T. assimile Mett.	*Gonocormus* ?
T. Aswijkii Racib.	*Microtrichomanes* sp.
T. atrovirens Kunze.	*Cephalomanes atrovirens.*
T. auriculatum Bl.	*Vandenboschia auriculata.*
T. axillare Sod.	*Vandenboschia* sp.
T. badium Fourn.	id.
T. Baldwinii Copel.	*Callistopteris Baldwinii.*
T. barklianum Baker.	*Didymoglossum* ?
T. barnardianum Bailey.	*Crepidomanes* ?
T. batrachoglossum Copel.	*Selenodesmium batrachoglossum.*
T. bauerianum Endl.	*Callistopteris baueriana.*
T. beccarianum Cesati.	*Microgonium beccarianum.*
T. Beckeri Krause.	*Vandenboschia* sp.
T. bicorne Hooker.	id.
T. bilabiatum Nees et Bl.	*Crepidomanes bilabiatum.*
T. bilobatum v. A. v. R.	*Crepidomanes bilobatum.*
T. bimarginatum v. d. B.	*Microgonium bimarginatum.*
T. bipunctatum Poir.	*Crepidomanes bipunctatum.*
T. birmanicum Bedd.	*Vandenboschia radicans.*
T. blepharistomum Copel.	*Nesopteris thysanostoma.*
T. Boivini v. d. B.	*Selenodesmium* (?)
T. Bonapartei C. Chr.	*Gonocormus* sp.
T. bonincolum Nakai.	*Gonocormus* sp.
T. boninense Koidzumi.	*Crepidomanes* sp.
T. borneense v. A. v. R.	*Cephalomanes singaporianum.*
T. boryanum Kunze.	*Cephalomanes boryanum.*
T. botryoides Kaulf.	*Feea botryoides.*
T. brachyblastos Mett.	*Vandenboschia* sp.
T. Bradei Christ.	*Vandenboschia* sp.
T. brevipes Baker.	*Crepidomanes brevipes.*
T. Brooksii Copel.	*Gonocormus* sp.

T. *caespitosum* Hooker.	*Serpyllopsis caespitosa.*
T. *calvescens* v. d. B.	*Sphaerocionium Lyallii.*
T. *capillaceum* L.	*Vandenboschia capillacea.*
T. *capillatum* Taschner.	*Crepidomanes bilabiatum.*
T. *cartilagineum* Vieill. et Pancher.	*Selenodesmium dentatum.*
T. *caudatum* Brack.	*Macroglena caudata.*
T. *cellulosum* Kl.	*Vandenboschia* sp.
T. *Chevalieri* Christ.	*Vandenboschia* ?
T. *Christii* Copel.	*Crepidomanes Christii.*
T. *Cocos* Christ.	*Vandenboschia* sp.
T. *cognatum* Cesati.	*Microgonium beccarianum.*
T. *Colensoi* Hooker f.	*Vandenboschia Colensoi.*
T. *compactum* v. A. v. R.	*Macroglena compacta.*
T. *concinnum* Mett.	*Crepidopteris humile.*
T. *corcovadense* v. d. B.	id.
T. *cordifolium* Alston.	*Didymoglossum cordifolium.*
T. *corticola* Bedd.	*Microtrichomanes nitidulum.*
T. *crassipilis* Weatherby.	id.
T. *craspedoneurum* Copel.	*Microgonium craspedoneurum.*
T. *crassum* Copel.	*Cephalomanes.*
T. *crinitum* Sw.	id.
T. *crispum* L.	id.
T. *cristatum* Kaulf.	id.
T. *cultratum* Baker.	*Microgonium cultratum.*
T. *Cumingii* C. Chr.	*Abrodictyum Cumingii.*
T. *cuneatum* Christ.	*Microtrichomanes Francii.*
T. *cupressifolium* Hayata.	*Vandenboschia latifrons.*
T. *cupressoides* Desv.	*Selenodesmium cupressoides.*
T. *Curranii* Weatherby.	id.
T. *Curtii* Ros.	*Didymoglossum lineolatum.*
T. *cuspidatum* Willd.	*Microgonium cuspidatum.*
T. *cyrtotheca* Hilleb.	*Vandenboschia cyrtotheca.*
T. *dacylites* Sod.	*Vandenboschia* sp.
T. *daguense* Weatherby.	id.
T. *davallioides* Gaud.	*Vandenboschia davallioides.*
T. *debile* v. d. B.	*Vandenboschia* sp.
T. *delicatum* v. d. B.	id.
T. *densinervium* Copel.	*Cephalomanes densinervium.*
T. *dentatum* v. d. B.	*Selenodesmium dentatum.*
T. *denticulatum* Baker.	*Meringium Bakeri.*
T. *diaphanum* H. B. K.	*Vandenboschia diaphana.*
T. *dichotomum* Kze.	*Microtrichomanes dichotomum.*
T. *diffusum* Bl.	*Gonocormus diffusus.*
T. *digitatum* Sw.	*Microtrichomanes digitatum.*
T. *diversifrons* Mett.	*Feea diversifrons.*
T. *draytonianum* Brack.	*Vandenboschia draytoniana.*
T. *elegans* Rich.	*Davalliopsis elegans.*
T. *elongatum* A. Cunn.	*Selenodesmium elongatum.*
T. *endlicherianum.*	*Crepidopteris endlicheriana.*
T. *englerianum* Brause.	*Selenodesmium* ?

T. erectum Brack.	*Crepidopteris Endlicheriana.*
T. eriophorum v. d. B.	id.
T. erosum Willd.	*Microgonium erosum.*
T. exiguum Baker.	*Didymoglossum exiguum.*
T. exsectum Kze.	*Vandenboschia exsecta.*
T. extravagans Copel.	*Selenodesmium extravagans.*
T. fallax Christ.	*Vandenboschia fallax.*
T. Fargesii Christ.	*Vandenboschia* sp.
T. ferrugineum Fourn.	*Selenodesmium dentatum* (?)
T. filiculoides Christ.	*Crepidopteris humile.*
T. fimbriatum Backh.	id.
T. flabellatum v. d. B.	*Microtrichomanes* sp.
T. flavo-fuscum v. d. B.	*Macroglena flavo-fusca.*
T. Foersteri Ros.	*Cephalomanes* sp.
T. fontanum Lindm.	*Didymoglossum fontanum.*
T. formosanum Yabe.	*Crepidomanes latemarginale.*
T. Foxworthyi C. Chr.	*Pleuromanes pallidum.*
T. Francii Christ.	*Microtrichomanes Francii.*
T. Frappieri Cord.	?
T. Fraseri Jenman.	*Didymoglossum* sp.
T. fruticulosum Jenm.	*Didymoglossum* sp.
T. fulgens C. Chr.	*Microgonium* sp.
T. furcatum v. d. B.	id.
T. Galeottii Fourn.	id.
T. Gardneri v. d. B.	id.
T. gemmatum J. Sm.	*Macroglena gemmata.*
T. Giesenhagenii C. Chr.	*Didymoglossum* sp.
T. giganteum Bory.	*Vandenboschia* sp.
T. Godmani Hooker.	*Didymoglossum Petersii.*
T. goebelianum Gies.	*Didymoglossum* sp.
T. Goetzii Hieron.	*Vandenboschia* sp.
T. gracile v. d. B.	*Gonocormus* sp.
T. gracillimum Copel.	*Crepidopteris gracillima.*
T. grande Copel.	*Nesopteris grandis.*
T. guianense Sturm.	id.
T. Hartii Baker.	*Vandenboschia* ?
T. Harveyi Carr.	*Nesopteris intermedia.*
T. henzaianum Parish.	*Microgonium henzaianum.*
T. Herzogii Ros.	*Vandenboschia Herzogii.*
T. heterophyllum HBW.	*Feea heterophylla.*
T. Hieronymi Brause.	*Meringium* sp.
T. Hildebrandtii Kuhn.	*Microgonium* ?
T. hispidulum Mett.	*Nesopteris superba.*
T. holopterum Kze.	id.
T. Hookeri Presl.	*Microgonium Hookeri.*
T. Hosei Baker.	*Meringium penangianum.*
T. hostmannianum Kunze.	id.
T. Huberi Christ.	id.
T. humile Forster.	*Crepidopteris humile.*
T. hymenophylloides v. d. B.	*Vandenboschia hymenophylloides.*

T. hymenoides Hedwig.	*Didymoglossum hymenoides.*
T. hypnoides Christ.	*Vandenboschia* sp.
T. ignobile Cesati.	*Nesopteris superba.*
T. imbricatum Sod.	id.
T. infundibulare v. A. v. R.	*Cephalomanes* sp.
T. Ingae C. Chr.	*Vandenboschia Ingae.*
T. insigne Bedd.	*Crepidomanes* sp.
T. intermedium v. d. B.	*Nesopteris intermedia.*
T. intramarginale H. and G.	*Crepidomanes intramarginale.*
T. javanicum Bl.	*Cephalomanes javanicum.*
T. johnstonense Bailey.	*Vandenboschia johnstonensis.*
T. junceum Christ.	*Vandenboschia* sp.
T. jungermannioides Fourn.	*Crepidopteris Vieillardii.*
T. kalamocarpum Hayata.	*Vandenboschia radicans.*
T. Kalbreyeri Baker.	id.
T. kapplerianum Sturm.	*Didymoglossum* sp.
T. Killipii Weatherby.	id.
T. Kingii Copel.	*Cephalomanes Kingii.*
T. Kirkii Hooker.	*Crepidomanes vel Microgonium.*
T. Kraussii H. and G.	*Didymoglossum Kraussii.*
T. Krugii Christ.	*Selenodesmium* sp.
T. Kurzii Bedd.	*Crepidomanes latemarginale.*
T. labiatum Jenman.	*Didymoglossum* sp.
T. laetum v. d. B.	*Macroglena laeta.*
T. lambertianum Hk.	id.
T. lasiophyllum v. A. v. R.	*Meringium* ?
T. latealatum. (v. d. B., *Didymoglossum.*)	*Crepidomanes latealatum.*
T. latemarginale Eaton.	*Crepidomanes latemarginale.*
T. latifrons v. d. B.	*Vandenboschia latifrons.*
T. latilabiatum E. Brown.	*Gonocormus latilabiatus.*
T. latipinnum Copel.	*Selenodesmium obscurum.*
T. latisectum Christ.	*Vandenboschia* sp.
T. Lauterbachii Christ.	*Crepidopteris humile.*
T. laxum Kl.	id.
T. Ledermanni Brause.	*Cephalomanes* sp. (prob. *C. atrovirens.*)
T. Lehmannii Hieron.	*Didymoglossum* sp.
T. Lenormandi v. d. B.	*Crepidomanes ? vide sub Microgonio.*
T. Leptophyllum A. Cunn.	*Macroglena stricta.*
T. levissimum Fée.	?
T. liberiense Copel.	*Didymoglossum liberiense.*
T. Lindigii Fourn.	id.
T. lineolatum Hooker.	*Didymoglossum lineolatum.*
T. liukiuense Yabe.	*Vandenboschia radicans.*
T. longicollum v. d. B.	*Selenodesmium longicollum.*
T. longifrons Nakai.	*Vandenboschia* sp.
T. longilabiatum Bonap.	? *Gonocormus* ?
T. lucens Sw.	id.
T. ludovicianum Ros.	id.

T. Luerssenii F. v. M.	*Macroglena laeta.*
T. Lyallii Hooker f.	*Sphaerocionium Lyallii.*
T. Macgillivrayi Baker.	*Meringium Macgillivrayi.*
T. macilentum v. d. B.	id.
T. madagascariense Moore.	*Cephalomanes madagascariense* v. d. B.
T. Majorae Watts.	*Crepidomanes* sp.
T. Makinoi C. Chr.	*Crepidomanes Makinoi.*
T. maluense Brause.	*Cephalomanes* sp.
T. mandioccanum Raddi.	*Selenodesmium mandioccanum.*
T. Mannii Hooker.	*Gonocormus* sp.
T. Martinezi Rovirosa.	*Vandenboschia* sp.
T. Martiusii Presl.	id.
T. Matthewi Christ.	*Microtrichomanes* sp.
T. maximum Bl.	*Vandenboschia maxima.*
T. megistostomum Copel.	*Crepidomanes megistostomum.*
T. meifolium Bory.	*Macroglena meifolia.*
T. melanopus Baker.	*Didymoglossum melanopus.*
T. melanotrichum Schlecht.	*Vandenboschia* sp.
T. membranaceum L.	*Lecanium membranaceum.*
T. Merrillii Copel.	*Macroglena setacea.*
T. Mettenii C. Chr.	*Vandenboschia* ?
T. meyenianum v. d. B.	*Meringium meyenianum.*
T. micayense Hier.	id.
T. microchilum Baker.	*Mecodium polyanthos.*
T. microlirion Copel.	*Crepidomanes Christii.*
T. Milbraedii Brause.	*Vandenboschia* sp.
T. Milnei v. d. B.	*Macroglena caudata.*
T. mindorense Christ.	*Microgonium mindorense.*
T. minimum v. A. v. R.	*Crepidomanes bilabiatum.*
T. minutissimum v. A. v. R.	*Microgonium beccarianum.*
T. minutum Bl.	*Gonocormus minutus.*
T. Miyakei Yabe.	*Vandenboschia* sp.
T. montanum Hooker.	*Didymoglossum Robinsonii.*
T. Mosenii Lindm.	*Didymoglossum Mosenii.*
T. Motleyi v. d. B.	*Microgonium Motleyi.*
T. musolense Brause.	*Gonocormus minutus.*
T. myrioneuron Lindm.	*Didymoglossum myrioneuron.*
T. naseanum Christ.	*Vandenboschia radicans.*
T. Naumannii Kuhn and Luerss.	*Crepidopteris endlicheriana.*
T. nipponicum Nakai.	*Vandenboschia* sp.
T. nitidulum v. d. B.	*Microtrichomanes nitidulum.*
T. novo-guineense Brause.	*Gonocormus* ?
T. nummularium C. Chr.	*Didymoglossum nummularium.*
T. Nymani Christ.	*Crepidomanes Nymani.*
T. obscurum Bl.	*Selenodesmium obscurum.*
T. omphalodes C. Chr.	*Microgonium omphalodes.*
T. opacum v. d. B.	id.
T. orbiculare Christ.	*Didymoglossum* sp.
T. orientale C. Chr.	*Vandenboschia radicans.*
T. ornatulum v. d. B.	id.

T. osmundoides DC.	*Feea osmundoides.*
T. pabstianum K. Müll.	*Didymoglossum pabstianum.*
T. pachyphlebium C. Chr.	*Davalliopsis* ?
T. pallidum Bl.	*Pleuromanes pallidum.*
T. palmatifidum K. Müll.	*Microtrichomanes palmatifidum.*
T. palmicola v. d. B.	*Didymoglossum* sp.
T. palmifolium Hayata.	*Crepidomanes latemarginale.*
T. paniculatum v. A. v. R.	? (*Crepidomanes* ?)
T. papillatum K. Müller.	*Selenodesmium obscurum.*
T. papuanum Brause.	*Microgonium, veris. M. sublimbatum.*
T. paradoxum Domin.	*Didymoglossum* ?
T. parviflorum Poir.	*Macroglena parviflora.*
T. parvulum Poir.	*Microtrichomanes parvulum.*
T. parvulum aliorum.	*Gonocormus minutus.*
T. parvum Copel.	*Vandenboschia parva.*
T. pedicellatum Desv.	id.
T. pellucens Kze.	id.
T. pennatum Kaulf.	*Trichomanes pinnatum.*
T. perpusillum v. A. v. R.	*Crepidopteris* ?
T. pervenulosum v. A. v. R.	*Crepidomanes pervenulosum.*
T. Petersii A. Gray.	*Didymoglossum Petersii.*
T. philippianum Sturm.	*Vandenboschia philippiana.*
T. piliferum v. A. v. R.	*Microtrichomanes* sp.
T. pilosum Raddi.	id.
T. pinnatifidum v. d. B.	id.
T. pinnatinervium Jenman.	*Didymoglossum* sp.
T. pinnatum Hedwig.	id.
T. platyrachis Domin.	*Feea* sp.
T. plicatum Bedd.	*Crepidomanes* sp.
T. Pluma Hooker.	*Macroglena meifolia.*
T. plumosum Kze.	id.
T. Poeppigii Presl.	*Trichomanes polypodioides* ?
T. polyanthum Hooker.	*Callistopteris polyantha.*
T. polyodon Col.	*Selenodesmium elongatum.*
T. polypodioides L.	id.
T. Powellii Baker.	*Microtrichomanes vitiense.*
T. preslianum Nakai.	*Nesopteris grandis.*
T. procerum Fée.	id.
T. proliferum Blume.	*Gonocormus prolifer.*
T. pseudo-arbuscula v. A. v. R.	*Selenodesmium* ?
T. pseudocapillatum v. A. v. R.	*Crepidomanes* sp.
T. pulcherrimum Copel.	*Vandenboschia aphlebioides.*
T. pumilum v. d. B.	*Selenodesmium dentatum* ?
T. punctatum Christ.	*Crepidomanes bipunctatum.*
T. punctatum Poir.	*Didymoglossum punctatum.*
T. pusillum Sw.	*Didymoglossum pusillum.*
T. pygmaeum C. Chr.	*Crepidomanes vel Microgonium.*
T. pyxidiferum L.	*Vandenboschia pyxidifera.*
T. quelpaertense Nakai.	*Vandenboschia radicans.*

T. racemulosum v. d. B.	*Selenodesmium obscurum.*
T. radicans Sw.	*Vandenboschia radicans.*
T. recedens Ros.	*Crepidomanes Christii.*
T. reniforme Forster.	*Cardiomanes reniforme.*
T. reptans Sw.	*Didymoglossum reptans.*
T. rhizophyllum Slosson.	*Didymoglossum* sp.
T. rhomboideum J. Sm.	*Cephalomanes atrovirens.*
(*C. rhomboideum* v. d. B. =	*C. javanicum.*)
T. Ridleyi Copel.	*Microtrichomanes Ridleyi.*
T. rigidum Sw.	*Selenodesmium rigidum.*
T. Robinsoni Baker.	*Didymoglossum Robinsonii.*
T. robustum Fourn.	id.
T. roemerianum Ros.	? (*Meringium* ?).
T. roraimense Jenman.	?
T. Rosenstockii v. A. v. R.	*Cephalomanes singaporianum.*
T. Rothertii v. A. v. R.	*Crepidomanes Rothertii.*
T. rotundifolium Bonap.	*Microgonium cuspidatum.*
T. rupestre v. d. B.	id.
T. rupicolum Racib.	*Crepidomanes rupicolum.*
T. savaiense Lauterb.	*Pleuromanes pallidum.*
T. saxatile Moore.	*Selenodesmium obscurum.*
T. saxifragoides Presl.	*Gonocormus minutus.*
T. Sayeri F. Müller and Baker.	*Microgonium* sp.
T. scandens L.	*Vandenboschia scandens.*
T. Schlechteri Brause.	*Macroglena Schlechteri.*
T. schmidianum Zenker.	*Vandenboschia schmidiana.*
T. schomburgkianum Sturm.	*Trichomanes pinnatum.*
T. Schultzei Brause.	*Macroglena* sp.
T. Seemanni Carr.	*Selenedesmium dentatum.*
T. sellowianum Presl.	id.
T. serratifolium Ros.	*Vandenboschia serratifolia.*
T. serratulum Baker.	*Meringium Lobbii.*
T. setaceum v. d. B.	*Macroglena setacea.*
T. setiferum Baker.	*Didymoglossum* sp.
T. siamense Christ.	*Selenodesmium obscurum.*
T. sibthorpioides Bory.	*Microtrichomanes parvulum.*
T. singaporianum v. A. v. R.	*Cephalomanes singaporianum.*
T. sinuatum Bonap.	*Vandenboschia* sp.
T. sociale Lindm.	*Didymoglossum sociale.*
T. societense J. W. Moore.	*Callistopteris polyantha.*
T. solitarium Jenman.	*Didymoglossum punctatum.*
T. Somai Nakai.	*Vandenboschia* sp.
T. speciosum Willd.	*Vandenboschia* sp.
T. sphenoides Kunze.	*Didymoglossum sphenoides.*
T. spinulosum Phil.	*Leptocionium dicranotrichum.*
T. stenosiphon Christ.	*Vandenboschia stenosiphon.*
T. strictum Menzies.	*Macroglena stricta.*
T. stylosum Poir.	*Selenodesmium stylosum.*
T. subdeltoideum C. Chr.	? (*Macroglena* ?).
T. sublabiatum v. d. B.	id.

T. sublimbatum K. Müller.	*Microgonium sublimbatum.*
T. subpinnatifidum v. d. B.	*Gonocormus minutus.*
T. subtilissimum Brause.	*Gonocormus* sp.
T. subtrifidum Matthew and Christ.	*Gonocormus minutus.*
T. suffrutex v. A. v. R.	*Cephalomanes* sp.
T. sumatranum v. A. v. R.	*Cephalomanes sumatranum.*
T. superbum Backh.	*Nesopteris superba.*
T. taeniatum Copel.	*Microtrichomanes taeniatum.*
T. tamarisciforme Jacq.	*Selenodesmium* sp.
T. tanaicum Hooker.	id.
T. tenerum Spr.	*Vandenboschia tenera.*
T. tenue Brack.	*Crepidopteris endlicheriana.*
T. tenuissimum v. d. B.	*Vandenboschia* sp.
T. tereticaulum Ching.	*Selenodesmium tereticaulum.*
T. Teysmannii v. d. B.	*Gonocormus Teysmannii.*
T. thysanostomum Mak.	*Nesopteris thysanostoma.*
T. Tosae Christ.	*Crepidomanes Makinoi.*
T. trichophorum v. A. v. R.	*Meringium* sp.
T. trichophyllum Moore.	*Macroglena setacea* ?
T. trigonum Desv.	id.
T. trinerve Baker.	*Gonocormus* sp.
T. Trollii Bergdolt.	*Feea Trollii.*
T. Türckheimii Christ.	id.
T. Ujhelyii Kümmerle.	*Trichomanes polypodioides.*
T. Ulei Christ.	*Vandenboschia* sp.
T. varians v. A. v. R.	*Microgonium bimarginatum.*
T. Vaupelii Brause.	*Crepidopteris* sp.
T. venosum R. Br.	*Polyphlebium venosum.*
T. venulosum Copel.	*Crepidomanes venulosum.*
T. vestitum Baker.	*Meringium pachydermicum.*
T. Vieillardii v. d. B.	*Crepidopteris Vieillardii.*
T. virgatulum v. d. B.	*Vandenboschia* sp.
T. viridans Mett.	*Crepidomanes latemarginale.*
T. vitiense Baker.	*Microtrichomanes vitiense.*
T. Vittaria D. C.	id.
T. Walleri Watts.	*Crepidomanes* ?
T. Wallii Thwaites.	*Didymoglossum Wallii.*
T. Warburgii Christ.	*Selenodesmium* ?
T. Werneri Ros.	*Crepidopteris Werneri.*
T. Wildii Bailey.	*Vandenboschia* ?

ILLUSTRATIONS

[The plates illustrate only those genera not illustrated in my treatises on Trichomanes and Hymenophyllum. The drawings are by Alicbusan.]

PLATE 1

Apteropteris Malingii (Hooker) Copel., *l, Th. Ranft.* *1,* Frond, × 0.5; *2,* transverse section of segment, × 235; *3,* sorus, laid open, × 29; *4,* sporangium, × 77.

PLATE 2

Buesia Sodiroi (C. Chr.) Copel., *l. Rimbach.* *1,* Frond, × 0.5; *2,* cells, × 380; *3,* sorus, × 14.5; *4,* receptacle, × 14.5; *5,* sporangium, × 77.

PLATE 3

Leptocionium dicranotrichum Presl, *l. Gundhel.* *1,* Frond, × 1.5; *2,* hairs, × 77; *3,* cells, × 380; *4,* sorus, × 29; *5,* sporangium, × 77.

PLATE 4

Serpyllopsis caespitosa (Gaud.) C. Chr., *l. Capt. Dow, ex* U. S. Nat. Herb. *1,* Plant, × 1.5; *2,* cells, × 380; *3,* trichome, × 77; *4,* sorus, × 29; *5,* sporangium, × 77.

PLATE 5

Hymenoglossum cruentum (Cav.) Presl, *l. p. Claude Joseph, ex* Herb. Univ. Calif. *1,* Frond, × 0.5; *2,* cells, surface view, × 380; *3,* transverse section of margin of frond, × 235; *4,* sorus, × 29; *5,* receptacle, × 29; *6,* sporangium, × 77.

PLATE 6

Cardomanes reniforme (Forster) Presl, *l. Th. Ranft.* *1,* Frond, × 0.5; *2,* cells, surface view, × 380; *3,* transverse section, × 235; *4,* sorus, × 29; *5,* sporangium, × 77.

PLATE 7

Polyphlebium venosum (R. Br.) Copel., *l, Th. Ranft.* *1 and 2,* Frond, × 1; *3,* cells, × 380; *4,* sorus, × 29; *5,* receptacle, × 14.5; *6,* sporangium, × 77.

PLATE 8

Trichomanes crispum L., *l. Underwood,* in Jamaica. *1,* Frond, × 0.33; *2,* cells, × 253.3; *3,* sorus, × 19.3; *4,* sporangium, × 51.3.

PLATE 9

Feea osmundoides (DC.) Copel., *l. Tonduz*, in Costa Rica, *ex* Herb. Univ. Calif. *1*, Frond, × 0.5; *2*, cells, × 235; *3*, sorus, × 29; *4*, sporangium, × 77.

PLATE 10

Lecanium membranaceum (L.) Presl, *l. D. Watt*, in Jamaica. *1 and 2*, Frond, × 0.5; *3*, marginal scale, × 38.5; *4*, cells, surface view, × 380; *5*, transverse section, × 235; *6*, sorus, × 14.5; *7*, sporangium, × 77.

PLATE 11

Davalliopsis elegans (Rich.) Copel., *l. Bauer*, in Brazil (Bahia). *1*, Frond, × 0.33; *2*, cells, surface view, × 253.3; *3*, transverse section, × 156.6; *4*, sorus, × 19.3; *5*, sporangium, × 51.3.

TEXT FIGURE

Diagram of affinities of genera.

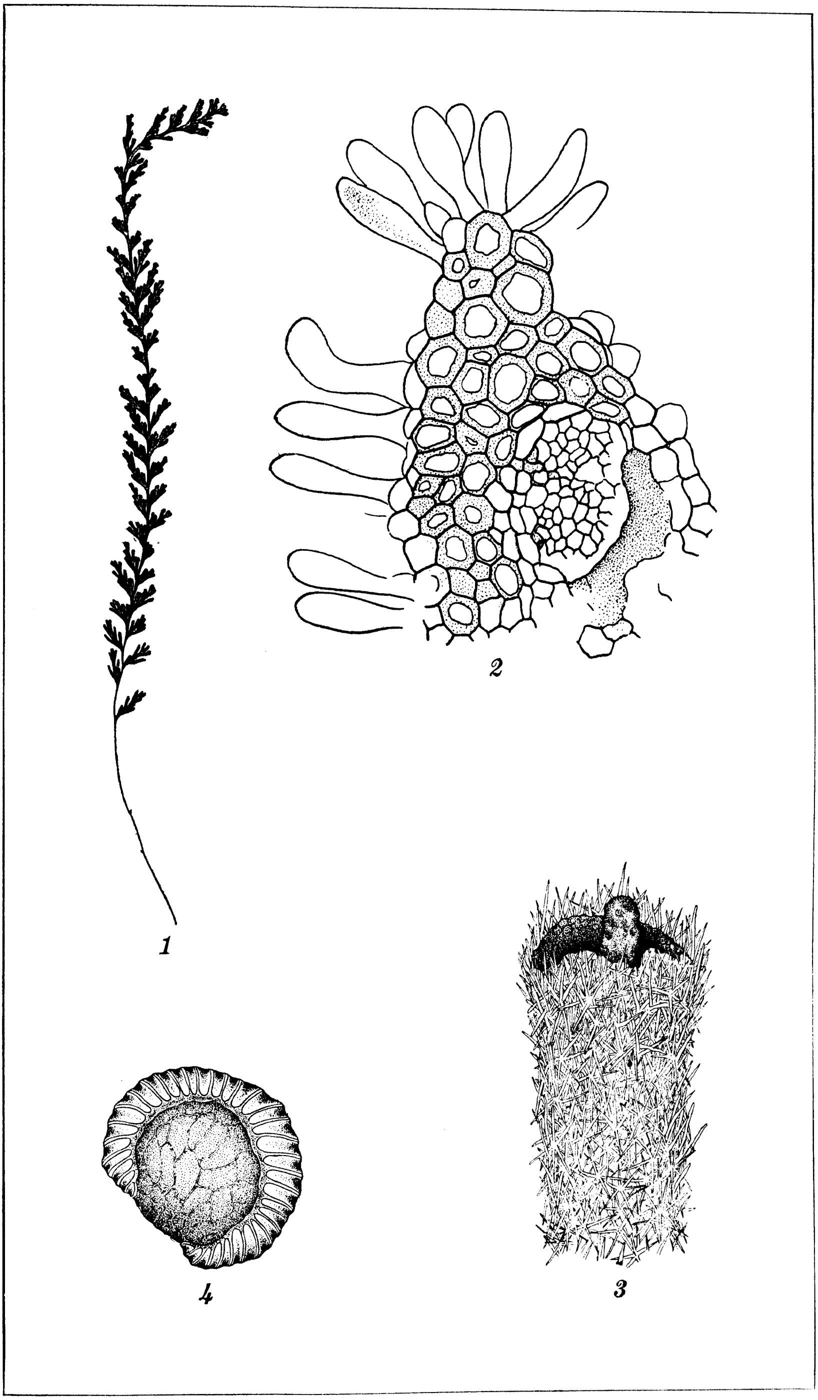


PLATE 1.

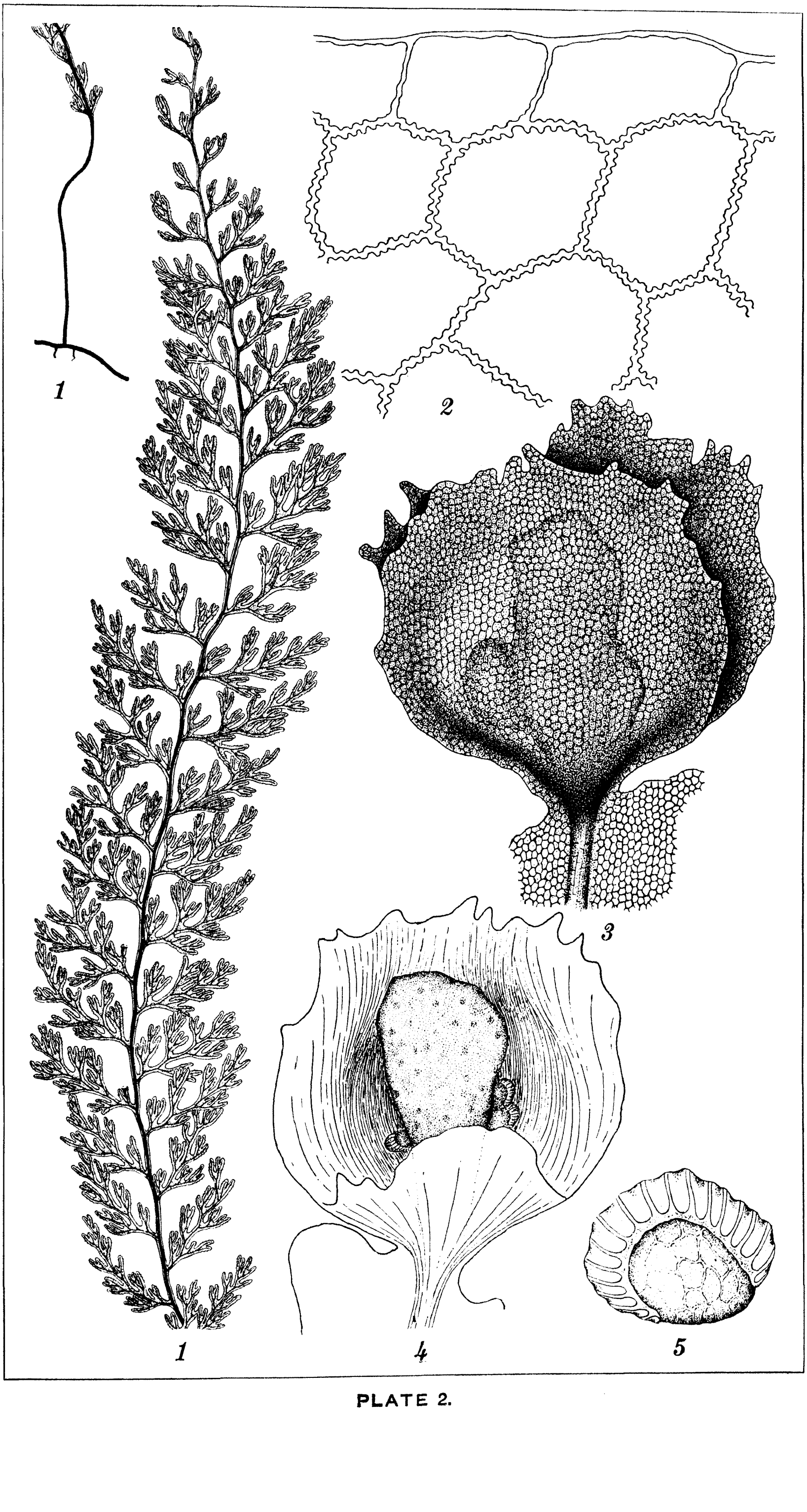


PLATE 2.

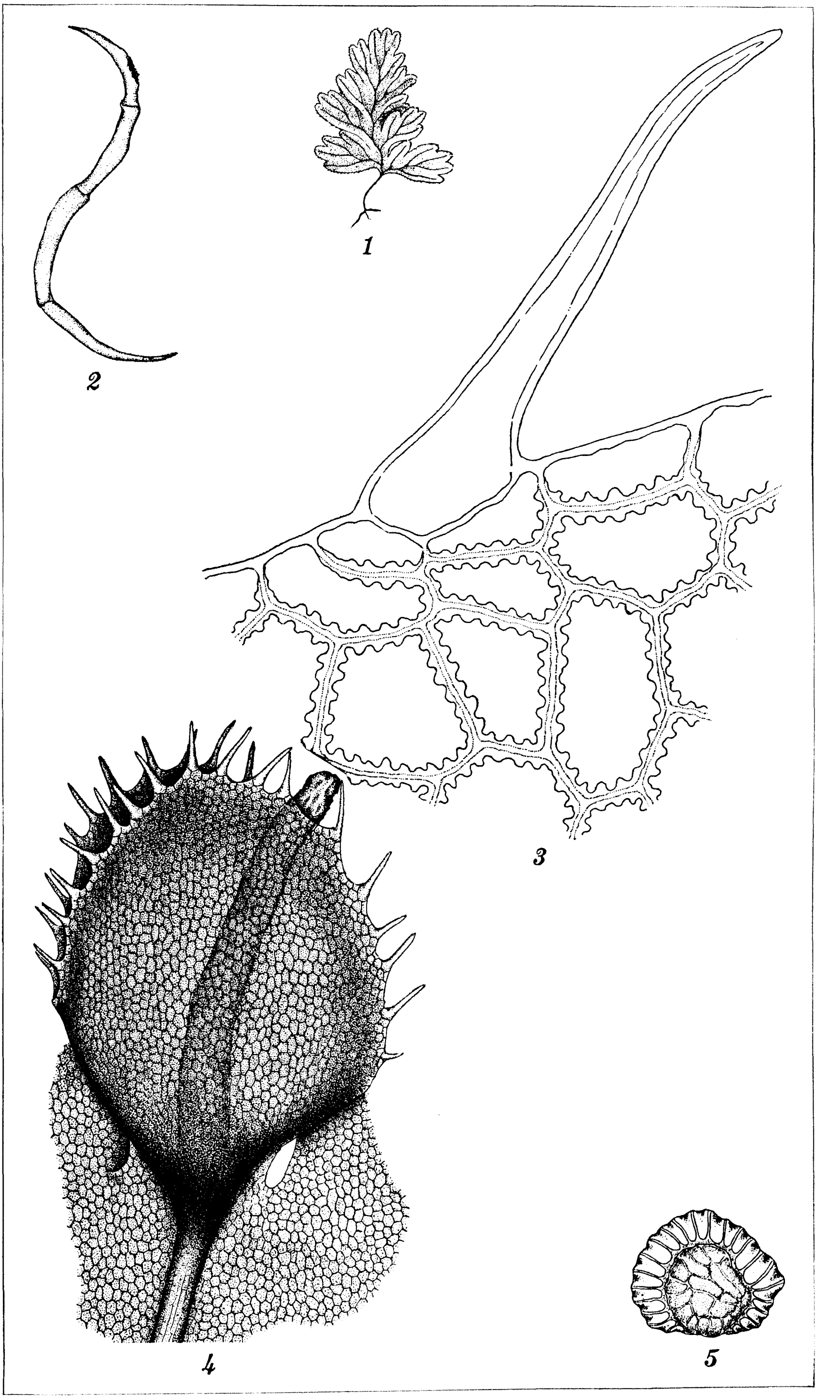


PLATE 3.

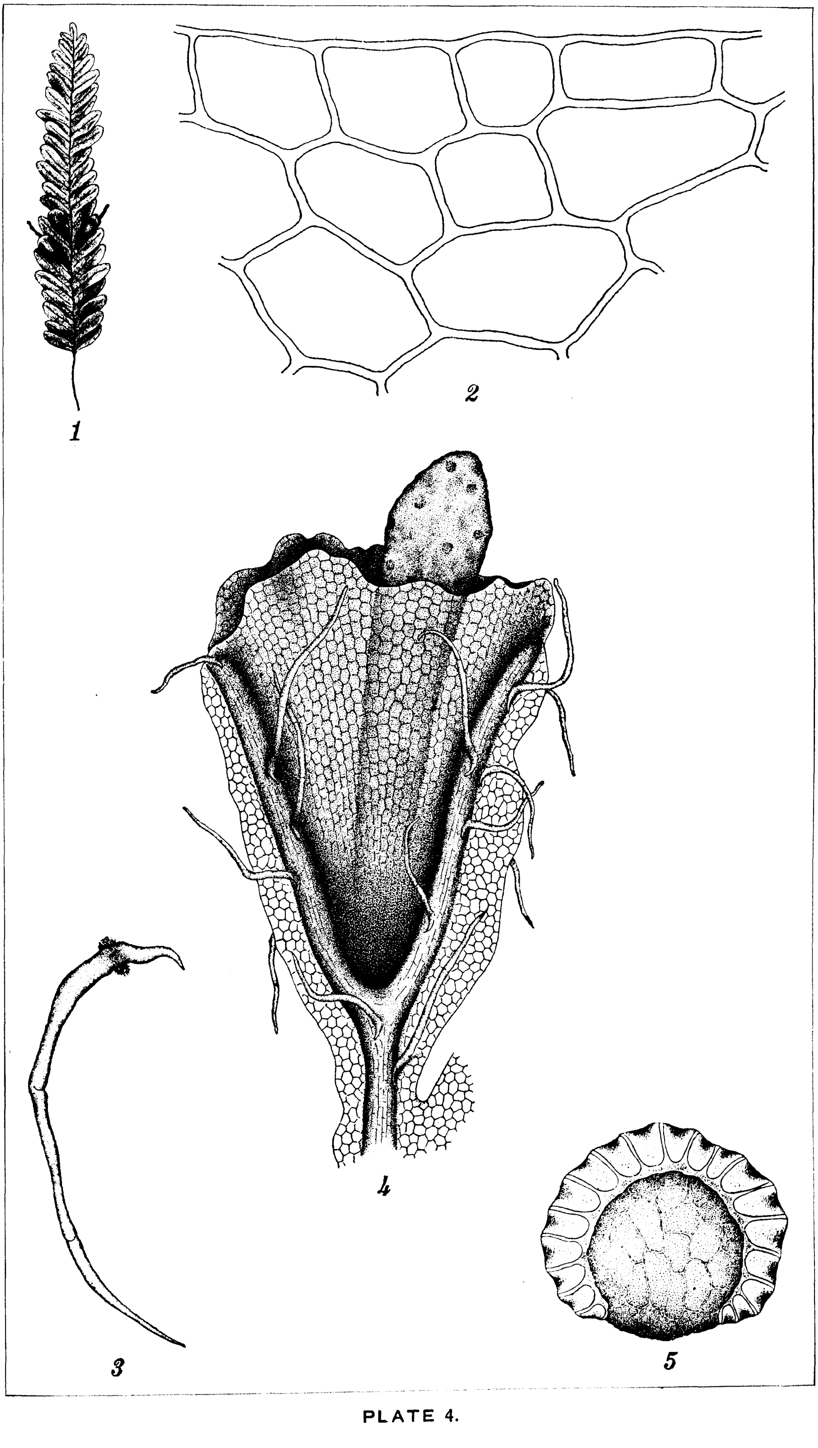


PLATE 4.

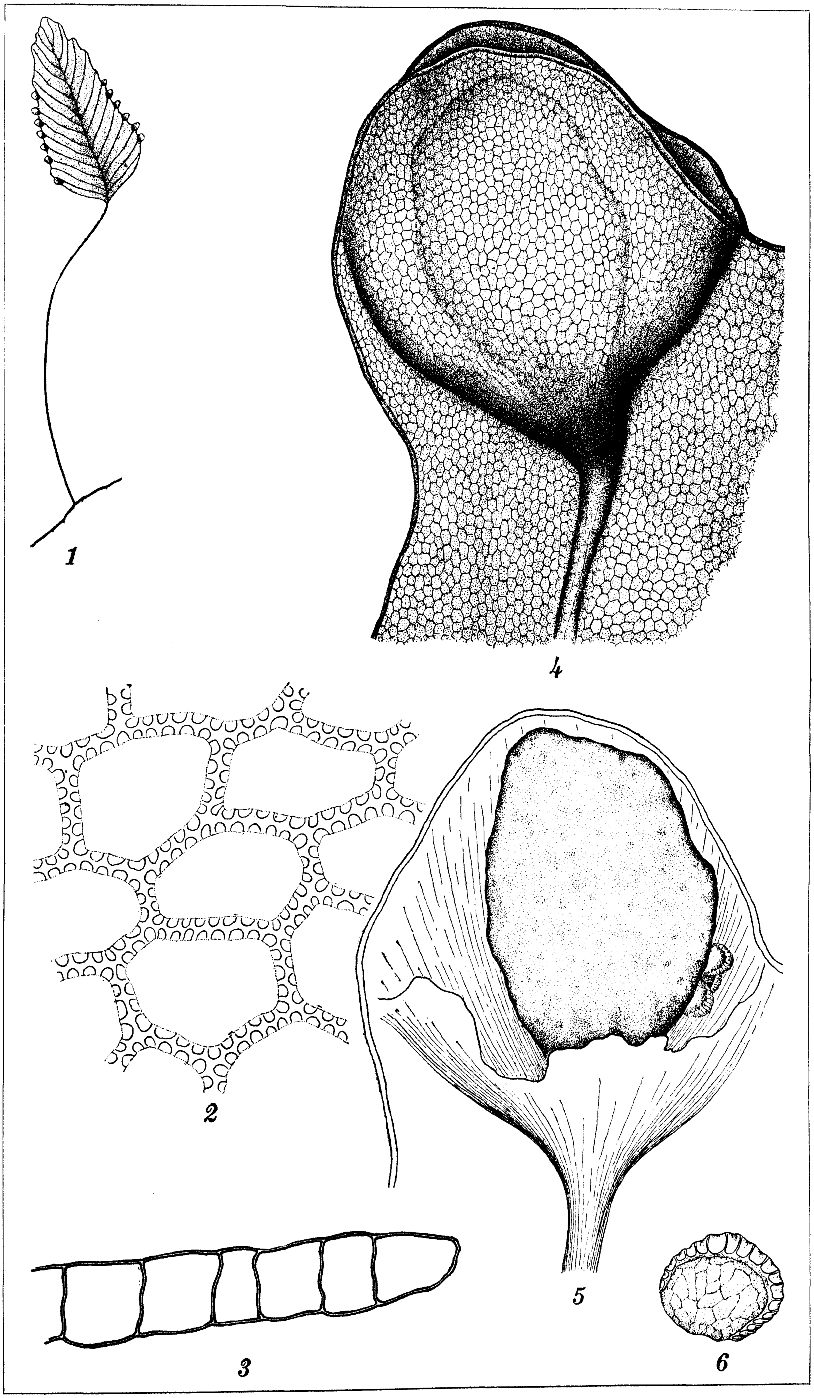


PLATE 5.

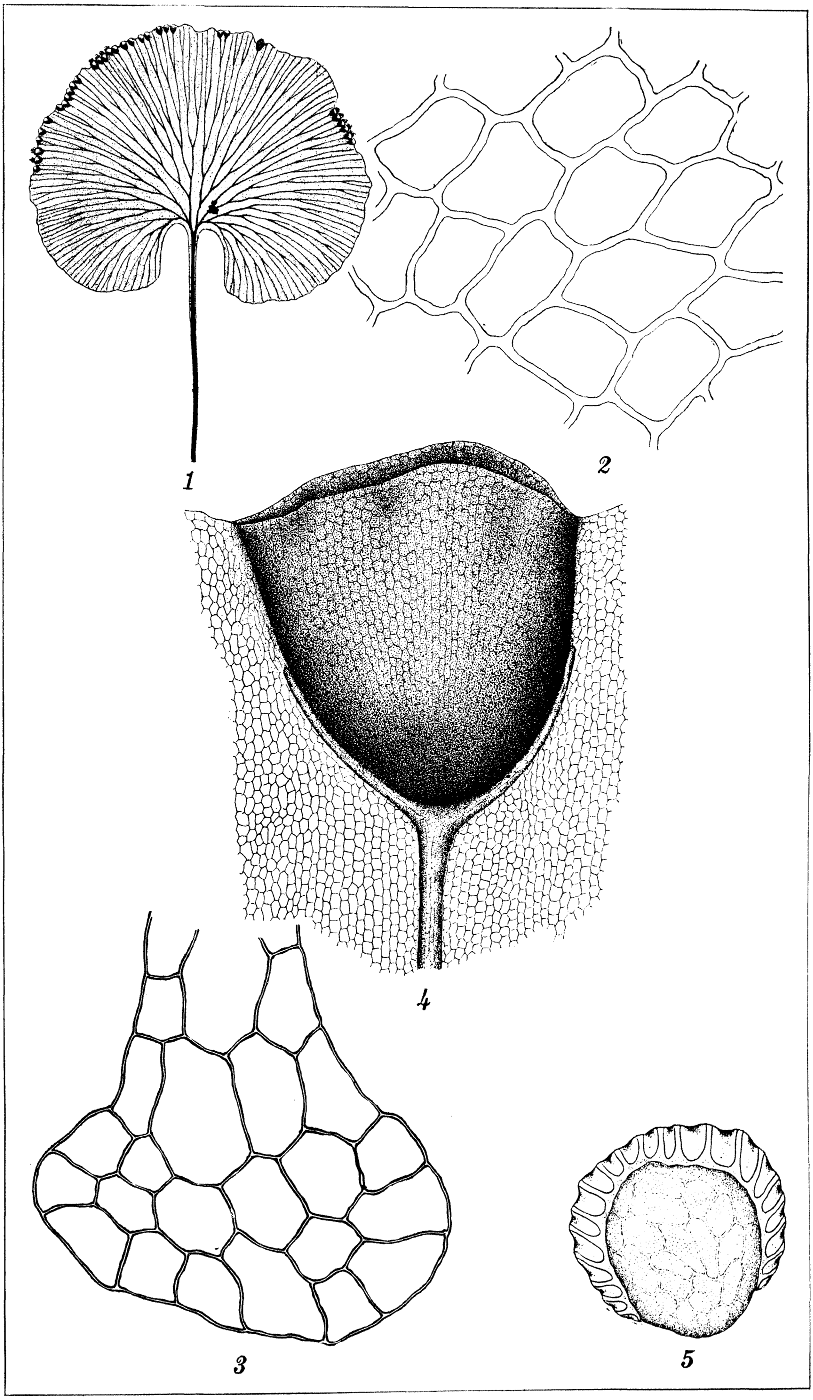


PLATE 6.

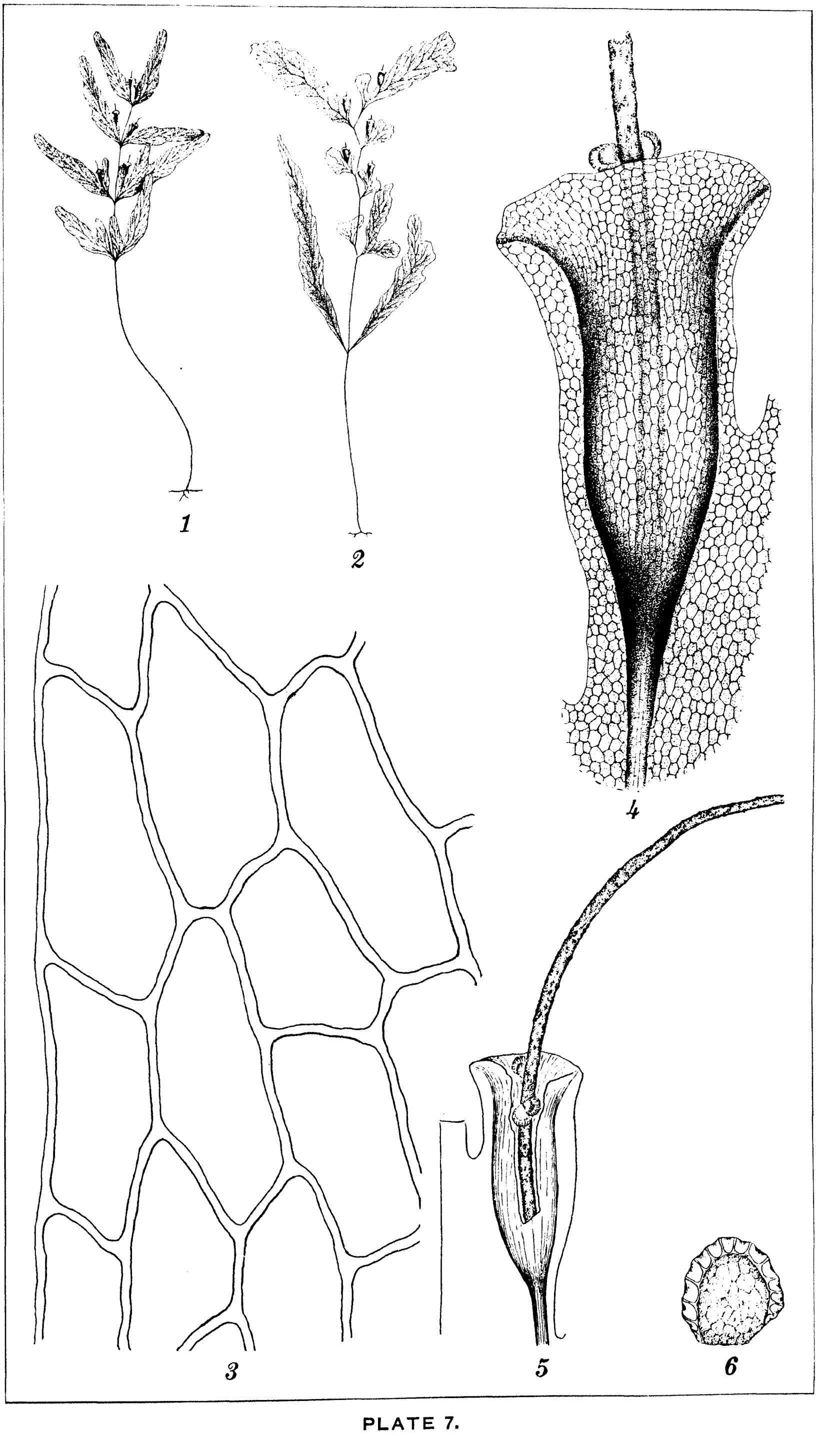


PLATE 7.

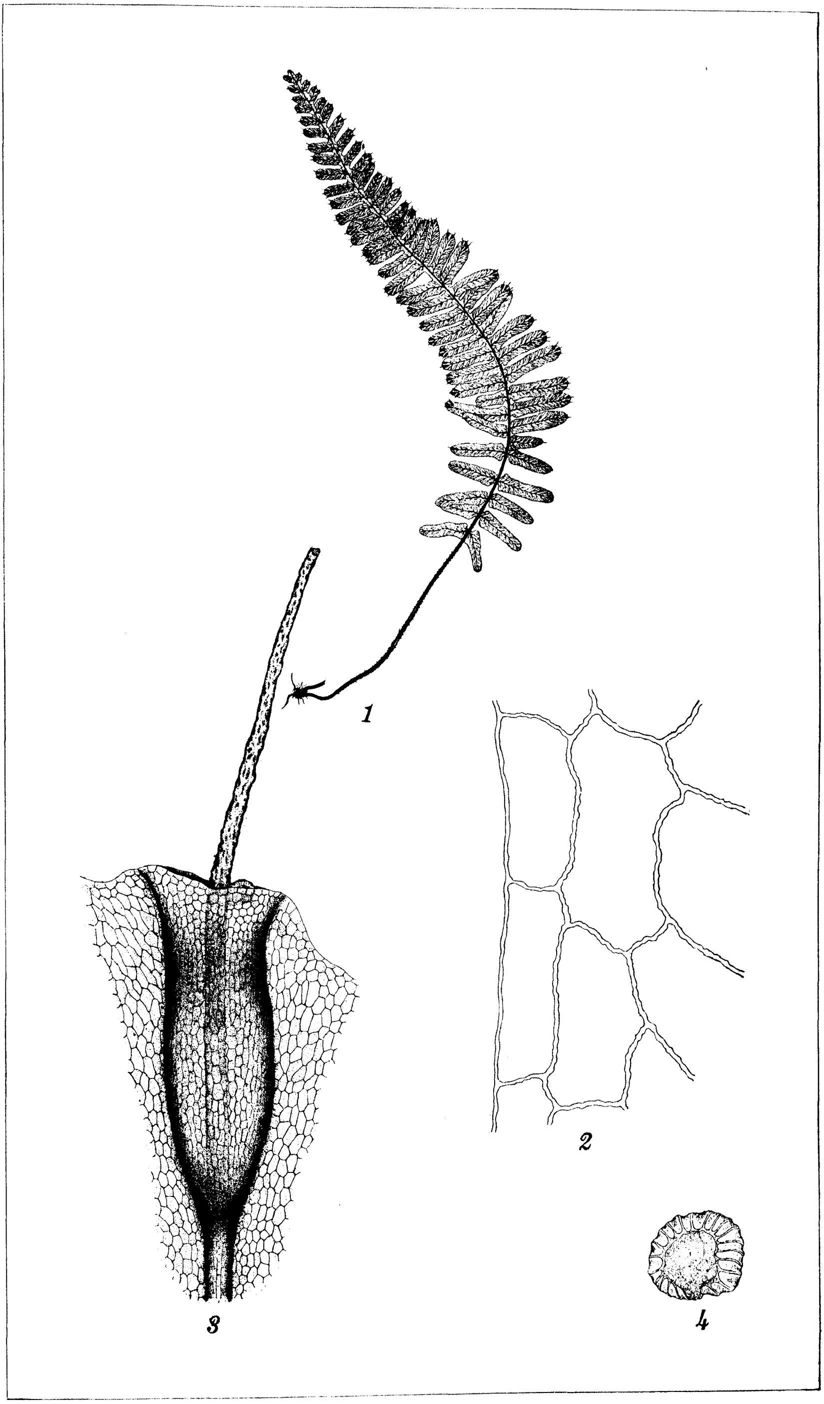


PLATE 8.

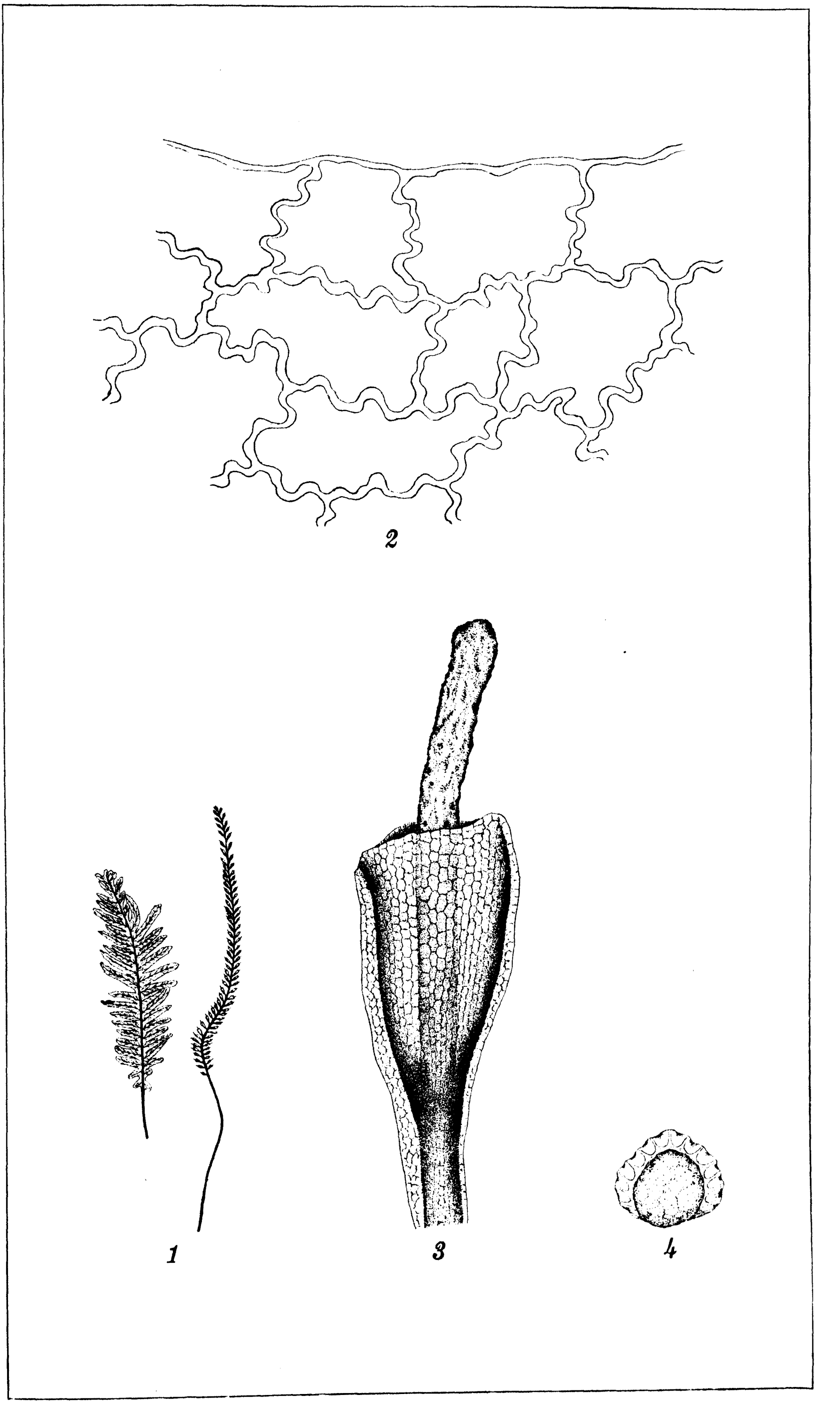


PLATE 9.

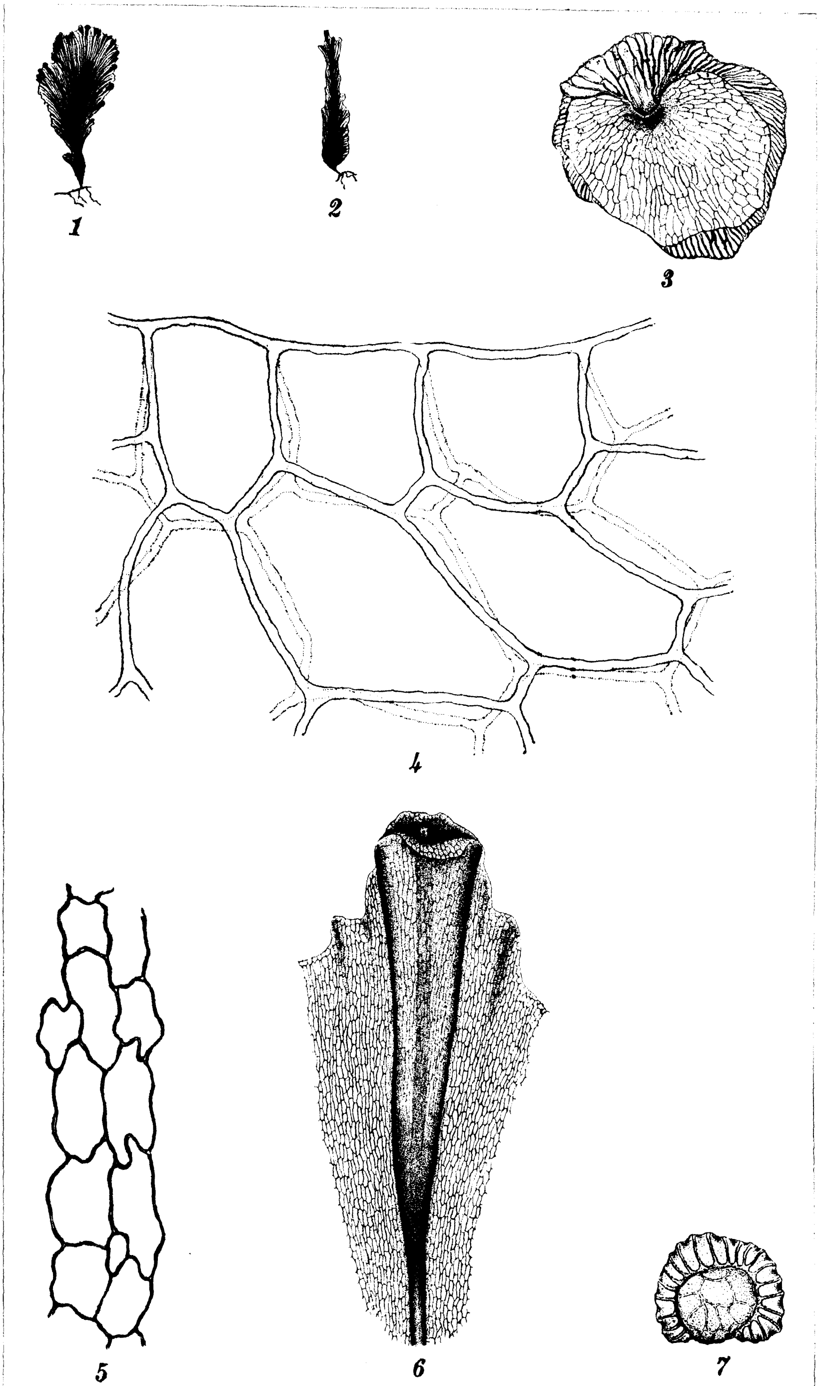


PLATE 10.

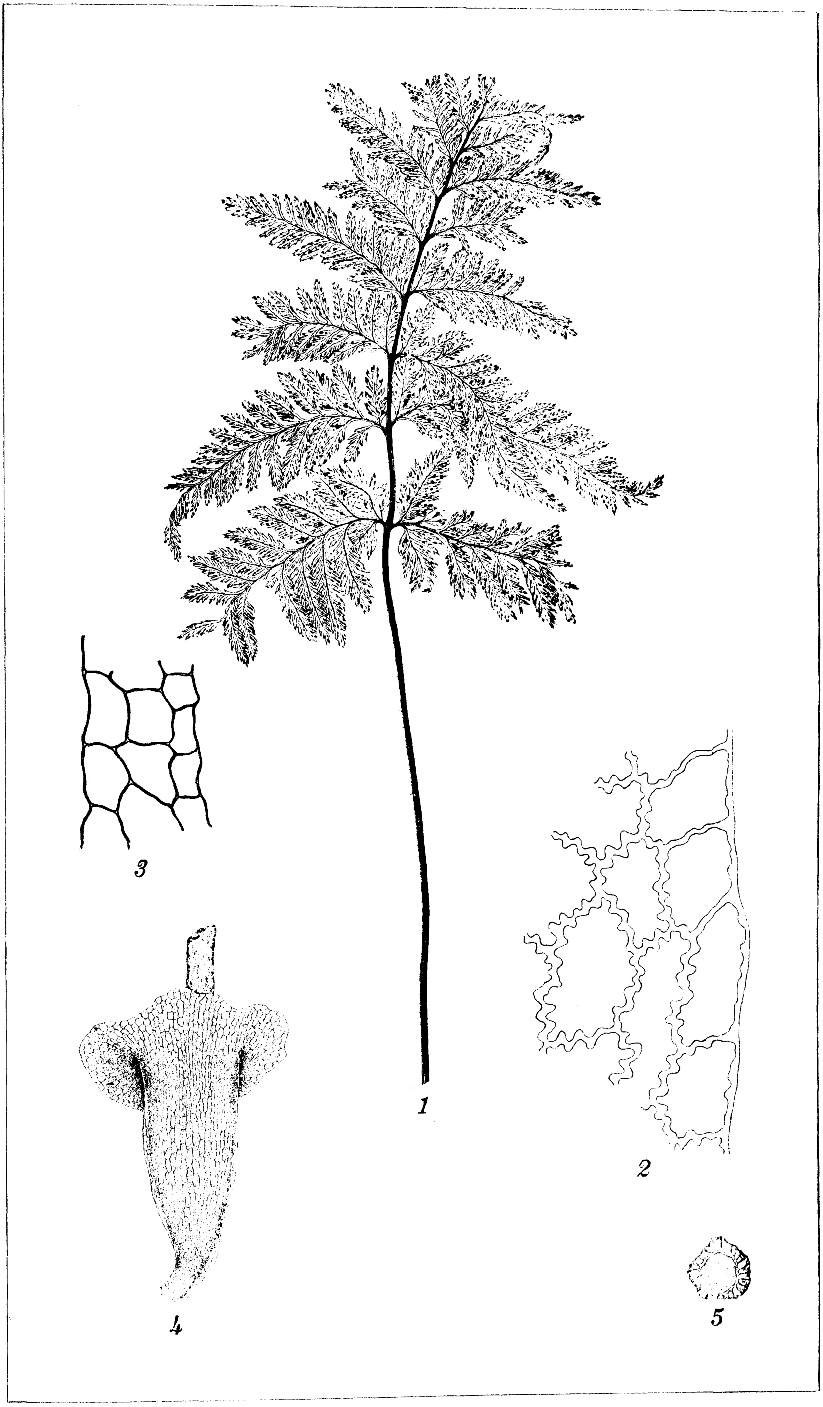


PLATE 11.

THE PHILIPPINE
JOURNAL OF SCIENCE

VOL. 67 OCTOBER, 1938 No. 2

THE NUTRITION OF FILIPINO STUDENT OFFICERS

By IGNACIO E. VILLANUEVA [1]

Of the Magnolia Dairy Products Company, Manila

Proper nutrition is necessary for health and efficiency. The present investigation is made on the nutrition of the student officers in the Reserve Officers Service School at Camp Henry T. Allen, Baguio, Mountain Province, Philippines.

Baguio is located at an elevation of nearly 5,000 feet and is very sanitary. It has a large, well-constructed market which is open every day. Fresh meats, fish, and many kinds of vegetables and fruits are usually on sale there.

During the week of October 9 to October 15, 1936, a study was made of the daily ration of the 174 student officers who ate at the Quezon Mess Hall. The average temperature of Baguio during this period was 16.6° C.

The weights and amounts of the food materials used daily for a period of seven days were recorded. The individual weights of the student officers were obtained from the Post Surgeon's Office. The average body weight of the students was 55.4 kilograms, and the distribution of body weights was as follows:

Percentage of students.	Average body weight. Kilos.
26.35	43–50
46.62	51–60
20.94	61–70
5.40	71–80
0.69	81–83

The maximum and minimum weights found were 83 and 43 kilograms respectively. The ages ranged from 22 to 46 years.

The results of this investigation are given in Tables 1 to 4.

[1] Formerly on active duty as Probationary Third Lieutenant, Philippine Army Reserve.

TABLE 1.—*Individual food intake per day of Filipino student officers.*

Date.	Proteins.	Fats.	Carbohydrates.	Ash.	Fuel value.
October, 1936	*g.*	*g.*	*g.*	*g.*	*Calories.*
9	229	280	383	29	5,063
10	150	288	303	19	4,885
11	152	108	868	24	5,193
12	148	136	551	22	4,118
13	170	165	679	29	5,098
14	80	69	445	12	2,711
15	234	193	430	31	3,762
Total	1,183	1,239	3.659	166	30,830
Average	169	177	522	23	4,404

Table 1 shows that the average individual intake per day of the student officers was as follows: Proteins, 169 grams; fats, 177 grams; carbohydrates, 522 grams; with a fuel value of 4,404 calories. The average ash consumption was only 23 grams.

Table 2 shows that the individual food intake of the student officers is relatively high compared to the individual intake of foreign armies. Generally, when the necessary funds are available, the Filipino diet consists of rice, fish, meat, fruits, and vegetables. Milk, although a rich food, is used only by the very few who have the means to purchase it.

TABLE 2.—*The individual food intake of Filipino student officers compared with those of other organizations.*

Countries.	Proteins.	Fats.	Carbohydrates.	Calories.
	g.	*g.*	*g.*	
British Home Ration (1918)	124.0	136.00	419.00	3,483
Canadian (1918)	107.0	118.00	344.00	2,946
French Normal March (1918)	138.0	98.00	467.00	3,604
Italian (1917)	127.0	38.00	469.00	2,797
United States (1921)	147.0	174.00	643.00	4,859
United States Training Camps	129.0	136.00	545.00	3,898
Philippine Constabulary[a]	116.9	14.23	579.41	3,731
Reserve Officers Service School	169.0	177.00	522.00	4,404

[a] Concepcion, I., Philip. Journ. Sci. 62 (1937) 89. All other data, given in the table were taken from L. R. Murlin and F. M. Hildebrandt, Amer. Journ. Physiol. 49 (1919) 531.

The protein intake was high, being 169 grams compared to 107 grams for the Canadians. The student officers had much more protein intake than those of the Philippine Constabulary (116.9 grams) as found by Concepcion. Fat was also very high, about twice as much as the intake of the Philippine Constabulary and nearly six times as much as that of the Italians. The United States Army has the highest carbohydrate intake, 643 grams, with the Philippine Constabulary second and the student officers fourth. The Canadians have the lowest carbohydrate intake (344 grams). The diet of the Philippine student officers had a fuel value of 4,404 calories, next to that of the United States Army diet, which has 4,859. The Philippine Constabulary has a higher carbohydrate intake than have the student officers, but the latter exceed in proteins and fats, with a difference in fuel value of 673 calories.

The protein and fuel values per kilogram body weight, as compared with those given by Concepcion for the Philippine Constabulary, are shown in Table 3, which shows that the diet of the student officers has a higher fuel and protein value per kilogram body weight than the Constabulary and the United States Army Training Camps, with a difference of 12.03 and 20.80 calories for fuel values and 0.94 and 1.11 calories for proteins per kilogram body weight, respectively.

TABLE 3.—*Average weight and protein and calorific value per kilogram body weight of Filipino student officers as compared with similar data for other organizations.*

Organization.	Average weight.	Fuel value, in calories.		Protein, in calories.	
	kg.	*Total.*	*Per kg.*	*Total.*	*Per kg.*
Philippine Constabulary	55.3	3,731.21	67.47	116.9	2.11
United States Army Training Camp	66.4	3,898.00	58.7	219.0	1.94
Philippine Scouts	55.0	3.672.00	66.7		
Reserve Officers Service School	55.4	4.404.00	79.5	169.0	3.05

Table 4 shows the percentage distribution of nutrients in relation to calories as compared with the data obtained, and the recommendations made by previous investigators. In Table 4 33.82 per cent was the grain products and cereals consumption compared to 67.94 per cent found by Concepcion for the Constabulary rations. The results, however, are close to those of Rose for a moderate diet. Meat, fish, and eggs constitute more than twice the Constabulary ration and Concepcion's recommendation for low-cost diet. Milk and dairy products are very low, only 2.08 per cent. During the early days of training there was a large supply of milk, but when it was found that a financial deficit was likely to occur the milk was reduced in order that the mess allowance could conform to the allowance for each student officer.

TABLE 4.—*Percentage distribution of nutrients in relation to calories as compared with those recommended by previous workers.*

Food materials.	Moderate (Rose).	Recommended by Concepcion for low-cost diet.	Concepcion's Constabulary ration.	Reserve Officers Service School.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*
Grain products or cereals	30	50	67.94	33.82
Meat, fish, and eggs	15	10	10.40	24.57
Milk and dairy products	13	10	2.30	2.08
Fruits and vegetables	15	17	7.40	16.83
Fatty foods and cereals	27	13	4.60	18.16
Sugar and sweets	----------	----------	6.8	----------
Miscellaneous	----------	----------	0.56	4.54

The writer is in accord with the recommendations of Concepcion that an additional allowance be made for the student officers and the Constabulary to overcome the existing calcium and phosphorus deficiency in the diets of these organizations.

Although the percentage of fatty foods was much higher than recommended by Concepcion, it falls below the percentage recommended by Rose.

SUMMARY

A dietary study was made of the food served the Filipino Student Officers at the Reserve Officers Service School at Camp Henry T. Allen, Baguio.

This investigation was conducted for seven days.

There were 174 individuals of various body weights, with an average weight of 55.4 kilograms, and their ages ranged from 22 to 46 years.

The average individual intake per day as found was as follows: 169 grams proteins, 177 grams fats, 522 grams carbohydrates, 23 grams ash, and a fuel value of 4,404 calories.

When the officers do extensive muscular work and a greater fuel value is needed they should be given more carbohydrate foods.

More milk should be given to the officers. The importance of this food lies in the fact that it is a source of proteins, minerals, and vitamins.

Meat, fish, and eggs should be served as often as possible, provided they are cooked variably. The diet should be made palatable, efficient, and reasonably inexpensive.

As compared with that of other organizations, it appears that the food served at the Reserve Officers Service School in Baguio is of fair quality.

LITERATURE

ADRIANO, F. T. The proximate chemical analyses of Philippine foods and feeding stuffs. Philip. Agriculturist **14** (1925) 57.

ADRIANO, F. T., MAMERTA MANAHAN, and FRANCISCO BARRO. The proximate chemical analyses of Philippine foods and feeding stuffs, II. Philip. Agriculturist **18** (1929) 119.

ADRIANO, F. T., H. T. RAMOS, and LAURO YNALVEZ. The proximate chemical analyses of Philippine foods and feeding stuffs, III. Philip. Agriculturist **20** (1932) 530.

ADRIANO, F. T., and M. S. DE GUZMAN. The proximate chemical analyses of some Philippine food products, IV. Philip. Agriculturist **20** (1932) 580.

CONCEPCION, ISABELO. Nutritional requirement of Filipinos. Journ. of Philip. Is. Med. Assoc. (1) **13** (1933) 26.

CONCEPCION, ISABELO. The nutritive value and cost of the Philippine Constabulary ration. Philip. Journ. Sci. **62** (1937) 89.

HERMANO, A. J. Food Values. Bur. Sci. Pop. Bull. **16** (1932).

MARAÑON, J. Nutritive mineral value of Philippine food plants (calcium, phosphorus, and iron contents). Philip. Journ. Sci. **58** (1935) 317.

SANTOS, F. O., and F. T. ADRIANO. The Chemical composition of Philippine Food Materials. The Government of the Philippine Islands Dept. of the Interior, Office of the Public Welfare Commission. Manila (1929) 1.

THE SYSTEMATIC POSITION OF SOME TREMATODES REPORTED FROM THE PHILIPPINES

By MARCOS A. TUBANGUI
Of the Bureau of Science, Manila

and

CANDIDO M. AFRICA
Of the School of Hygiene and Public Health, University of the Philippines, Manila

THREE TEXT FIGURES

Among the trematodes reported from the Philippines by Tubangui (1933) and Africa and Garcia (1935) are some species the systematic status of which has been open to question. For this reason it was decided to study again their morphology so that their systematic relationships may be better established.

Family MICROPHALLIDÆ Travassos, 1920

Genus SPELOTREMA Jaegerskioeld, 1901

SPELOTREMA BREVICÆCA (Africa and Garcia, 1935) comb. nov. Text fig. 1.

Synonym.—Heterophyes brevicæca Africa and Garcia, 1935.

This trematode is considered a dangerous parasite of man, its eggs having been found by Africa and his collaborators (1935, 1936, 1937) associated with lesions in the heart, brain, and spinal cord of persons who died of acute cardiac dilatation. Recently it was encountered by one of us (C. M. A.) in the intestine of a bird (*Sterna albifrons sinensis*).

The fluke presents several morphological features which are not encountered among the established members of the genus *Heterophyes* Cobbold. The examination of a large number of stained specimens has shown among other things the absence of a receptaculum seminis, and this fact alone would exclude the parasite from the family Heterophyidæ, as the latter has been defined by Witenberg (1929). In that respect as well as in the location of the genital glands, the absence of a gonotyl, and the possession of short intestinal cæca, it resembles another group of flukes represented by the genera *Levinseniella* Stiles and Hassall, 1901, *Spelotrema* Jaegerskioeld, 1901, and *Spelophallus* Jaegerskioeld, 1908. The status of these three genera, which seem to differ from each other mainly in the structure of the terminal portions of the genitalia, does not appear to have been fully established; but relying on their being independent zoölogical units we refer the trematode in question to the genus *Spelotrema* because of its great similarity to the members of the latter.

The position of *Spelotrema* and related genera in the scheme of classification of the trematodes has been a matter of uncertainty. Some writers have classified them together with *Microphallus, Maritrema,* and *Monocæcum,* under the subfamily Microphallinæ of the Heterophyidæ; while others have removed these different genera from the heterophyids and placed them in a separate family, the Microphallidæ. According to Mueller and Van Cleave (1932), however, "Until the detailed morphology of Levinseniella, Spelotrema, Spellophallus, Monocæcum and Maritrema has been determined as compatible with that of Microphallus, these genera should be excluded from the Microphallidae, though Poche (1926: 151) has attempted to relate them to the subfamily Microphallinae." Recently Rothschild (1937) studied the excretory system of a species of *Maritrema* and observed that it corresponds with that of *Microphallus* and allied genera. On the basis of our interpretation of the anatomy of *Spelotrema brevicæca* we have included *Spelotrema* in the family Microphallidæ because it agrees with *Microphallus* in many important points, such as the absence of a gonotyl, a cirrus pouch, and a seminal receptacle, and the general plan of the main excretory system.

Description.—Spelotrema: Body pyriform to triangular in outline, thinner anteriorly than posteriorly, 0.5 to 0.7 by 0.3 to 0.4 millimeter; in preserved specimens dorsal surface convex, ventral surface concave, with acetabulum prominently elevated. Cuticle armed with scalelike spines from anterior end to posterior level of vitellaria. Oral sucker subterminal, 0.065 to 0.095 millimeter in diameter; acetabulum slightly larger than oral sucker, 0.080 to 0.105 millimeter across, at middle of body length or behind that level in well-extended specimens. Prepharynx very short, in most specimens practically absent; pharynx 0.032 to 0.034 by 0.034 to 0.043 millimeter; œsophagus 0.08 to 0.09 millimeter long, with relatively thick walls but narrow lumen; intestinal cæca wide in diameter but short, only 0.15 to 0.19 millimeter long, not reaching posteriorly beyond middle level of acetabulum. Genital pore near left margin of acetabulum, communicating with a small genital sinus.

Testes globular to oval, postovarial, 0.052 to 0.075 by 0.067 to 0.094 millimeter, with zones coinciding and fields widely separated, one on each side of body behind level of acetabulum, and more or less completely concealed in ventral view by anterior

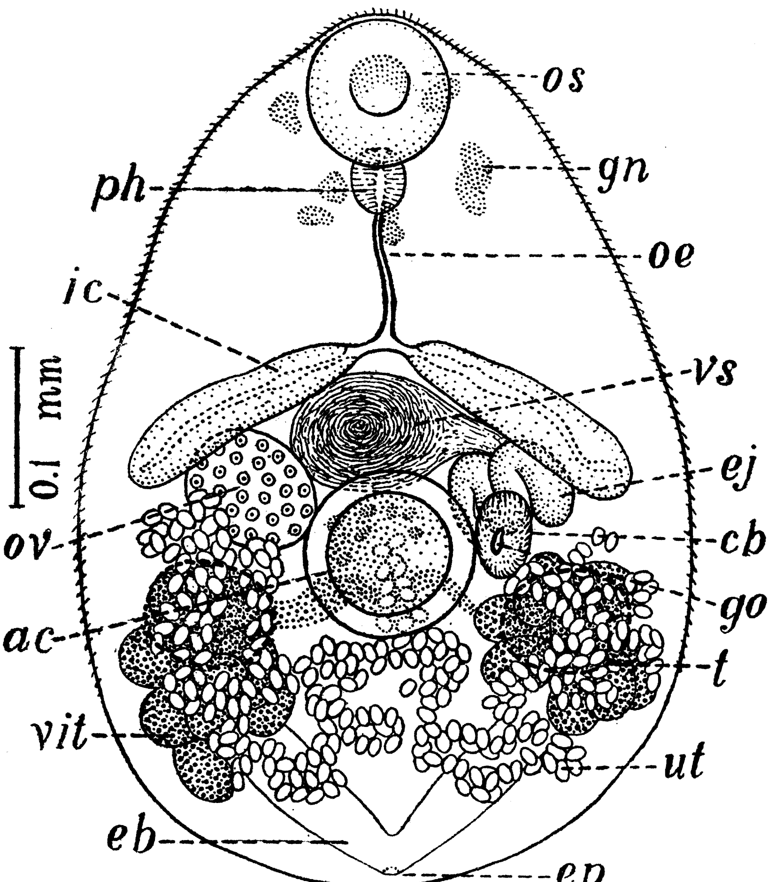


FIG. 1. *Spelotrema brevicæca* (Africa and Garcia, 1935). Entire worm, ventral view.

vitelline follicles and uterus. Seminal vesicle large, pyriform, 0.090 to 0.110 by 0.055 to 0.075 millimeter, crowded in between intestinal cæca and acetabulum and slightly overlapped by latter; in contracted specimens it is displaced posteriorly, dorsal to acetabulum. Seminal vesicle followed by a short prostate and then a long coiled ejaculatory duct which opens into a genital sinus through the apex of a muscular, cone-shaped body (kegelförmiger Körper) that measures 0.037 to 0.045 by 0.030 to 0.034 millimeter.

Ovary slightly oval, usually a trifle larger than testes, 0.052 to 0.098 by 0.067 to 0.105 millimeter, at or near middle of body length, on right side of median line, between acetabulum, right intestinal cæcum, and right testis. Seminal receptacle absent. Uterus moderately long, loosely coiled, mostly postacetabular, its terminal portion (metraterm) opening into genital sinus near base of conical body and to left of male genital opening. Vitellaria prominent, mostly posttesticular, follicular. consisting of two groups of 7 to 9 (usually 8) oval to roundish follicles each. Small vitelline reservoir and shell gland median, immediately behind acetabulum. Eggs small, yellowish, operculated, 15 to 16 by 9.4 to 10 microns.

Excretory pore dorsoterminal at posterior end of body; excretory bladder V-shaped, its branches reaching anteriorly to level of acetabulum.

Hosts.—Man and the bird, *Sterna albifrons sinensis* Gmelin.

Location.—Intestines.

Locality.—Manila, Philippines.

Compared with the members of the genus *Spelotrema* listed by Jaegerskioeld (1908), the Philippine parasite appears to be most closely related to *Spelotrema similis.* It may be distinguished from the latter by its shorter œsophagus, greater number of vitelline follicles, and smaller eggs.

Family HETEROPHYIDÆ Odhner, 1914

Genus HETEROPHYOPSIS novum

HETEROPHYOPSIS EXPECTANS (Africa and Garcia, 1935) comb. nov. Text fig. 2.

Synonym.—*Heterophyes expectans* Africa and Garcia, 1935.

This trematode was originally reported from dogs. Recently it was found by one of us (M. A. T.) in the small intestine of a bird, *Fregata ariel ariel* (G. R. Gray), which was caught in Obando, Bulacan Province, Luzon, and obtained for dissection through the courtesy of Dr. C. Manuel, of the Fish and Game Administration Division of the Bureau of Science. By means of feeding experiments with young dogs, it was determined by Vasquez-Colet and Africa (1938) that the parasite utilizes several species of marine fishes as second intermediate hosts.

In their original description Africa and Garcia (1935) called attention to a number of morphological features which separate this fluke from the established members of the genus

Heterophyes; namely, the relative position of the testes, the location of the vitellaria and acetabulum, and the number of hooks found on the gonotyl. To these should be added the extent of the uterus which is not confined between the testes and the acetabulum, as is the case in members of the genus *Heterophyes,* but passes posteriorly beyond the testes to near the posterior end of the body; and the shape of the excretory bladder which has a long S-shaped stem, instead of a short one as found in *Heterophyes.* We consider these differences to be of more than specific importance, and for this reason we propose the new genus *Heterophyopsis* for the trematode in question.

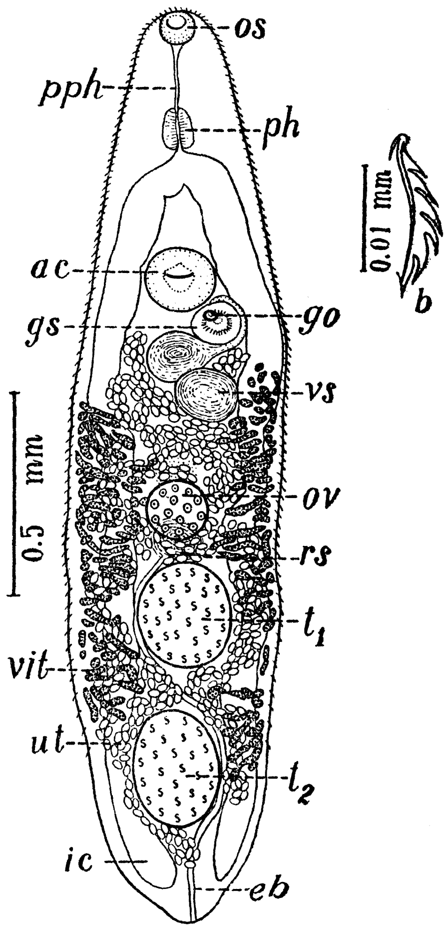


FIG. 2. *Heterophyopsis expectans* (Africa and Garcia, 1935). *a*, Entire worm, ventral view; *b*, one of the spines on the gonotyl.

Generic diagnosis.—Heterophyidæ: Body elongate. Prepharynx well marked; œsophagus very short or absent; intestinal cæca long, reaching to near posterior end of body. Acetabulum in anterior third of body length. Genital sac independent of ventral sucker, sinistral, alongside posteroexternal border of acetabulum; gonotyl disc-shaped, occupying the whole of genital sac and armed with a circlet of serrated spines. Testes in posterior portion of body, in a straight line or one slightly obliquely behind the other. Ovary median, pretesticular, equatorial. Seminal vesicle large, immediately behind genital sac, constricted into at least two portions. Seminal receptacle behind ovary. Uterus long, loosely coiled, between genital sac and posterior end of body. Vitellaria mostly lateral, between seminal vesicle and second testis. Excretory bladder with a long S-shaped stem and two short branches. Adults in intestines of birds and mammals.

Type species.—Heterophyopsis expectans (Africa and Garcia, 1935).

Description of type species.—Heterophyopsis: Body 1.5 to 2.2 millimeters in length by 0.3 to 0.5 millimeter in maximum width across ovary. Cuticular spines thickly-set anteriorly, scantier after middle of body length, finally disappearing near posterior end. Oral sucker 0.06 to 0.09, acetabulum 0.11 to 0.17 millimeter in diameter, the latter at posterior portion of anterior third of body length. Prepharynx 0.11 to 0.27 millimeter long; pharynx 0.06 to 0.09 by 0.05 to 0.07 millimeter; œsophagus from very short, practically absent, to 0.06 millimeter long; intestinal cæca reaching to near posterior end of body.

Genital pore immediately behind acetabulum, to left side of median line, at tip of gonotyl which measures 0.08 to 0.10 by 0.08 to 0.13 millimeter and is provided with a circlet of serrated spines about 15 microns long.

Testes roundish to oval, median, postovarial, one immediately behind the other in a straight line or a little obliquely; anterior testis 0.12 to 0.27 by 0.12 to 0.22, posterior testis 0.13 to 0.29 by 0.11 to 0.22 millimeter. Seminal vesicle median, prominent, constricted near middle of its length into two portions; prostate short; ejaculatory duct narrow, passing anteriorly around left border of genital sac, then bending posteriorly towards genital pore.

Ovary globular, median, at or near middle of body length, 0.09 to 0.16 millimeter in diameter. Receptaculum seminis almost as large as ovary when well distended with spermatozoa, median or sometimes displaced to either side of median line. Uterus moderately long. Vitellaria consisting of irregularly shaped follicles arranged in two lateral bands and extending from level of seminal vesicle to as far as middle level of second testis. Transverse vitelline ducts meeting dorsal to ovary to form a small vitelline reservoir. Shell gland dorsal to ovary and slightly anterior to it. Eggs oval, yellowish, thick-shelled, with a slight "shouldering" at opercular end, 22.5 to 26.3 by 14 to 18 microns.

Excretory pore terminal at posterior end; excretory bladder with a long S-shaped stem which divides into two short branches behind ovary.

Hosts.—Dog and the bird, *Fregata ariel ariel* (G. R. Gray).
Location.—Small intestine.
Localities.—Manila; Obando, Bulacan Province, Luzon.

Genus GALACTOSOMUM Looss, 1899

GALACTOSOMUM ANGUILLARUM (Tubangui, 1933) comb. nov. Text fig. 3.

Synonym.—*Haplorchis anguillarum* Tubangui, 1933.

Chen (1936) has called attention to the systematic status of this trematode which, according to him, does not belong in the genus *Haplorchis* Looss, 1899. A reëxamination of the original side and its comparison with the different members of the famly Heterophyidæ has shown that Chen is correct in his contention and that the parasite has closer affinity with species of the genus *Galactosomum* Looss, 1899, than with those of *Haplorchis*.

It may be of interest to note that *Galactosomum anguillarum* is the second sexually immature heterophyid to be recorded from the intestines of fishes, the other one being *Apophallus americanus* Van Cleave and Mueller, 1932. Although Mueller and Van Cleave (1932) have described a number of adult heterophyids belonging to distinct genera from fishes, it is doubtful if species of *Galactosomum* and *Apophallus* can develop into full maturity in this group of hosts.

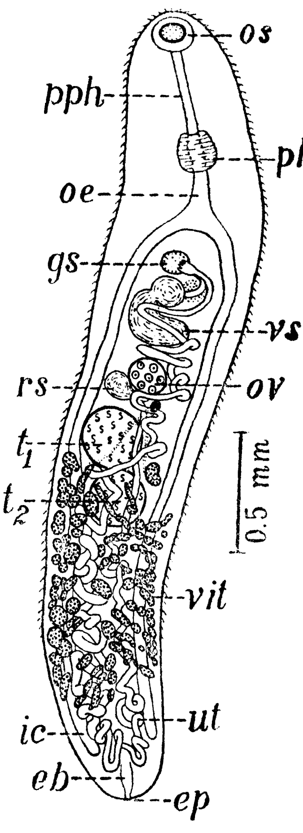


FIG. 3. *Galactosomum anguillarum* (Tubangui, 1933). Entire worm, ventral view.

Description.—*Galactosomum*: Body elongate, 2.9 by 0.56 millimeters. Cuticle armed with numerous small spines from anterior end to level midway between second testis and posterior end of body. Oral sucker 0.15 by 0.18 millimeter; acetabulum absent. Prepharynx 0.34 millimeter long; pharynx 0.14 by 0.16 millimeter; œsophagus 0.18 millimeter long; intestinal cæca reaching to about 0.2 millimeter from posterior end of body.

Genital pore median, behind œsophageal bifurcation, at junction of anterior and middle thirds of body length. Genital sac occupied wholly by pyriform gonotyl measuring 0.10 by 0.13 millimeter and armed with five stout hooks.

Testes roundish in outline, postovarial, one immediately but somewhat obliquely behind the other; anterior testis 0.26, posterior testis 0.24 millimeter in diameter. Seminal vesicle median, between gonotyl and ovary, 0.42 by 0.13 millimeter, bent and constricted at anterior third of its length into two unequal portions. Prostate short, followed by equally short ejaculatory duct.

Ovary median, slightly oval and compressed, immediately preequatorial, 0.14 by 0.17 millimeter. Oviduct arising from posterior border of ovary. Receptaculum seminis well developed, immediately behind ovary and to right side of median line. Vitellaria moderate, meeting in median line and extending from posterior level of first testis to in front of blind ends of intestinal cæca. Vitelline reservoir and shell gland behind ovary, alongside seminal receptacle. Uterus moderately long, mostly posttesticular, arranged in short descending and ascending coils, and reaching posteriorly beyond terminations of cæca. No eggs present.

Excretory pore posteroterminal; excretory bladder Y-shaped.

Host.—*Anguilla mauritiana* (Bennet).

Location.—Intestine.

Locality.—Palo, Leyte.

REFERENCES

AFRICA, C. M., and E. Y. GARCIA. Heterophyid trematodes of man and dogs in the Philippines with descriptions of three new species. Philip. Journ. Sci. 57 (1935) 253–267.

AFRICA, C. M., E. Y. GARCIA, and W. DE LEON. Intestinal heterophyidiasis with cardiac involvement: a contribution to the etiology of heart failures. Philip. Journ. Publ. Health 2 (1935) 1–22.

AFRICA, C. M., W. DE LEON, and E. Y. GARCIA. Heterophyidiasis. IV, Lesions in the myocardium of eleven infested hearts including three cases with valvular involvement. Philip. Journ. Publ. Health 3 (1936) 1–27. V, Ova in the spinal cord of man. Philip. Journ. Sci. 62 (1937) 393–399.

CHEN, H. T. A study of the Haplorchinae (Looss, 1899) Poche 1926 (Trematoda: Heterophyidae). Parasit. 28 (1936) 40–55.

JAEGERSKIOELD, L. A. Kleine Beitraege zur Kenntnis der Vogeltrematoden. Centralbl. Bakteriol. Parasitenk. Infektionskr. 1 Abt. Orig. 48 (1908) 302–317.

LOOSS, A. Weitere Beitraege zur Kenntniss der Trematoden-Fauna Aegyptens. Zool. Jahrb. Syst **12** (1899) 521–784.

MUELLER, J. F., and H. J. VAN CLEAVE. Parasites of Oneida Lake fishes, II. Descriptions of new species and some general taxonomic considerations, especially concerning the trematode family Heterophyidae. Roosevelt Wild Life Annals **3** (1932) 79–137.

ROTHSCHILD, M. Note on the excretory system of the trematode genus Maritrema Nicoll, 1907, and the systematic position of the Microphallinae Ward, 1901. Ann. & Mag. Nat. Hist. X **19** (1937) 355–365.

TUBANGUI, M. A. Trematode parasites of Philippine vertebrates, VI. Descriptions of new species and classification. Philip. Journ. Sci. **52** (1933) 167–197.

VAN CLEAVE, H. J., and J. F. MUELLER. Parasites of the Oneida Lake fishes, I. Descriptions of new genera and new species. Roosevelt Wild Life Annals **3** (1932) 9–71.

VASQUEZ-COLET, A., and C. M. AFRICA. Determination of the piscine intermediate hosts of Philippine heterophyid trematodes by feeding experiments. Philip. Journ. Sci. **65** (1938) 293.

WITENBERG, G. Studies on the trematode family Heterophyidae. Ann. Trop. Med. and Parasit. **23** (1929) 131–239.

ILLUSTRATIONS

TEXT FIGURES

[Abbreviations: *ac*, Acetabulum; *cb*, cone-shaped body (genital papilla); *eb*, excretory bladder; *ej*, ejaculatory duct; *ep*, excretory pore; *gn*, nerve ganglion; *go*, genital opening; *gs*, genital sac; *ic*, intestinal cæcum; *oe*, œsophagus; *os*, oral sucker; *ov*, ovary; *ph*, pharynx; *pph*, prepharynx; *rs*, seminal receptacle; *t*, testis; *ut*, uterus; *vit*, vitelline glands; *vs*, seminal vesicle.]

FIG. 1. *Spelotrema brevicæca* (Africa and Garcia, 1935). Entire worm, ventral view.

2. *Heterophyopsis expectans* (Africa and Garcia, 1935). *a*, Entire worm, ventral view; *b*, one of the spines on the gonotyl.

3. *Galactosomum anguillarum* (Tubangui, 1933). Entire worm, ventral view.

NEW OR LITTLE-KNOWN TIPULIDÆ FROM EASTERN ASIA (DIPTERA), XL

By CHARLES P. ALEXANDER
Of Amherst, Massachusetts

THREE PLATES

The crane flies discussed in the present report are all from northern Korea (Chosen), where they were collected by Mr. Alexander Yankovsky, well-known entomologist and naturalist. The materials included are from a variety of localities that may be grouped under the following four major categories:

OMPO, altitude 120 to 2,000 feet; average, 600 to 800 feet.

MOUNT CHONSANI (Chonsany), Paiktusan, on the border of Manchuria, altitude 3,000 to 5,100 feet, July 12 to 26, 1937.

SEREN MOUNTAINS, 30 miles above the Ompo River, altitude 2,100 to 6,200 feet.

YANCHEN LAKE, 80 miles northeast of Ompo, altitude 30 to 65 feet.

I wish to express my very deep gratitude to Mr. Yankovsky for the time and care that he has devoted to the collecting of the Korean Tipulidæ. All types are preserved in my collection of these flies. I am including in this report a few species of the families Tanyderidæ and Trichoceridæ, commonly called crane flies though not belonging to the restricted family Tipulidæ.

TANYDERIDÆ

PROTANYDERUS YANKOVSKYI sp. nov. Plate 1, fig. 1.

Large (wing, 14 millimeters or more); antennal flagellum yellow; mesonotal præscutum gray, with four poorly defined more brownish stripes; scutellum testaceous yellow; knobs of halteres dark brown; femora yellow, tips blackened, tibiæ and tarsi black; wings whitish subhyaline with four brown crossbands, the three outer crossbands interconnected by the uniformly brown cell R_4; abdomen with basal five segments brown or yellowish brown, the outer segments, including male hypopygium, black; diststyle of male hypopygium simple.

Male.—Length, about 13 millimeters; wing, 14.

Female.—Length, about 13 millimeters; wing, 14.5.

Rostrum black, a little shorter than remainder of head not including the brown porrect labial palpi; maxillary palpi black. Antennæ relatively short, 16-segmented; scape dark brown, pruinose; pedicel dark, flagellum yellow; flagellar segments cylindrical, longest verticils a little exceeding segments. Head gray; a low darkened tubercle on anterior vertex behind antennal fossa; posterior vertex a little darker.

Cervical sclerites dark brown. Pronotum gray. Mesonotal præscutum gray with four poorly defined, more brownish stripes; setigerous punctures of interspaces somewhat conspicuous; scutal lobes darkened, pruinose, median area and scutellum testaceous yellow; parascutella dark; mediotergite brown. Pleura chiefly dark brownish gray, variegated by paler gray. Halteres with stem yellow, knob dark brown. Legs with coxæ and trochanters yellow; femora yellow, tips passing into black, a little more extensive on fore femora where it includes about distal fifth; tibiæ and tarsi black. Wings (Plate 1, fig. 1) with ground color whitish subhyaline, prearcular and subcostal fields more cream-yellow; a very heavy brown pattern, distributed as follows: Cell C; four complete crossbands, the first postarcular, including basal portion of cell Cu and axillary region of anal cell; second band at cord, widened posteriorly in cells Cu and A; third band at level of fork of R_{2+3} and outer end of cell 1st M_2, more expanded at posterior border; last band apical, involving cells Sc_2 to M_1 inclusive; cell R_4 uniformly darkened, interconnecting the three outer crossbands; a major isolated dark area at origin of Rs and adjoining portion of cell Sc; a small marginal spot at end of vein M_2; veins yellow, darker in clouded areas. Venation: Cell R_2 subequal in length to its cell; cell 1st M_2 longer than any of veins beyond it.

Abdomen with basal five segments brown to yellowish brown; remaining segments, including male hypopygium, black; ovipositor small, orange. Male hypopygium with dististyle relatively long and slender, gradually narrowed outwardly.

Habitat.—Northern Korea.

Holotype, male, Chonsani, Paiktusan, altitude 4,300 feet, July 12, 1937 (*Yankovsky*). Allotopotype, female.

I name this striking species in honor of the collector, Mr. Alexander Yankovsky. The fly is very distinct from the five other members of the genus so far made known. The four Asiatic species of *Protanyderus* may be separated by the following key.

Key to Asiatic species of Protanyderus.

1. Very large (wing, 14 millimeters or more); wings with four brown crossbands, second crossband, at cord, to fourth, at apex, interconnected by uniformly darkened cell R_4 (northern Korea). *P. yankovskyi* sp. nov.
   Small (wing, under 10 millimeters); wings with crossbands, if present, narrow, not interconnected along cell R_4; interspaces, especially cell C, broken by additional spots and dots .... 2.
2. Very small (wing, male, about 6.5 to 7 millimeters); wing pattern chiefly dotted and spotted, including a series of spots in cell M adjoining vein Cu (Turkestan) .... *P. beckeri* (Riedel).
   Larger (wing, male, about 8 to 9 millimeters); wing pattern crossbanded, interspaces with restricted dots and spots; dark area at origin of Rs interconnected across cell M with darkened cloud in cells Cu and A, forming a complete oblique crossband near wing base; a continuous dark band along vein Cu, connecting basal two dark fasciæ .... 3.
3. Wings (male) narrow, not conspicuously widened opposite termination of vein A; cells M_1 and 2d M_2 at margin moderately wide, subequal to cell M_3; ædeagus with median branch much smaller than others, subatrophied (Japan; Kiushiu; Manchuria) .... *P. esakii* Alexander.
   Wings (male) broad, especially opposite termination of vein A; cells M_1 and 2d M_2 very wide at margin, much more extensive than cell M_3; ædeagus with all three branches elongate and subequal (Japan; Honshiu) .... *P. alexanderi* Kariya.

TRICHOCERIDÆ

TRICHOCERA TUBERCULIFERA sp. nov. Plate 1, fig. 2; Plate 2, fig. 25.

Belongs to *major* group; general coloration of mesonotum reddish brown, præscutum with a broad, darker brown, median stripe that is more or less divided by a central pale vitta; legs dark brown; wings with a strong brown tinge, stigma slightly darker; abdomen dark brown; male hypopygium with ventromesal lobes of basistyles not forming a continuous bridge; dististyle with a strong tubercle on mesal face at base; gonapophyses fused into a depressed median phallosome, lateral horns strongly divergent.

Male.—Length, about 7 to 7.5 millimeters; wing, 8 to 8.5.

Female.—Length, about 7.5 millimeters; wing, 8.5.

Rostrum dark brown; palpi black. Antennæ black, pedicel obscure yellow. Head dark brownish gray; vertex broad.

Mesonotum pale reddish brown, sparsely pruinose, with a broad, darker brown to brownish black median stripe that is more or less completely split by a central pale vitta; posterior sclerites of notum paler brown to brownish yellow. Pleura pale brown. Halteres dark brown, base of stem restrictedly yellow.

Legs with coxæ obscure yellow, base of fore coxæ more darkened; trochanters yellow; remainder of legs dark brown. Wings (Plate 1, fig. 2) with a strong brown tinge, the slightly darker stigma lying beyond level of R_2; prearcular field a trifle brighter; veins dark brown. Venation: R_{2+3+4} subequal to or a little shorter than R_{2+3}.

Abdomen dark brown throughout. Male hypopygium (Plate 2, fig. 25) with ventromesal lobes of basistyles, *b*, not forming a continuous bridge, touching at midline. Dististyle, *d*, of moderate length, with a low conspicuous tubercle on mesal face at base. Gonapophyses fused into a depressed median phallosome, *p*, as in the group, lateral horns strongly divergent, apex between horns gently convex. Ovipositor with cerci of moderate length, relatively slender, especially on distal half.

Habitat.—Northern Korea.

Holotype, male, Seren Mountains, altitude 5,000 feet, October 3, 1937 (*Yankovsky*). Allotopotype, female. Paratopotypes, 2 males.

I propose the name *major* for the group of species having the gonapophyses fused into a single depressed-flattened median plate, with their apices protruding laterad or caudad as strong horns. In the majority of species in this group the ventromesal lobes of the basistyles are fused at midline to form a continuous bridge. Three of the species, *Trichocera major* Edwards (northern Europe), *T. longisetosa* Alexander (western United States) and *T. setosivena* Alexander (Alaska) have simple dististyles, while *T. siberica* Edwards (northern and northeastern Asia) and *T. bituberculata* Alexander (Alaska) each have two unusually conspicuous lobes on each dististyle. The present fly is readily told from all these allied forms by possessing a single small basal tubercle on the relatively short dististyle.

TRICHOCERA SIBERICA Edwards.

Trichocera siberica EDWARDS, Ann. & Mag. Nat. Hist. IX 5 (1920) 431.

The unique type, a male, was from Verschininsk, Yenesei River, Siberia, 69° 5′ north latitude, some 3,000 miles northwest of the station here recorded. Seren Mountains, northern Korea, altitude 5,000 feet, October 3, 1937 (*Yankovsky*), males and females. The female, characterized here as allotype, differs, from the male only in sexual characters. The ovipositor has the cerci relatively elongate, only gently curved, the ventral edge nearly straight, the dorsal margin very gently curved.

TRICHOCERA MIRABILIS Alexander.

Trichocera mirabilis ALEXANDER, Philip. Journ. Sci. 55 (1934) 20, 21.

The types were from Kongo San, Korea, taken in October by Machida. NORTHERN KOREA, Yanchen, altitude 40 feet, October 6, 1937. OMPO, altitude 600 feet, November 17, 1937. SEREN MOUNTAINS, altitude 1,800 feet, October 13, 1937 (*Yankovsky*).

TRICHOCERA LATILOBATA sp. nov. Plate 1, fig. 3; Plate 2, fig. 26.

General coloration dark blackish gray, præscutum with two still darker submedian stripes; legs brownish black; wings grayish subhyaline, prearcular field more whitened; stigma and a small cloud on r-m pale brown; R_{2+3+4} longer than R_{2+3}; abdomen, including hypopygium, brownish black; male hypopygium with bridge of basistyles entire; dististyle relatively short and flattened, on mesal face beyond base with a broad-based triangular lobe.

Male.—Length, about 5 millimeters; wing, 5.5.

Rostrum and palpi black. Antennæ black, outer segments paler. Head brownish black.

Mesonotal præscutum dark blackish gray with two still darker submedian stripes; posterior sclerites of notum blackened, sparsely pruinose, posterior border of scutellum somewhat paler. Pleura brownish black, including dorsopleural membrane. Halteres infuscated, base of stem yellow. Legs with fore coxæ brownish black, middle coxæ testaceous, hind coxæ yellow; trochanters yellow; remainder of legs brownish black, extreme femoral bases yellow. Wings (Plate 1, fig. 3) grayish subhyaline, prearcular field more whitened; stigma and a small cloud on r-m pale brown; veins brown. Venation: R_{2+3+4} longer than R_{2+3}; vein 2d A somewhat angularly bent on distal third.

Abdomen, including hypopygium, brownish black. Male hypopygium (Plate 2, fig. 26) with ventromesal lobes of basistyles, *b*, forming a continuous bridge. Dististyle, *d*, relatively short and flattened, on mesal face beyond base with a broad-based triangular lobe. Gonapophyses, *g*, long and slender.

Habitat.—Northern Korea.

Holotype, male, Ompo, altitude 650 feet, August 11, 1937 (*Yankovsky*).

Trichocera latilobata is readily told from the other described species of the genus by the continuous bridge of the basistyles, in conjunction with the position and shape of the lobe on the mesal face of the dististyle. In other species with a simple lobe on the mesal face of the dististyle, this is much smaller and nearly basal in position.

TIPULIDÆ

LIMONIINÆ

LIMONIINI

LIMONIA (LIMONIA) VENERABILIS sp. nov. Plate 1, fig. 4; Plate 2, fig. 27.

General coloration black; antennæ black throughout; halteres brownish black, base of stem pale yellow; femora pale brown, narrowly blackened close to tips; tibiæ and tarsi black; wings with a brownish tinge, oval stigma darker brown; R_{2+3} subequal to R_{1+2}; abdomen brownish black, caudal margins of segments narrowly paler; male hypopygium with ninth tergite very extensive; mesal-apical lobe of gonapophysis unusually long and slender, gently curved, tips a little expanded, terminating in a black spine.

Male.—Length, about 10 millimeters; wing, 10.

Rostrum and palpi black. Antennæ black throughout; flagellar segments passing through oval to elongate-cylindrical, with unusually long verticils. Head dark gray; anterior vertex moderately wide, about twice diameter of scape.

Pronotum brownish black, with coarse erect setæ. Mesonotal præscutum and scutum black, setæ of interspaces sparse but long and conspicuous; median area of scutum and scutellum paler than remainder; postnotum black, heavily pruinose. Pleura black, sparsely pruinose; dorsopleural membrane dark. Halteres brownish black, base of stem pale yellow. Legs with fore coxæ black, midcoxæ brown, posterior coxæ brownish yellow; trochanters yellow; femora pale brown, narrowly brighter basally, narrowly blackened close to tips, extreme apices pale; tibiæ and tarsi black; claws long, with an elongate median spine and smaller, more basal teeth. Wings (Plate 1, fig. 4) with a brownish tinge; stigma oval, darker brown; outer radial cells vaguely darker than remainder of ground; cord narrowly and insensibly darker; a dark cloud along vein Cu; veins brown, paler in prearcular field. Venation: Sc_1 ending about opposite one-third length of Rs, Sc_2 longer; R_{2+3} subequal to R_{1+2}; m-cu at fork of M.

Abdomen brownish black, caudal borders of sternites paler, obscure yellow, caudal borders of tergites more narrowly and less distinctly so; hypopygium black, tips of dististyles yellow. Male hypopygium (Plate 2, fig. 27) with tergite, *9t,* unusually extensive, divided into three parts by longitudinal lines, median section with caudal border very weakly emarginate. Basistyle, *b*, with ventromesal lobe low. Dististyle, *d*, with basal half darkened, moderately enlarged, with long coarse setæ; distal half narrowed, yellow. Gonapophysis, *g*, with mesal apical lobe unusually long and slender, gently curved, tips a little expanded, terminating in a black spine. Ædeagus, *a*, narrow, terminating in two short divergent points, surface with microscopic acute spicules, more concentrated down median line.

Habitat.—Northern Korea.

Holotype, male, Ompo, altitude 600 feet, June 23, 1937 (*Yankovsky*).

Limonia (*Limonia*) *venerabilis* is most similar to *L.* (*L.*) *pullata* Alexander and *L.* (*L.*) *tristina* Alexander, differing in the coloration, details of venation, and the structure of the male hypopygium, especially the unusually long slender lobe of the gonapophysis.

LIMONIA (DICRANOMYIA) MESOSTERNATA (Alexander).

Dicranomyia mesosternata ALEXANDER, Ann. Ent. Soc. America 12 (1919) 329, 330.

Northern Korea, Ompo, altitude 700 to 900 feet, October 26, 1937 (*Yankovsky*).

LIMONIA (DICRANOMYA) SPARSA (Alexander).

Dicranomyia sparsa ALEXANDER, Philip. Journ. Sci. 24 (1924) 544, 545.

Northern Korea, Ompo, altitude 120 to 160 feet, June 9 to 15, 1937 (*Yankovsky*). The type was from Saghalien.

LIMONIA (DICRANOMYIA) INFENSA sp. nov. Plate 1, fig. 5; Plate 2, fig. 28.

General coloration obscure brownish yellow, præscutum with three darker brown stripes; antennæ dark brown; pleura yellow; halteres pale, knob darkened at apex; femora yellow, tips very narrowly blackened; tibiæ yellow, extreme base narrowly darkened; wings cream-yellow, with a relatively heavy dark pattern, including four costal areas, last at stigma; Sc_2 far removed from the tip of Sc_1, at near midlength of vein Sc; m-cu shortly before fork of M; abdominal tergites brownish black, sternites obscure yellow; male hypopygium with rostral spines two, placed close together on short stout prolongation.

Male.—Length, about 6.5 to 8 millimeters; wing 7 to 9.

Rostrum brown; palpi black. Antennæ dark brown; flagellar segments oval, incisures well marked; two last segments subequal in length. Head dark brownish gray, paler behind; anterior vertex moderately wide.

Mesonotal præscutum obscure brownish yellow, with three darker brown stripes, in cases the surface more heavily pruinose to obscure these stripes; scutal lobes darkened, median area abruptly paler, more pruinose; scutellum darkened medially, paler on sides; mediotergite darkened. Pleura yellow, more pruinose in more heavily patterned specimens, somewhat darker along suture between anepisternum and sternopleurite. Halteres pale, apex of knob darkened. Legs with coxæ and trochanters pale; femora yellow, tips very narrowly but conspicuously blackened, the amount subequal on all legs; tibiæ yellow, bases very narrowly darkened; tarsi yellow, outer segments passing into black. Wings (Plate 1, fig. 5) cream-yellow, heavily patterned with brown, including four costal areas, last largest, at stigma, confluent with a seam along cord; third area large, involving both tip of Sc and origin of Rs; second major area at Sc_2; basal area smallest; cord and outer end of cell 1st M_2 narrowly seamed with brown; wing tip in outer radial field very narrowly and insensibly seamed with brown; veins yellow, darker in clouded areas. Venation: Sc_1 ending opposite or just beyond origin of Rs, Sc_2 far from its tip, at near middistance between arculus and origin of Rs; m-cu shortly before fork of M; cell 2d A wide.

Abdominal tergites brownish black, sternites obscure yellow to brown; hypopygium yellow. Male hypopygium (Plate 2, fig. 28) with caudal margin of tergite, *9t*, emarginate, lobes obtusely rounded. Ventromesal lobe of basistyle, *b*, subglobular, darkened. Dorsal dististyle strongly curved, tip narrowed. Ventral dististyle, *vd*, subglobular, rostral prolongation short and stout; two rostral spines of moderate length, placed close together. One paratype specimen showing three rostral spines on one style only, evidently an abnormality of the specimen. Gonapophysis, *g*, with mesal-apical lobe curved, tip acute.

Habitat.—Northern Korea.

Holotype, male, Seren Mountains, altitude 2,600 feet, October 3, 1937 (*Yankovsky*). Paratopotypes, 5 males.

Limonia (*Dicranomyia*) *infensa* is most generally similar to *L.* (*D.*) *didyma* (Meigen), differing in the details of coloration and structure of the male hypopygium, as the short, slightly separated rostral spines and the less strongly curved dorsal dististyle.

LIMONIA (DICRANOMYIA) SUBAURITA sp. nov. Plate 1, fig. 6; Plate 2, fig. 29.

Belongs to *morio* group, allied to *aurita;* large (wing, male, over 8 millimeters); halteres with base of stem yellow, remainder black; fore femora extensively blackened, bases narrowly yellow; middle and hind femora yellow basally, passing through brown to brownish black; wings with a strong brownish tinge, stigma darker; abdomen black, caudal borders of segments, especially of tergites, pale; basal sternites on subterminal portion extensively yellow; male hypopygium with tergal arms slender, notch between them about as wide as deep; ædeagus dilated beyond midlength.

Male.—Length, about 7.5 to 8 millimeters; wing, 8.5 to 9.

Rostrum and palpi black. Antennæ black; flagellar segments oval, constricted at incisures, with conspicuous verticils; terminal segment elongate. Head with front and broad anterior vertex silvery white; posterior sclerites of head dull black.

Pronotum grayish black. Mesonotum polished black, median region of scutum, central portion of scutellum, and cephalic end of mediotergite with a yellowish gray pollen. Pleura black, sparsely gray-pruinose. Halteres relatively long, basal half or more of stem yellow, remainder black. Legs with fore coxæ blackened basally, apex narrowly yellow; middle and posterior coxæ uniformly yellow; trochanters yellow; fore femora extensively blackened, bases narrowly yellow; middle and hind femora yellow basally, passing into brown, tips more brownish black; tibiæ brown; tarsi black. Wings (Plate 1, fig. 6) with a strong brown tinge, oval stigma darker brown; cord and outer end of cell 1st M_2 very narrowly and vaguely seamed with darker; prearcular field more yellowish; veins dark, yellow in prearcular field. Venation: Sc_1 long, ending opposite or just beyond origin of Rs; m-cu just before fork of M.

Abdomen black, caudal borders of more basal tergites narrowly pale; basal sternites with subterminal portion conspicuously yellow, caudal borders narrowly grayish; hypopygium black. Male hypopygium (Plate 2, fig. 29) with tergal arms, *9t,* stouter than in *aurita,* notch narrower, about as wide as deep. Basistyle, *b,* with ventromesal lobe shorter than in *aurita,* stem stouter, pendant distal portion shorter than either the stem or the thickness at the bend. Dorsal dististyle, *dd,* with apex expanded, bispinous. Spine of ventral dististyle, *vd,* conspicuous but pale, from a low basal tubercle; apex of prolongation narrow. Gonapophysis, *g,* with mesal-apical lobes relatively short, nearly straight. Ædeagus, *a*, narrower than in either *aurita* or *pseudomorio*, dilated beyond midlength, sides setiferous.

Habitat.—Northern Korea.

Holotype, male, Ompo, May 28, 1937 (*Yankovsky*). Paratopotype, male, June 12, 1937.

The nearest ally is *Limonia* (*Dicranomyia*) *aurita* Alexander, of Formosa, which differs especially in the details of structure of the male hypopygium, as described above. The fly is more or less intermediate between *aurita* and *L.* (*D.*) *pseudomorio* (Alexander), of Japan, yet evidently distinct from either in the genitalic details.

LIMONIA (GERANOMYIA) GIFUENSIS (Alexander).

Geranomyia (*Geranomyia*) *gifuensis* ALEXANDER, Ann. Ent. Soc. America 14 (1921) 114, 115.

Known hitherto from the Japanese Islands. Northern Korea, Ompo, altitude 160 feet, June 3 to 12, 1937; Seren Mountains, altitude 3,000 to 3,500 feet, October 9, 1937 (*Yankovsky*).

LIMONIA (GERANOMYIA) NEAVOCETTA sp. nov.

Allied to *avocetta;* general coloration of mesonotum dark gray, humeral and sublateral portions of præscutum obscure yellow; median area of scutum, scutellum, and a central triangle on mediotergite paler gray; thoracic pleura chiefly pale yellow; femora yellow, tips of posterior femora brownish black, remaining femora less distinctly darkened; wings brownish yellow, heavily patterned with brown; dark spots at ends of veins R_3 and R_{4+5} interconnected by dark marginal seams; abdominal tergites dark brown, sternites yellow.

Female.—Length, excluding rostrum, about 10 millimeters; wing, 9.8; rostrum alone, about 3.

Rostrum black, relatively long, stout at base; palpi black. Antennæ black, first flagellar segment a trifle paler; flagellar segments oval, outer ones a little more elongate. Head dark brownish gray; anterior vertex narrow.

Pronotum dark brownish gray, lined sublaterally with paler. Mesonotal præscutum with disc dark gray, humeral and sublateral portions posteriorly broadly obscure yellow; a capillary black median vitta on anterior portion of sclerite; scutal lobes dark gray, lateral portions restrictedly paler, mesal edge of each lobe narrowly blackened; median area of scutum, scutellum, and a central triangle on mediotergite paler gray, lateral borders of mediotergite darker. Pleura chiefly obscure yellow, pleurotergite darker. Halteres pale yellow, knobs weakly darkened. Legs with coxæ and trochanters pale yellow; femora yellow, tips of posterior pair conspicuously brownish black, of remaining femora less distinctly darkened; tibiæ and tarsi brownish yellow, outer tarsal segments blackened. Wings brownish yellow, prearcular region and costal border, especially cell Sc, light yellow; a heavy brown pattern, largest areas costal in distribution, first at arculus, third at origin of Rs, fourth at fork Sc, the two latter separated by a distance a little narrower than diameter of either; stigmal area large, produced behind into cell R_3; areas at ends of veins R_2 and R_{4+5} interconnected by a dark marginal seam in cells R_2 and R_3; narrow brown seams along cord and outer end of cell 1st M_2; a small oval spot at end of vein 2d A; vein 1st A unmarked or virtually so; veins yellow, darker in clouded areas. Venation: Sc long, Sc_1 ending nearly opposite midlength of Rs; m-cu shortly before fork of M.

Abdominal tergites dark brown, caudal borders of segments narrowly paler; sternites yellow; subterminal segments more uniformly darkened.

Habitat.—Northern Korea.

Holotype, female, Ompo, altitude 170 feet, June 3, 1937 (*Yankovsky*).

Closest to *Limonia* (*Geranomyia*) *avocetta* (Alexander), of Japan, differing as follows: Mesonotum dark gray, scutum, scutellum, and central area of mediotergite conspicuously pale; femoral tips darkened.

DICRANOPTYCHA PROLONGATA sp. nov. Plate 1, fig. 7; Plate 2, fig. 30.

General coloration brown; antennæ with basal two segments obscure yellow, flagellum dark brown; halteres pale yellow; femora yellow, tips narrowly blackened, the amount subequal on all legs; wings with a brown tinge, cell Sc clearer yellow; no dark cubital seam; Rs subequal in length to cell 1st M_2; Rs almost in longitudinal alignment with R_{4+5}; abdominal tergites dark brown, proximal segments paler medially, subterminal segments black, hypopygium yellow; male hypopygium with outer dististyle relatively narrow, apex long-produced; lateral tergal arms pale, nearly parallel-sided, tips obtuse.

Male.—Length, about 8.5 to 9 millimeters; wing, 9 to 9.5.

Female.—Length, about 8.5 to 9 millimeters; wing, 9.5 to 10.

Rostrum and palpi black. Antennæ with scape and pedicel obscure yellow, flagellum dark brown; flagellar segments elongate-oval, with conspicuous verticils. Head brownish gray, opaque.

Pronotum opaque brown. Mesonotum brown, humeral region of præscutum a little more reddish brown; scutellum slightly more testaceous; postnotum more pruinose. Pleura brown, sparsely pruinose, ventral anepisternum and meron, with ventral sternopleurite, darker, forming incomplete stripes. Halteres pale yellow. Legs with coxæ and trochanters yellow; femora yellow, tips narrowly but conspicuously blackened, the amount subequal on all legs; tibiæ yellow, extreme bases and tips blackened; basitarsi yellow, outer segments infuscated. Wings (Plate 1, fig. 1) with a brown tinge, cell Sc clearer yellow; very vaguely indicated darker seams at origin of Rs, along cord, and at outer end of cell 1st M_2; no dark cubital seam as in *venosa;* veins brown, Sc yellow. Venation: Sc_1 opposite r-m; Rs moderately long, subequal in length to cell 1st M_2; basal section of R_{4+5} long, almost in alignment with Rs; m-cu variable in position, from about one-fourth to midlength of cell 1st M_2.

Abdominal tergites dark brown, proximal segments with basal portions more brightened, in cases segments almost uniformly pale with lateral borders darkened; subterminal segments uniformly black; hypopygium yellow. Male hypopygium (Plate 2, fig. 30) with outer dististyle, *od,* relatively narrow, apex produced into a long, gently curved, black spine; before apex with numerous erect spinulæ and scabrous points, the former on ventral surface. Inner dististyle, *id,* with apex narrowed. Lateral tergal arms, *9t,* gently curved, nearly parallel-sided, tips a trifle widened, obtuse.

Habitat.—Northern Korea.

Holotype, male, Ompo, altitude 800 feet, September 13, 1937 (*Yankovsky*). Allotopotype, female. Paratopotypes, males and females, altitude 800 to 1,750 feet, September 13 to October 27, 1937 (*Yankovsky*). Paratypes, males and females, Seren Mountains, altitude 2,000 to 3,000 feet, October 10 to 15, 1937 (*Yankovsky*).

The nearest regional ally is *Dicranoptycha venosa* Alexander, which differs especially in the coloration of the body, legs, and wings, and in the distinct structure of the male hypopygium. A few specimens of the type series show abnormalities of venation. One paratype has an adventitious crossvein in cell R_3 of both wings, almost immediately beneath R_2. A second paratype, on one wing only, has a short spur on distal section of vein R_{4+5} at near four-fifths the length, jutting cephalad into cell R_3.

DICRANOPTYCHA DIACANTHA sp. nov. Plate 1, fig. 8; Plate 2, fig. 31.

General coloration black, sparsely pruinose; halteres pale yellow throughout; legs black, femora very restrictedly paler at bases; wings with a weak brown tinge; Rs considerably longer than cell 1st M_2; branches of Rs lying parallel to one another for virtually their entire length; abdomen (male) almost uniformly light yellow, with a dark-brown or brownish-black subterminal ring; hypopygium brown; outer dististyle small, outer margin smooth; gonapophyses conspicuously bispinous.

Male.—Length, about 10 millimeters; wing, 11 to 11.5.

Female.—Length, about 12 millimeters; wing, 11.5.

Rostrum and palpi brownish black. Antennæ brownish black, pedicel a trifle paler. Head light gray; anterior vertex wide, about twice diameter of scape.

Thorax black, sparsely pruinose, præscutum with three more or less distinct darker and more nitidous stripes that are more cr less confluent to cover the disc behind; posterior sclerites of notum more heavily pruinose, especially in female. Pleura black, pruinose. Halteres pale yellow throughout. Legs with coxæ yellow, fore pair slightly darker; remainder of legs black, femoral bases very restrictedly paler, tibiæ a little more brownish black. Wings (Plate 1, fig. 8) with a weak brown tinge, prearcular field and costal border a trifle more yellowish, not conspicuously so as in *stygipes;* veins dark brown. Venation: Rs considerably longer than cell 1st M_2; branches of Rs parallel to one another for virtually their whole length, rather strongly deflected caudad at their outer ends; m-cu shortly before midlength of cell 1st M_2.

Abdomen of male almost uniformly light yellow, subterminal segments dark brown or brownish black; hypopygium brown. In the female, the abdomen is more uniformly darkened. Male hypopygium (Plate 2, fig. 31) with lateral tergal arms, 9*t*, slender, erect, nearly parallel-sided, their tips obtuse. Outer dististyle, *od,* small, much shorter than inner, curved to a long black apical point, outer margin smooth, inner margin before spine with small scabrous points. Ædeagus, *a,* long. Gonapophysis, *g,* produced into two long conspicuous spines.

Habitat.—Northern Korea.

Holotype, male, Seren Mountains, altitude 5,000 to 6,000 feet, October 3, 1937 (*Yankovsky*). Allotopotype, female. Paratopotype, 1 male; paratype, 1 male, Chonsani, Paiktusan, altitude 3,700 feet, July 22, 1937 (*Yankovsky*).

The closest relative of the present fly is *Dicranoptycha stygipes* Alexander, of Japan, which has somewhat similarly blackened legs, differing especially in the coloration of the body and wings and in the details of venation, as the short Rs. The male sex of *stygipes* is unknown to me.

ANTOCHA (ANTOCHA) BIFIDA Alexander.

Antocha (*Antocha*) *bifida* ALEXANDER, Philip. Journ. Sci. 24 (1924) 564–566.

One male, from Ompo, northern Korea, altitude 900 feet, October 28, 1937, collected by Yankovsky, has cell M_2 open by the atrophy of m. The structure of the male hypopygium does not appear to differ significantly from the type material.

HELIUS (HELIUS) POLIONOTA sp. nov. Plate 1, fig. 9.

General coloration gray, præscutum with three brown stripes; rostrum longer than remainder of head; antennæ with scape and pedicel black, flagellum obscure yellow; halteres pale yellow; femora yellow, tips abruptly and conspicuously black; wings whitish subhyaline, tip broadly but inconspicuously darkened; stigma oval, dark brown; prearcular field and costal border very pale yellow; m-cu less than its own length beyond fork of M.

Female.—Length, including rostrum, 7.5 to 8.5 millimeters; wing, 8.5 to 9; rostrum alone, 1.

Rostrum longer than remainder of head, black; palpi black. Antennæ with scape and pedicel black; flagellum obscure yellow, outer segments a little darker. Head gray, with a very narrow and poorly indicated darker median line on center of vertex; anterior vertex narrow, a little more than diameter of scape; head prolonged behind.

Pronotum gray. Mesonotum gray, præscutum with three brown stripes, median stripe broader and darker, not reaching suture behind; scutellum posteriorly a trifle more reddish brown. Pleura, including dorsopleural membrane, dark brown. Halteres uniformly pale yellow. Legs with coxæ yellow, fore and middle pair somewhat more infuscated basally; trochanters yellow; tips abruptly and conspicuously black, the amount subequal on all legs; tibiæ obscure yellow, tips very narrowly blackened; basitarsi yellow basally, passing into black; remaining tarsal segments black. Wings (Plate 1, fig. 9) whitish subhyaline, tip broadly but inconspicuously darkened; prearcular field and costal border very pale yellow; stigma oval, dark brown; veins dark brown, paler in yellow areas. Venation: Sc_1 ending about opposite fork of Rs, Sc_2 at its tip; cell 1st M_2 long, a little wider at basal end, subequal in length to vein M_4 beyond it; m-cu less than its own length beyond fork of M.

Abdomen dark brown, very sparsely gray pruinose; valves of ovipositor elongate, horn-colored.

Habitat.—Northern Korea.

Holotype, female, Chonsani, Paiktusan, altitude 3,000 feet, July 18, 1937 (*Yankovsky*). Paratopotypes, 5 females, altitude 3,000 to 3,500 feet, July 18 to 20, 1937 (*Yankovsky*).

Helius (*Helius*) *polionota* is entirely distinct from the other regional species of the genus, the gray coloration of the thorax, the pale antennal flagellum and the distinctive pattern of the legs and wings.

HELIUS (HELIUS) GRACILLIMUS sp. nov. Plate 1, fig. 10; Plate 2, fig. 32.

General coloration of mesonotum obscure yellow, præscutum with faint indications of darker stripes; posterior sclerites of notum darkened, pleura and pleurotergite yellow; rostrum dark, a little longer than remainder of head; halteres yellow, knobs infuscated; legs obscure yellow, tips of femora and tibiæ narrowly dark brown; wings grayish subhyaline, prearcular and costal portions a little more yellowish; a restricted brown pattern, including seams at origin of Rs and along cord; m-cu shortly beyond fork of M; abdominal tergites dark brown, lateral margins yellow; basal sternites more uniformly yellow; male hypopygium with basistyles slender, on mesal face near base with a stout setiferous lobe; outer dististyle an unusually slender blackened rod, apex simple and obtuse.

Male.—Length, including rostrum, about 7 millimeters; wing, 8; antennæ, about 3.

Female.—length, including rostrum, about 9.5 to 11 millimeters; wing, 9 to 10.

Rostrum slightly longer than remainder of head, dark brownish gray; palpi black. Antennæ black, pedicel a trifle brightened; flagellum elongate, especially in male, as shown by measurements; flagellar segments long-cylindrical, with a dense erect pale pubescence and scanty, slightly longer verticils; terminal segment short, approximately one-third to one-fourth penultimate. Head dark gray; anterior vertex narrow.

Pronotum obscure yellow. Mesonotal præscutum obscure yellow, with faint indications of darker stripes, especially behind; scutal lobes conspicuously blackened; posterior sclerites of notum blackened, posterior margin of scutellum narrowly more reddish. Pleura and pleurotergite yellow. Halteres yellow, knobs infuscated. Legs with coxæ and trochanters yellow; femora obscure yellow, tips rather narrowly dark brown; tibiæ obscure yellow, tips narrowly dark brown; tarsi passing into dark brown. Wings (Plate 1, fig. 10) grayish subhyaline in male, somewhat more cream-yellow in female, prearcular and costal regions more yellowish; a restricted brown pattern, including stigma and a confluent seam on cord, together with a smaller cloud at origin of Rs; veins dark brown, pale yellow in luteous areas. Venation: Rs weakly angulated and, in cases, short-spurred at origin; branches of Rs weakly divergent outwardly; cell 1st M_2 rectangular; m-cu shortly beyond fork of M.

Abdominal tergites dark brown, paler yellow laterally, especially conspicuous on outer segments; basal sternites more yellow; ninth segment darkened, styli obscure yellow. Male hypopygium (Plate 2, fig. 32) with basistyle, *b*, unusually long and slender, on mesal face near base with a stout setiferous lobe. Outer dististyle, *od*, an unusually slender blackened rod, very gently curved to simple obtuse tip. Inner dististyle, *id*, longer, tip narrow, gently curved; outer or dorsal portion of style without setæ. Interbases appearing as flattened paddlelike blades, outer margins thickened and darkened.

Habitat.—Northern Korea.

Holotype, male, Seren Mountains, altitude 3,000 to 3,500 feet, October 9, 1937 (*Yankovsky*). Allotopotype, female, altitude 1,800 feet, October 13, 1937. Paratopotypes, 3 males, several females, altitude 1,800 to 3,500 feet, October 3 to 16, 1937; paratypes, 5 females, altitude 1,600 feet, October 27, 1937 (*Yankovsky*).

Helius (*Helius*) *gracillimus* somewhat resembles *H.* (*H.*) *obliteratus* Alexander and *H.* (*H.*) *subfasciatus* Alexander in the general appearance and elongate antennæ in the male sex, but is entirely distinct in the structure of the male hypopygium.

PEDICINI

PEDICIA (PEDICIA) LÆTABILIS sp. nov. Plate 1, fig. 11; Plate 2, fig. 33.

General coloration gray, præscutum with more darker gray stripes that are narrowly bordered by blackish; scutellum yellow; halteres pale yellow; femora brownish yellow, tips not or scarcely darkened; wings grayish, patterned with brown, markings paler in male than in female; abdomen orange, basal five tergites with three grayish black stripes, outer segments uniformly darkened; basal sternites uniformly light yellow; male hypopygium with outer angle of diststyle terminating in a long black spine from a conspicuous basal tubercle; caudal border of style with a single strong black spine.

Male.—Length, 25 to 27 millimeters; wing, 22 to 25.

Female.—Length, 33 to 35 millimeters; wing, 26 to 27.

Rostrum dark gray; palpi black. Antennæ black, pedicel more reddish; basal segments short and crowded, outer two or three slender and elongate. Head dark gray; vertical tubercle conspicuous, apex truncated and circular in outline, appearing like a scar with slightly raised margins.

Pronotum brownish black, pruinose, posterior border more yellowish. Mesonotal præscutum with humeral region dark brown, disc almost covered by four gray stripes that are narrowly bordered by blackish; posterior sclerites of notum black, sparsely pruinose; scutellum yellow, weakly darkened medially. Pleura dark gray; dorsopleural membrane buffy. Halteres pale yellow. Legs with coxæ gray; trochanters yellow; femora brownish yellow, bases brighter, tips not or scarcely darkened; tibiæ light brown, tips darker brown; tarsi passing into brownish black. Wings (Plate 1, fig. 11) grayish, central portion of disc, including cell R_4 to apex, more yellowish subhyaline; a pale-brown pattern in male, much darker brown in female; cells C and Sc yellow; dark pattern extensive, including major areas in bases of cells R and M and at origin of Rs, these nearly confluent with one another, the latter not quite reaching vein M behind; seam at cord broad, that along vein Cu narrow, in cases more or less obsolete along distal section of Cu_1 but attaining margin; veins brown, more yellow in costal field. Venation: Cord oblique; r-m at or beyond fork of Rs; cell 1st M_2 long.

Abdomen with ground color orange, basal five tergites with three grayish black stripes, lateral pair very narrow, all stripes narrowly interrupted by reddish borders to tergites; sternites uniformly light yellow; outer segments dark brown, more or less pruinose. In female the pattern heavy, median dark tergal stripe distinct, bordered sublaterally by fulvous areas, lateral borders of segments broadly light gray, widened behind; sternites dark brownish gray, narrowly bordered posteriorly by pale. Male hypopygium (Plate 2, fig. 33) with diststyle, *d*, having outer angle terminating in a long black spine from a conspicuous basal tubercle; inner angle produced, apex truncated; caudal border of style between these angles with a single strong black spine, more or less cultriform in outline; mesal margin of style with a series of black spines, toward base slenderer and passing into setæ.

Habitat.—Northern Korea.

Holotype, male, Ompo, altitude 160 feet, May 20, 1937 (*Yankovsky*). Allotype, female, Seishin, altitude 70 feet, May 13, 1937. Paratopotypes, males, May 20 to 21, 1937; paratypes, 5 males, 1 female, with the allotype, May 13 to 18, 1937 (*Yankovsky*).

Pedicia (*Pedicia*) *lætabilis* is readily told from other large regional species by the pale wing pattern of the male, the brightened color of the abdomen, and the structure of the male hypopygium.

PEDICIA (PEDICIA) SIMULATA sp. nov. Plate 1, fig. 12; Plate 2, fig. 34.

General coloration gray, præscutum with four more brownish gray stripes; antennæ uniformly blackened, flagellar segments short and crowded; halteres pale yellow; femora yellow, tips broadly blackened; tibiæ brownish black, tarsi black; wings brownish yellow, patterned with darker brown, the two colors not conspicuously contrasting; abdominal tergites gray, with two dusky longitudinal lines, interrupted by broad pale posterior borders of segments; male hypopygium with outer angle produced into a strong spine, apex blackened and acute.

Male.—Length, about 16 to 19 millimeters; wing, 15 to 17.

Rostrum grayish pruinose; palpi black. Antennæ black, basal segments pruinose; flagellum very short, normal number of antennal segments apparently 14 but the number apparently variable, basal segments short, crowded. Head gray, with indications of a dusky capillary median vitta; vertical tubercle low.

Pronotum gray, variegated with brown. Mesonotal præscutum light gray, with four more brownish gray stripes, interspaces with conspicuous yellow setæ; posterior sclerites of notum gray, scutal lobes scarcely darkened. Pleura gray; dorsopleural membrane brownish ochreous. Halteres pale yellow. Legs with coxæ gray; trochanters brownish gray; femora yellow, tips broadly blackened, the amount subequal on all legs and including distal fourth or fifth; in some specimens fore femora more extensively blackened, involving distal third or more; tibiæ brownish black; tarsi black. Wings (Plate 1, fig. 12) with ground color brownish yellow, patterned with darker brown, colors not conspicuously contrasting as is usual in the subgenus; costal and cubital darkenings and a transverse band on cord present; basal third of cells C and Sc more yellowish; basal third of cells R and M extensively darkened, more or less confluent with a broad seam at origin of Rs; a darkened cloud at outer end of cell 1st M_2; veins brown, Sc yellow. Venation: Cord subtransverse to weakly oblique; Rs angulated to spurred at origin; m-cu close to or beyond fork of M. In one paratype cell M_2 of both wings open by atrophy of m.

Abdominal tergites gray, with two dusky longitudinal sublateral lines, broken by broad ochreous posterior borders of segments, lateral borders more narrowly pale; sternites yellowish gray; hypopygium dark gray. Male hypopygium (Plate 2, fig. 34) with basistyle, *b*, unarmed with spines but with numerous elongate setæ. Dististyle, *d*, with outer angle produced into a strong spine, apex acutely pointed and blackened; inner lobes much as in *baikalica*. In the latter species the apical margin of the basistyle bears a group of several stout black spines; outer margin of dististyle scoop-shaped, obtuse at apex, not blackened or produced into a spine.

Habitat.—Northern Korea.

Holotype, male, Chonsani, Paiktusan, altitude 4,650 feet, July 17, 1937 (*Yankovsky*). Paratopotypes, 4 males, altitude 3,800 to 4,650 feet, July 17 to 19, 1937 (*Yankovsky*).

In the nature of the wing pattern, *Pedicia* (*Pedicia*) *simulata* is surprisingly like the Siberian *P.* (*P.*) *baikalica* (Alexander), but differs conspicuously in the details of structure of the male hypopygium, especially the dististyle, which is acutely spined, as is commonly the case in the subgenus *Pedicia*. The series of small-sized members of the subgenus *Pedicia* in eastern Asia, including *baikalica, cubitalis* Alexander, *gaudens* Alexander, *grandior* Alexander, and *subtransversa* Alexander, show a perfect transition in characters between those formerly accepted as distinguishing *Pedicia* from *Tricyphona*. These characters in *Pedicia* include major physical size, the nature of the wing pattern, obliquity of the cord, and presence of a primary spine on the outer angle of the dististyle of the male hypopygium. All of these characters break down in the series of small-sized species listed above, and it is very evident that it will be almost impossible to differentiate *Tricyphona* from *Pedicia* except as a matter of convenience in handling the complex of included forms.

PEDICIA (PEDICIA) SUBTRANSVERSA Alexander.

Pedicia subtransversa ALEXANDER, Philip. Journ. Sci. 50 (1933) 146, 147.

Described from the Japanese Alps, Honshiu, Japan.

NORTHERN KOREA, Chonsani, Paiktusan, altitude 5,100 feet, July 21, 1937 (*Yankovsky*). SEREN MOUNTAINS, altitude 2,000 to 3,000 feet, October 2 and 3, 1937 (*Yankovsky*). I can detect no significant differences between the type material and the present series of specimens.

PEDICIA (TRICYPHONA) PATENS sp. nov. Plate 1, fig. 13; Plate 3, fig. 35.

Large (wing, 15 millimeters or more); general coloration yellow, præscutum with more reddish stripes; antennæ with basal segments yellow, remainder brownish black; halteres yellow; femora obscure yellow, tips weakly darkened; tibiæ brown, tips darker; wings tinged with brownish yellow, costal border brown; stigma yellow, ends delimited by slightly darker clouds; r-m at or before fork of Rs; cell M_2 open by atrophy of m; m-cu close to fork of M; abdomen brown, hypopygium blackened; male hypopygium with dististyle bilobed, lobes stout; interbase a strongly curved spine.

Male.—Length, about 14 to 16 millimeters; wing, 15 to 18.

Female.—Length, about 19 to 20 millimeters; wing, 17 to 18.

Rostrum brownish gray; palpi black. Antennæ 16-segmented; scape and pedicel yellow, flagellum brownish black, basal two or three segments paler; flagellar segments passing through oval to long-oval; longest verticils unilaterally distributed, much longer than segments; terminal segment shorter than penultimate. Head gray; vertical tubercle subcircular in outline, darkened.

Pronotum yellow. Mesonotal præscutum testaceous-yellow, chiefly covered by three reddish stripes, posterior interspaces slightly pruinose; scutal lobes reddish; scutellum and postnotum testaceous. Pleura yellow. Halteres relatively long and slender, yellow. Legs with coxæ and trochanters yellow; femora obscure yellow, tips weakly darkened; tibiæ brown, tips darker brown; tarsi black. Wings (Plate 1, fig. 13) with a strong brownish yellow tinge, cells C and Sc darker brown; stigma yellow, both ends delimited by slightly darker color; remainder of disc virtually unmarked or with cord insensibly seamed with darker; veins brown. Venation: Rs variable in length, angulated and spurred at origin; r-m at or before fork of Rs, latter in longitudinal alignment with R_{4+5}; cell M_2 open by atrophy of m; m-cu at or close to fork of M.

Abdomen brown, outer sternites and hypopygium blackened. Male hypopygium (Plate 3, fig. 35) with dorsal plate of tergite, *9t*, truncated across caudal margin, with a small U-shaped median notch; ventrad of dorsal plate a fleshy ventral plate, each side bilobed. Basistyle, *b*, without conspicuous lobes; interbase a strong curved spine, tip acute. Dististyle, *d*, bilobed, outer lobe a little longer and more heavily sclerotized than inner, both lobes stout, obtusely rounded at tips.

Habitat.—Northern Korea.

Holotype, male, Ompo, altitude 190 feet, June 2, 1937 (*Yankovsky*).

Allotopotype, female. Paratopotypes, several males, June 1 and 2, 1937.

Pedicia (*Tricyphona*) *patens* is most closely allied to the Japanese *P.* (*T.*) *confluens* (Alexander) and *P.* (*T.*) *kirishimensis* (Alexander), both of which are smaller, with distinctive wing patterns, and with the male hypopygia quite distinct. All three species normally have cell M_2 open by atrophy of m.

PEDICIA (TRICYPHONA) LONGILOBA sp. nov. Plate 1, fig. 14; Plate 3, fig. 36.

General coloration gray, præscutum with four more blackish gray stripes; antennæ 16-segmented, black throughout; halteres pale yellow; femora yellow, tips brownish black; wings yellowish subhyaline, with a restricted darker cloud on anterior cord; stigma lacking; r-m close to midlength of basal section of R_{4+5}; cell M_1 sessile; male hypopygium with interbase bearing a strong lateral spine; basistyle at apex produced into two lobes, outer one unusually long, subequal in length to style itself, expanded and darkened at apex, clothed with abundant long setæ; shorter lobe of basistyle densely set with short black spines; dististyle subequal in length to inner lobe of basistyle, slender, parallel-sided.

Male.—Length, about 9 to 10 millimeters; wing, 9.5 to 10.5.

Rostrum gray; palpi black. Antennæ short, 16-segmented, black throughout; flagellar segments oval; verticils about equal in length to segments. Head gray; vertical tubercle relatively conspicuous.

Thorax gray, præscutum with four more blackish gray stripes, intermediate pair not attaining suture behind; scutal lobes with darkened centers. Pleura gray; dorsopleural membrane buffy.

Halteres pale yellow. Legs with coxæ yellow, slightly darkened basally; trochanters yellow; femora yellow, tips brownish black, the amount subequal on all legs; tibiæ and basitarsi brownish yellow, tips narrowly darkened; terminal tarsal segments dark brown. Wings (Plate 1, fig. 14) yellowish subhyaline, prearcular field restrictedly bright yellow; a small darkened cloud on anterior cord; stigma lacking; veins brown. Venation: Rs relatively long, angulated, and spurred at origin; r-m close to midlength of basal section of R_{4+5}; cell M_1 sessile; m beyond fork of M_{1+2}.

Abdominal tergites brown, caudal borders narrowly pale; sternites more uniformly grayish yellow or brownish yellow; ninth segment blackened, basistyles yellow. Male hypopygium (Plate 3, fig. 36) with tergal lobes, *9t*, appearing as glabrous flattened ears, widely separated; surface of tergite with abundant long delicate setulæ. Basistyle, *b*, with interbase, *i*, unusually long, narrowed to a curved apical hook, at near midlength bearing a long conspicuous spine, with long delicate setæ on hook beyond spine; basistyle at apex prolonged into two lobes, outer lobe very long, subequal in length to basistyle itself, expanded and darkened at tips, with abundant long setæ; shorter lobe oval in outline, densely set with short black peglike spines. Dististyle, *d*, subequal in length to shorter lobe of basistyle, narrow, parallel-sided, apex rounded with four or five elongate setæ; base of style with additional setæ.

Habitat.—Northern Korea.

Holotype, male, Ompo, May 28, 1937 (*Yankovsky*). Paratopotypes, 5 males, May 28 to June 15, 1937 (*Yankovsky*).

The present fly rather closely resembles *Pedicia* (*Tricyphona*) *optabilis* (Alexander) and *P.* (*T.*) *ussurica* Alexander, but has the male hypopygium entirely different in construction, the unusually long, clavate outer lobe of the basistyle being quite unique among the species of *Tricyphona* known to me.

PEDICIA (TRICYPHONA) DIAPHANOIDES sp. nov. Plate 1, fig. 15.

Belongs to *diaphana* group; general coloration yellowish gray, præscutum with three dark-brown stripes, median stripe narrowly split behind; antennæ black, 14-segmented; femora dark brown, bases yellow; wings with a brown tinge, oval stigma darker brown; Rs angulated at origin; r-m connecting with vein R_5 about its own length beyond origin.

Female.—Length, about 10 to 11 millimeters; wing, 10 to 10.5.

Rostrum gray; palpi black. Antennæ 14-segmented, black throughout; flagellar segments oval. Head dark brown, anterior vertex and orbits gray.

Pronotum brownish gray. Mesonotal præscutum yellowish gray, with three dark-brown stripes, median stripe broad, slightly divided behind; centers of scutal lobes darkened. Pleura gray; dorsopleural membrane grayish yellow. Halteres with stem yellow, knob brown. Legs with coxæ gray, tips yellow; trochanters yellow; femora dark brown, bases yellow; tibiæ and tarsi brownish black. Wings (Plate 1, fig. 15) with a brown tinge; stigma oval, darker brown, conspicuous against the ground; veins brown. Venation: Rs variable in length, from subequal in length to distance between Sc_2 and its origin to about two-thirds this distance, strongly angulated at origin; cell M_1 present; cell M_2 normally open by atrophy of m, in cases closed; m-cu some distance beyond fork of M.

Abdomen brown, outer segments darker.

Habitat.—Northern Korea.

Holotype, female, Ompo, May 28, 1937 (*Yankovsky*). Paratopotypes, 2 females.

Pedicia (*Tricyphona*) *diaphanoides* is most closely allied to *P.* (*T.*) *diaphana* (Doane) of western North America. It differs in the number and structure of the flagellar segments and in the less extensively divided median præscutal stripe. No representatives of the group have been found hitherto in the eastern Palæarctic Region.

HETERANGAEUS GLORIOSUS (Alexander) var.

> *Polyangaeus gloriosus* ALEXANDER, Philip. Journ. Sci. 24 (1924) 569–571.

The types are from Saghalien. One female, Chonsani, Paiktusan, northern Korea, altitude 3,700 feet, July 14, 1937 (*Yankovsky*).

DICRANOTA (RHAPHIDOLABIS) FLAVIBASIS MINUSCULA subsp. nov.

Male.—Length, about 6.5 millimeters; wing, 7.

Generally similar to the typical form (Japan) but smaller and differing in the following respects: Legs pale brown, outer tarsal segments darker. Wings with stigma poorly indicated, pale brown; no distinct darkened clouds along cord or vein Cu; wing base less conspicuously yellow. Venation: Rs longer, gently arcuated; R_{2+3+4} long, subequal to or exceeding R_2; Sc relatively short, ending before proximal end of stigma or about opposite one-third length of R_{2+3}; m-cu nearly its own length beyond fork of M. Male hypopygium much as in typical *flavibasis*, differing as follows: Ninth tergite more deeply emarginate, lateral lobes thus more conspicuously, broadly rounded. Outer dististyle narrower; inner style shorter. Lateral tergal arms only gently curved to acute tips, not angularly bent at midlength.

Habitat.—Northern Korea.

Holotype, male, Ompo, altitude 800 feet, September 22, 1937 (*Yankovsky*).

DICRANOTA (RHAPHIDOLABIS) LUTEOLA sp. nov. Plate 1, fig. 16.

General coloration of thorax and abdomen yellow, gibbous præscutum pale brown; antennæ 13-segmented, scape and pedicel yellow, flagellum black; halteres yellow; femora brown, tibiæ and basitarsi whitish, tips narrowly darkened; wings whitish subhyaline, veins beyond cord a little darker; cell R_2 short- to long-petiolate.

Female.—Length, about 5.5 to 6 millimeters; wing, 6.5 to 7.

Rostrum yellow; basal segments of palpi yellow, terminal two segments black. Antennæ 13-segmented; scape and pedicel yellow, flagellum black; flagellar segments oval, with verticils of moderate length. Head brownish gray.

Mesonotal præscutum pale brown, gibbous; posterior sclerites of notum, together with the pleura, yellow. Halteres pale yellow. Legs with coxæ and trochanters yellow; femora brown; tibiæ and tarsi whitish, tips narrowly darkened; terminal tarsal segments more darkened. Wings (Plate 1, fig. 16) whitish subhyaline, cells beyond cord a trifle darker, best evidenced by darker veins. Venation: Cell R_3 short- to long-petiolate, R_{2+3+4} variable in length, from longer to shorter than basal section of R_5; cell M_1 present; cell M_2 closed; m-cu beyond one-third the length of M_{3+4}.

Abdomen yellow, tergites a little more infumed, especially medially; valves of ovipositor long and powerful.

Habitat.—Northern Korea.

Holotype, female, Ompo, altitude 150 feet, June 7, 1937 (*Yankovsky*). Paratopotype, female.

Dicranota (*Rhaphidolabis*) *luteola* is readily told by the general yellow color of the thorax and abdomen. It is apparently closest to the Japanese *D.* (*R.*) *consors* (Alexander) and *D.* (*R.*) *subconsors* (Alexander) which differ in the dark coloration and details of venation.

DICRANOTA (RHAPHIDOLABIS) NEOCONSORS sp. nov. Plate 1, fig. 17; Plate 3, fig. 37.

Allied to *consors*; general coloration of mesonotum grayish testaceous, præscutum with three conspicuous dark-brown to brownish black stripes; antennæ 12-segmented, halteres pale, knobs weakly darkened; legs pale brown; wings grayish subhyaline, stigma very slightly darker; R_2 transverse; R_{2+3+4} relatively short; male hypopygium with lateral tergal arms appearing as elongate-oval blades; basistyle with a group of strong setæ on mesal face near base; interbase a strongly flattened blade, ventral margin serrulate, apex produced into a strong spine.

Male.—Length, about 4.5 millimeters; wing, 5.2.

Female.—Length, about 5.5 millimeters; wing, 6.5.

Rostrum testaceous-yellow; basal segments of palpi pale, terminal segments dark brown. Antennæ 12-segmented; scape pale, remaining segments dark brown; terminal segment longer than penultimate. Head dark brown.

Mesonotum grayish testaceous, the highly convex præscutum with three conspicuous dark-brown stripes, median stripe even more blackened; lateral borders of præscutum paling to yellow; scutal lobes more diffusely darkened; scutellum and mediotergite weakly darkened. Pleura obscure yellow, ventral sternopleurite and ventral pleurotergite more darkened. Halteres pale, knobs weakly darkened. Legs with coxæ brownish yellow; trochanters yellow; remainder of legs pale brown, outer tarsal segments darker. Wings (Plate 1, fig. 17) grayish subhyaline, stigma very slightly darker; veins brown. Venation: R_2 transverse; R_{2+3+4} relatively short, subequal to r-m.

Abdomen dark brown. Male hypopygium (Plate 3, fig. 37) with median lobe of tergite, *9t*, broad, margin truncate, with numerous strong setæ; lateral tergal arms appearing as flattened, elongate-oval blades, on edge appearing linear. Basistyle, *b*, with a group of strong setæ on mesal face near base, as in *consors;* apex of basistyle without spinous points excepting a very few at inner apical angle. Interbase, *i*, a strongly flattened blade that terminates in a long straight acute spine, lateral or ventral edge with a series of microscopic serrulations.

Habitat.—Northern Korea.

Holotype, male, Seren Mountains, altitude 6,200 feet, October 10, 1937 (*Yankovsky*). Allotype, female, Ompo, altitude 650 feet, August 11, 1937 (*Yankovsky*).

The nearest ally of the present fly is *Dicranota* (*Rhaphidolabis*) *consors* Alexander, of Japan, which differs in the details of coloration and, especially, in the structure of the male hypopygium, notably the interbases.

HEXATOMINI

LIMNOPHILA (PHYLIDOREA) MEGAPYGIA sp. nov. Plate 1, fig. 18; Plate 3, fig. 38.

General coloration of mesothorax yellow, unmarked; antennæ (male) elongate, if bent backward extending about to third abdominal segment; basal three segments obscure yellow, remaining segments black, incisures of the more basal segments pale; femora yellow, tips narrowly blackened, the amount subequal on all legs; wings brownish yellow, prearcular and costal fields clearer yellow; a restricted brown pattern; Rs relatively long, square and spurred at origin; abdomen yellow with a black subterminal ring; male hypopygium large, caudal margin of tergite with a small notch; outer dististyle slender, at apex bent at a right angle, its outer margin roughened; gonapophyses bearing a very slender lateral branch at near midlength.

Male.—Length, about 8.5 to 9.5 millimeters; wing, 7.5 to 8.5; antennæ, about 3.7 to 3.8.

Female.—Length, about 11 millimeters; wing, 10.

Rostrum testaceous-yellow; palpi black. Antennæ (male) elongate, if bent backward extending about to third abdominal segment; basal three segments obscure yellow, succeeding segments black, incisures of more basal segments paler, outer segments uniformly darkened; flagellar segments fusiform, with a dense erect white pubescence; verticils just before midlength of segments. Head brownish gray, posterior portions obscure yellow.

Pronotum brown. Mesothorax uniformly yellow, surface more or less nitidous. Halteres pale, knobs weakly darkened. Legs with coxæ and trochanters yellow; femora yellow, tips rather narrowly but conspicuously blackened, the amount subequal on all legs; tibiæ yellow, tips more narrowly blackened; tarsi black, proximal portions of basitarsi extensively yellow. Wings (Plate 1, fig. 18) with a strong brownish yellow tinge, prearcular and costal fields clearer yellow; stigma oval, varying from pale to dark brown; restricted brown seams at origin of Rs, along cord and at outer end of cell 1st M_2; wing tip in outer radial field more weakly darkened; a central dusky streak in cell R; veins brown, luteous in yellow areas. Venation: Rs relatively long, square, and spurred at origin; R_{2+3+4} in direct longitudinal alignment with Rs; cell R_3 narrowed at proximal end; m-cu at midlength of cell 1st M_2; vein 2d A sinuous.

Abdomen polished yellow to rusty yellow, incisures, especially laterally on the more basal segments, blackened, the color more or less interrupted at the midline; subterminal segments and base of hypopygium black, styli of large hypopygium rusty. Male hypopygium (Plate 3, fig. 38) with caudal margin of tergite, 9*t*, with a small, very shallow median notch, margin not produced. Outer dististyle, *od*, slender, narrowed outwardly, at apex bent at a right angle, its outer margin roughened. Inner dististyle about two-thirds as long, narrowed to obtuse tip. Interbase, *i*, appearing as a fleshy lobe, apex truncate, mesal edge produced into a small cultriform blade. Gonapophyses, *g*, appearing as long slender curved spines, at near midlength bearing a very slender lateral branch that is about one-half as long as apophysis beyond its insertion.

Habitat.—Northern Korea.

Holotype, male, Chonsani, Paiktusan, altitude 3,800 feet, July 23, 1937 (*Yankovsky*). Paratopotypes, 10 males, altitude 3,500 to 3,800 feet, July 15 to 23, 1937 (*Yankovsky*).

Among the European species the present fly is most generally similar to *Limnophila* (*Phylidorea*) *glabricula* (Meigen), differing conspicuously in the structure of the hypopygium. It is likewise allied to *L.* (*P.*) *poetica* Osten Sacken and *L.* (*P.*) *subpoetica* Alexander, yet is amply distinct. I am following Edwards in placing these species that are allied to *bicolor* (Meigen) in the subgenus *Phylidorea.*

LIMNOPHILA (PHYLIDOREA) SUBPOETICA MULTIDENTATA subsp. nov.

Male.—Length, about 7 to 7.5 millimeters; wing, 7.5 to 8; antennæ, about 3.1 to 3.3.

Female.—Length, about 8.5 millimeters; wing, 7.5.

Differs from typical *subpoetica* Alexander, of Saghalien, as follows: Smaller. Antennal flagellum weakly bicolored, dark brown, incisures yellow, on outer segments the color more uniformly dark brown. Legs with femora yellow, tips rather narrowly blackened, the amount subequal on all legs, including about distal fourth or fifth; tibiæ yellow, tips narrowly dark brown. Wings with dark seams at origin of Rs and along cord more conspicuous; wing tip narrowly but more distinctly darkened and with small darkened marginal clouds at ends of longitudinal veins. Rs square and short-spurred at origin. Abdomen brownish yellow, outer segments uniformly blackened except obscure yellow to brown basistyles. Male hypopygium with apical lobes of tergite much stouter than in typical form, their apices broadly obtuse. Outer dististyle with apical point elongate, about equal to one-third length of stem. Gonapophysis with lateral appendage consisting of several short blunt points instead of two simple spurs as in *subpoetica.*

Habitat.—Northern Korea.

Holotype, male, Chonsani, Paiktusan, altitude 3,800 feet, July 23, 1937 (*Yankovsky*). Allotopotype, female. Paratopotypes, males and females.

I believe that this fly will be found to represent a valid species when more material of the typical form becomes available.

LIMNOPHILA (PHYLIDOREA) PERNIGRITA sp. nov. Plate 1, fig. 19; Plate 3, fig. 39.

General coloration gray-pruinose, præscutum and scutum with polished black areas; antennæ (male) black, relatively elongate; halteres yellow; femora yellow, tips black; wings cream-yellow, prearcular and costal regions more saturated yellow; a relatively heavy brown wing pattern; R_{2+3+4} short, subequal to basal section of R_5; cell M_1 present; abdomen black throughout; male hypopygium with basistyle produced caudad into a long conical lobe; outer dististyle bispinous at apex, at base on outer face with a setuliferous flange.

Male.—Length, about 9 to 10 millimeters; wing, 9 to 10; antennæ, about 3 to 3.2.

Rostrum and palpi black. Antennæ (male) black throughout, relatively elongate, as shown by measurements, if bent backward extending about to base of abdomen; basal flagellar segments short-oval to subglobular, ventral faces protuberant; longest verticils a little longer than segments; outer flagellar segments passing into oval, terminal segment slender. Head dull brownish gray, front and orbits clearer gray.

Pronotum brownish gray. Mesonotal præscutum with ground color heavily brownish gray-pruinose, conspicuously patterned with three polished black stripes; median stripe broad, not reaching suture behind, posterior third deeply incised; lateral stripes crossing suture onto scutal lobes; pseudosutural foveæ and lateral borders of præscutum black; posterior sclerites of notum heavily brownish gray-pruinose. Pleura heavily gray-pruinose. Halteres uniformly yellow. Legs with coxæ black, pruinose; trochanters obscure yellow; femora yellow, tips broadly and conspicuously blackened, most extensive on fore femora where nearly distal third to half is included, narrower on posterior femora; tibiæ light brown to yellowish brown, tips narrowly blackened; tarsi black. Wings (Plate 1, fig. 19) with ground color cream-yellow, prearcular region and cells C and Sc more saturated yellow; stigma dark brown; a relatively heavy pale brown pattern, as follows: At near one-third the length of cell R adjoining vein R; origin of Rs; cord and outer end of cell 1st M_2; forks of R_{2+3+4} and M_{1+2}; paler brown washes in outer ends of cells M, Cu, and anals; wing tip in outer radial field a little darkened; costal field unmarked except for a tiny spot on Sc_2; veins yellow in ground areas, infuscated in darkened portions. Venation: Rs relatively long, strongly arcuated at origin; R_{2+3+4} short, subequal to basal section of R_5; cell M_1 subequal to its petiole; m-cu at near midlength of cell 1st M_2; anterior arculus preserved.

Abdomen black throughout. Male hypopygium (Plate 3, fig. 39) with basistyle, *b*, produced into a long conical lobe. Outer dististyle, *od*, with a large basal flange on outer margin, surface with abundant microscopic setulæ; apex of style bispinous. Inner dististyle with apex prolonged into a slender cylindrical point. Ædeagus relatively short, slender, subtended on either side by flattened apophyses, *g*, the truncated apices of which bear three or four spinous points.

Habitat.—Northern Korea.

Holotype, male, Chonsani, Paiktusan, altitude 3,500 feet, July 18, 1937 (*Yankovsky*). Paratopotypes, 5 males.

Limnophila (*Phylidorea*) *pernigrita* is quite distinct from other palæarctic members of the *bicolor* group, as *L.* (*P.*) *abdominalis* (Meigen), *L.* (*P.*) *bicolor* (Meigen), *L.* (*P.*) *conifera* Lackschewitz, *L.* (*P.*) *nigricollis* (Meigen), *L.* (*P.*) *prolixicornis* Lundström, and others. *L. conifera* has the basistyles of the hypopygium conically produced, somewhat as in the present fly, but in all other respects is entirely distinct.

LIMNOPHILA (PRIONOLABIS) ACANTHOPHORA sp. nov. Plate, 1, fig. 20; Plate 3, fig. 40.

General coloration polished black, head and pronotum opaque; antennæ 16-segmented; halteres yellow; legs black, femoral bases narrowly yellow; wings brownish yellow, sparsely patterned with brown; cell M_1 present; male hypopygium with caudal margin of tergite emarginate; inner dististyle simple; gonapophyses pale yellow, stem slender, head expanded, its inner angle produced into a spine, the outer end a deep cultriform blade.

Male.—Length, about 10 millimeters; wing, 11.

Rostrum and palpi black. Antennæ 16-segmented, black throughout; basal flagellar segments subglobular, outer segments more elongate; terminal segment one-half longer than penultimate. Head black, with a yellow pollinosity.

Pronotum dull brownish black. Mesonotum polished black, vestiture sparse but erect. Pleura black, sparsely pruinose, especially on ventral pleurites. Halteres pale yellow. Legs with coxæ black; trochanters brownish black; femora black, bases narrowly (basal fifth or sixth) yellow; tibiæ and basitarsi brownish black, tips darker; remainder of tarsi black. Wings (Plate 1, fig. 20) brownish yellow, prearcular and costal regions clear light yellow; stigma oval, dark brown; restricted brown seams along cord, outer end of cell 1st M_2, along vein Cu, and as a spot at origin of Rs; veins brown, yellow in flavous areas. Venation: Cell M_1 present; m-cu beyond midlength of cell 1st M_2.

Abdomen, including hypopygium, black. Male hypopygium (Plate 3, fig. 40) with caudal margin of tergite, *9t,* with a deep U-shaped median notch. Outer dististyle, *od,* with outer setiferous lobe long and conspicuous; inner lobe terminating in an outer slender spine, inner lobe flattened, vaguely toothed. Inner dististyle, *id,* simple, terminating in four or five strong spines. Ædeagus, *a,* moderately narrow, tip long-produced. Gonapophysis, *g,* distinctive, pale yellow; stem very slender, head expanded, its inner angle produced into a slender spine, opposite end deep, more or less cultriform.

Habitat.—Northern Korea.

Holotype, male, Ompo, altitude 150 feet, May 29, 1937 (*Yankovsky*).

Limnophila (*Prionolabis*) *acanthophora* is quite distinct from the now rather numerous species of the subgenus in eastern Asia. The shape of the gonapophysis of the male hypopygium is entirely different from that in the forms hitherto described.

LIMNOPHILA (IDIOPTERA) USSURIANA Alexander.

Limnophila (*Idioptera*) *ussuriana* ALEXANDER, Philip. Journ. Sci. 52 (1933) 142, 143.

NORTHERN KOREA, Ompo, June 9, 1937 (*Yankovsky*).

LIMNOPHILA (ELÆOPHILA) SUBAPRILINA Alexander.

Limnophila (*Ephelia*) *subaprilina* ALEXANDER, Ann. Ent. Soc. America 12 (1919) 340, 341.

NORTHERN KOREA, Ompo, altitude 90 to 100 feet, June 10 to 14, 1937 (*Yankovsky*). Differs from the types chiefly in having the abdominal segments of certain of the specimens less evidently bicolored.

ULOMORPHA NIGRICOLOR Alexander var.

Ulomorpha nigricolor ALEXANDER, Ann. Mag. Nat. Hist. IX 15 (1925) 75, 76.

The unique type, a male, was from Lake Ozenuma, Honshiu, Japan. Northern Korea, Ompo, altitude 600 feet, June, 23, 1937 (*Yankovsky*); two males. These latter specimens are not entirely typical. The dark pattern of the wings is restricted to a long narrow stigma and a narrow seam along cord. Cell R_3 varies from very short-petiolate to entirely sessile. The male hypopygium shows the caudal margin of the tergite produced into two well-produced blackened lobes, separated by a broad U-shaped notch.

HEXATOMA (ERIOCERA) PERNIGRINA sp. nov. Plate 1, fig. 21.

General coloration opaque black, præscutum with four more glabrous stripes; antennæ, halteres, and legs black throughout; wings with a strong blackish tinge, costal border and stigma darker; macrotrichia of veins beyond cord sparse; R_{2+3+4} much shorter than basal section of R_5; m-cu at near midlength of cell 1st M_2.

Male.—Length, about 11 to 12 millimeters; wing, 10 to 11; antennæ, 3.8 to 4.

Female.—Length, about 17 to 18 millimeters; wing, 13 to 14.

Rostrum and palpi black. Antennæ of male 8-segmented, of female 11-segmented; black throughout, scape slightly more pruinose; flagellar segments gradually decreasing in length. Head dull black; vertical tubercle low.

Thorax dull black, præscutum with four more glabrous stripes that are not conspicuous against the ground; vestiture of thorax abundant, erect. Pleura more heavily dusted with brownish gray. Halteres and legs black throughout. Wings (Plate 1, fig. 21) with a strong blackish tinge, costal border and stigma darker; veins dark, less evidently seamed with darker. Macrotrichia of veins beyond cord very sparse, with two or three on each of veins R_3 and distal section of R_5. Venation: Rs long, exceeding R, arcuated at origin; R_{2+3+4} short, a little more than one-half basal section of R_5 and a little less than R_{1+2};

veins R_3 and R_4 weakly divergent at tips; m-cu at midlength of rectangular cell 1st M_2 longer than distal section of vein Cu_1.

Abdomen uniformly dull black. Ovipositor with elongate valves.

Habitat.—Northern Korea.

Holotype, male, Ompo, altitude 450 feet, June 14, 1937 (*Yankovsky*). Allotopotype, female. Paratopotypes, several males and females.

Hexatoma (*Eriocera*) *pernigrina* is allied to regional species such as *H.* (*E.*) *kamiyai* Alexander, *H.* (*E.*) *kariyai* Alexander, *H.* (*E.*) *longifurca* (Alexander), and *H.* (*E.*) *pleskei* Alexander, differing from all in the intensely black color of the body, antennæ, halteres, and legs, and in the strongly blackened but virtually unpatterned wings.

ERIOPTERINI

GONOMYIA (IDIOCERA) PERPALLENS sp. nov. Plate 1, fig. 22; Plate 3, fig. 41.

Allied to *pallens;* general coloration brownish yellow, segments sparsely pruinose, pleura unstriped; legs obscure yellow, outer tarsal segments slightly darker; wings pale grayish yellow, unmarked; Sc_1 ending about opposite midlength of Rs; R_{1+2} and R_3 close together at wing margin; male hypopygium with tergal lobes not developed; middle dististyle with outer arm unusually long and slender.

Male.—Length, about 5 millimeters; wing, 6.

Female.—Length, about 5.5 millimeters; wing, 7.

Rostrum brownish yellow; palpi black. Antennæ with scape and pedicel light yellow, flagellum dark brown; flagellar segments oval to long-oval. Head brownish ochreous.

Mesonotal præscutum pale brownish yellow, sparsely pruinose, with poorly defined darker stripes occupying interspaces behind; scutal lobes weakly darkened; posterior sclerites pale brownish yellow. Pleura pale yellow. Halteres pale, knobs weakly darkened. Legs with coxæ and trochanters pale yellow; remainder of legs obscure yellow, outer tarsal segments slightly darker. Wings (Plate 1, fig. 22) pale grayish yellow, unmarked; veins a little darker than ground. Venation: Sc_1 ending opposite or slightly beyond midlength of Rs; R_{1+2} and R_3 close together at wing margin; petiole of cell 2d M_2 a little exceeding one-third the cell; m-cu more than its own length before fork of M.

Abdominal tergites yellowish brown; sternites and hypopygium yellow. Male hypopygium (Plate 3, fig. 41) with tergal lobes not developed. Outer dististyle, *od*, a slender simple rod, tip blackened; middle style, *md*, with outer arm unusually long and slender; inner style, *id*, deeply bifid, outer arm acutely pointed and blackened. Ædeagus, *a*, trispinous and blackened at apex, the more basal spine much larger.

Habitat.—Northern Korea.

Holotype, male, Ompo, altitude 150 feet, June 7, 1937 (*Yankovsky*). Allotopotype, female, June 20, 1937. Paratopotype, 1 male, pinned with the holotype.

The nearest relative of the present fly is *Gonomyia* (*Idiocera*) *pallens* Alexander (Japan, Honshiu) which differs in the striped thoracic pleura and structure of the male hypopygium. The conspicuous tergal development of *pallens* is not apparent in the present fly. In *pallens* these arms are very long and conspicuous, only a little shorter than the outer dististyle.

GONOMYIA (GONOMYIA) SUPERBA Alexander var.

Gonomyia (*Gonomyia*) *superba* ALEXANDER, Canad. Ent. 45 (1913) 285, 286.

Widely distributed in Japan.

NORTHERN KOREA, Chonsani, Paiktusan, altitude 4,200 feet, July 24 and 25, 1937 (*Yankovsky*). I cannot separate these specimens specifically from the type material.

ERIOPTERA (ERIOPTERA) PALLIDIVENA sp. nov. Plate 1, fig. 23; Plate 3, fig. 42.

General coloration yellow, præscutum with four brownish stripes; antennæ dark brown; ventral thoracic pleura darkened, dorsal pleura yellow; halteres and legs yellow; wings deep saturated yellow, veins pale, poorly defined against ground; male hypopygium with both dististyles slender, simple, narrowed to acute blackened points; gonapophysis bispinous, inner spine nearly straight, outer spine strongly curved.

Male.—Length, about 5 millimeters; wing, 5.5.

Rostrum yellow; palpi black. Antennæ dark brown, scape a little paler. Eyes (male) large, contiguous beneath. Head infuscated, paling to yellow behind.

Pronotum light yellow. Mesonotal præscutum obscure yellow, with four brownish stripes, intermediate pair darker in front, not reaching suture behind; lateral borders yellow; scutum with lobes extensively infuscated, median area yellow; scutellum light yellow; postnotum obscure yellow, posterior portion of both mediotergite and pleurotergite darker. Pleura with dorsal pleurites and dorsopleural membrane yellow, ventral pleurites, including ventral anepisternum, sternopleurite, and meron more infuscated. Halteres yellow. Legs with coxæ yellow, fore coxæ a trifle darker; trochanters yellow; remainder of legs yellow, terminal tarsal segments darkened. Wings (Plate 1, fig. 23) deep saturated brownish yellow, veins pale yellow, very difficult to see against the ground. Venation: Vein M_3 at apex deflected strongly cephalad; vein 2d A strongly sinuous.

Abdomen brownish yellow; hypopygium yellow. Male hypopygium (Plate 3, fig. 42) with basistyles, *b*, slender. Both dististyles slender, simple, of approximately similar outline, narrowed gradually to acute blackened tips; outer style, *od*, glabrous; inner style with a few microscopic setulæ before tips. Gonapophyses, *g*, appearing as flattened plates, each bispinous, inner spine nearly straight, the shorter outer spine strongly curved.

Habitat.—Northern Korea.

Holotype, male, Chonsani, Paiktusan, altitude 4,200 feet, July 16, 1937 (*Yankovsky*).

Erioptera (*Erioptera*) *pallidivena* is quite distinct from the other regional members of the subgenus, differing especially in the body coloration, the pale wing veins, and the structure of the male hypopygium. The only other generally similar species in eastern Asia is *E.* (*E.*) *xanthoptera* Alexander, of Saghalien, which differs in the details of body coloration and in the color and venation of the wings. The male of the latter species is still unknown. Among the European species the fly is closest to *E.* (*E.*) *squalida* Loew, yet is amply distinct.

ORMOSIA (ORMOSIA) DUCALIS sp. nov. Plate 1, fig. 24; Plate 3, fig. 43.

Large (wing, male, over 7 millimeters); general coloration black, including antennæ and legs; halteres with conspicuous light yellow knobs; wings strongly tinged with blackish; cell M_2 open by atrophy of m; vein 2d A nearly straight; male hypopygium with caudal border of tergite moderately produced; three dististyles, outer clavate; gonapophyses appearing as slender, straight rods, tips acute.

Male.—Length, about 6.5 millimeters; wing, 7.2.

Rostrum and palpi black. Antennæ black throughout, of moderate length, if bent backward extending about to wing root; flagellar segments long-oval to elongate, especially the outer ones; longest verticils unilaterally arranged, much exceeding segments in length, especially the more basal ones. Head dull black.

Thorax dull black, pronotum and pleura more pruinose; interspaces with abundant long erect black setæ. Halteres with stem black, knob conspicuously light yellow. Legs black throughout. Wings (Plate 1, fig. 24) with a strong blackish tinge, stigmal region a trifle darker; veins and macrotrichia dark. Macrotrichia of cells unusually abundant and conspicuous (indicated in figure by stippled dots). Venation: Sc_1 ending nearly opposite R_2; Rs subequal in length to Sc_1; R_{1+3+4} short, slightly exceeding R_{2+3}; cell M_2 open by atrophy of m; cells beyond cord deep; vein 2d A nearly straight to very feebly concave.

Abdomen, including hypopygium, black. Male hypopygium (Plate 3, fig. 43) with caudal border of tergite, *9t*, moderately produced. Three dististyles or primary branches, the outer, *od*, longest, appearing as a dark clavate rod, head scabrous; intermediate style, *md*, about four-fifths as long, blackened, slender, gently sinuous, acute tip strongly curved; inner style, *id*, yellow, compressed, tip obtuse, near base darkened and with numerous setæ. Gonapophyses, *g*, appearing as slender, glabrous, nearly straight rods, tips long and slender, acute, darkened.

Habitat.—Nothern Korea.

Holotype, male, Ompo, altitude 170 feet, May 23, 1937 (*Yankovsky*).

Ormosia (*Ormosia*) *ducalis* is very different from all other species of the genus so far discovered. The open cell M_2, with m lacking, is found also in the otherwise entirely different *O.* (*O.*) *confluenta* Alexander, of Japan.

ILLUSTRATIONS

[Legend: *a*, Ædeagus; *b*, basistyle; *d*, dististyle; *dd*, dorsal dististyle; *g*, gonapophysis; *i*, interbase; *id*, inner dististyle; *md*, intermediate dististyle; *od*, outer dististyle; *p*, phallosome; *t*, tergite.]

PLATE 1

FIG. 1. *Protanyderus yankovskyi* sp. nov.; venation.
2. *Trichocera tuberculifera* sp. nov.; venation.
3. *Trichocera latilobata* sp. nov.; venation.
4. *Limonia* (*Limonia*) *venerabilis* sp. nov.; venation.
5. *Limonia* (*Dicranomyia*) *infensa* sp. nov.; venation.
6. *Limonia* (*Dicranomyia*) *subaurita* sp. nov.; venation.
7. *Dicranoptycha prolongata* sp. nov.; venation.
8. *Dicranoptycha diacantha* sp. nov.; venation.
9. *Helius* (*Helius*) *polionota* sp. nov.; venation.
10. *Helius* (*Helius*) *gracillimus* sp. nov.; venation.
11. *Pedicia* (*Pedicia*) *lætabilis* sp. nov.; venation.
12. *Pedicia* (*Pedicia*) *simulata* sp. nov.; venation.
13. *Pedicia* (*Tricyphona*) *patens* sp. nov.; venation.
14. *Pedicia* (*Tricyphona*) *longiloba* sp. nov.; venation.
15. *Pedicia* (*Tricyphona*) *diaphanoides* sp. nov.; venation.
16. *Dicranota* (*Rhaphidolabis*) *luteola* sp. nov.; venation.
17. *Dicranota* (*Rhaphidolabis*) *neoconsors* sp. nov.; venation.
18. *Limnophila* (*Phylidorea*) *megapygia* sp. nov.; venation.
19. *Limnophila* (*Phylidorea*) *pernigrita* sp. nov.; venation.
20. *Limnophila* (*Prionolabis*) *acanthophora* sp. nov.; venation.
21. *Hexatoma* (*Eriocera*) *pernigrina* sp. nov.; venation.
22. *Gonomyia* (*Idiocera*) *perpallens* sp. nov.; venation.
23. *Erioptera* (*Erioptera*) *pallidivena* sp. nov.; venation.
24. *Ormosia* (*Ormosia*) *ducalis* sp. nov.; venation.

PLATE 2

FIG. 25. *Trichocera tuberculifera* sp. nov.; male hypopygium.
26. *Trichocera latilobata* sp. nov.; male hypopygium.
27. *Limonia* (*Limonia*) *venerabilis* sp. nov.; male hypopygium.
28. *Limonia* (*Dicranomyia*) *infensa* sp. nov.; male hypopygium.
29. *Limonia* (*Dicranomyia*) *subaurita* sp. nov.; male hypopygium.
30. *Dicranoptycha prolongata* sp. nov.; male hypopygium.
31. *Dicranoptycha diacantha* sp. nov.; male hypopygium.
32. *Helius* (*Helius*) *gracillimus* sp. nov.; male hypopygium.
33. *Pedicia* (*Pedicia*) *lætabilis* sp. nov.; male hypopygium, dististyle.
34. *Pedicia* (*Pedicia*) *simulata* sp. nov.; male hypopygium.

PLATE 3

FIG. 35. *Pedicia* (*Tricyphona*) *patens* sp. nov.; male hypopygium.
36. *Pedicia* (*Tricyphona*) *longiloba* sp. nov.; male hypopygium.
37. *Dicranota* (*Rhaphidolabis*) *neoconsors* sp. nov.; male hypopygium.
38. *Limnophila* (*Phylidorea*) *megapygia* sp. nov.; male hypopygium.
39. *Limnophila* (*Phylidorea*) *pernigrita* sp. nov.; male hypopygium.
40. *Limnophila* (*Prionolabis*) *acanthophora* sp. nov.; male hypopygium.
41. *Gonomyia* (*Idiocera*) *perpallens* sp. nov.; male hypopygium.
42. *Erioptera* (*Erioptera*) *pallidivena* sp. nov.; male hypopygium.
43. *Ormosia* (*Ormosia*) *ducalis* sp. nov.; male hypopygium.

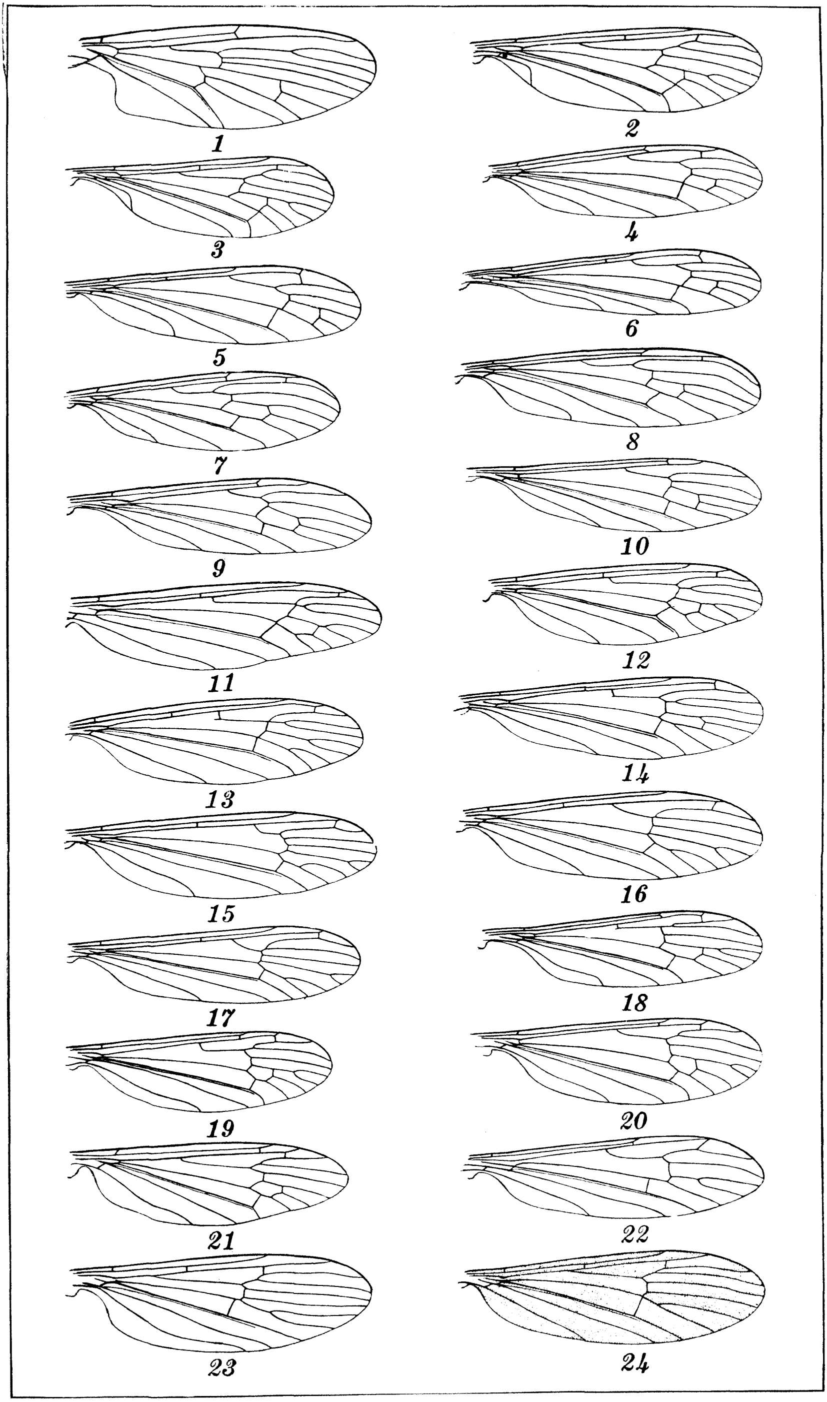


PLATE 1.

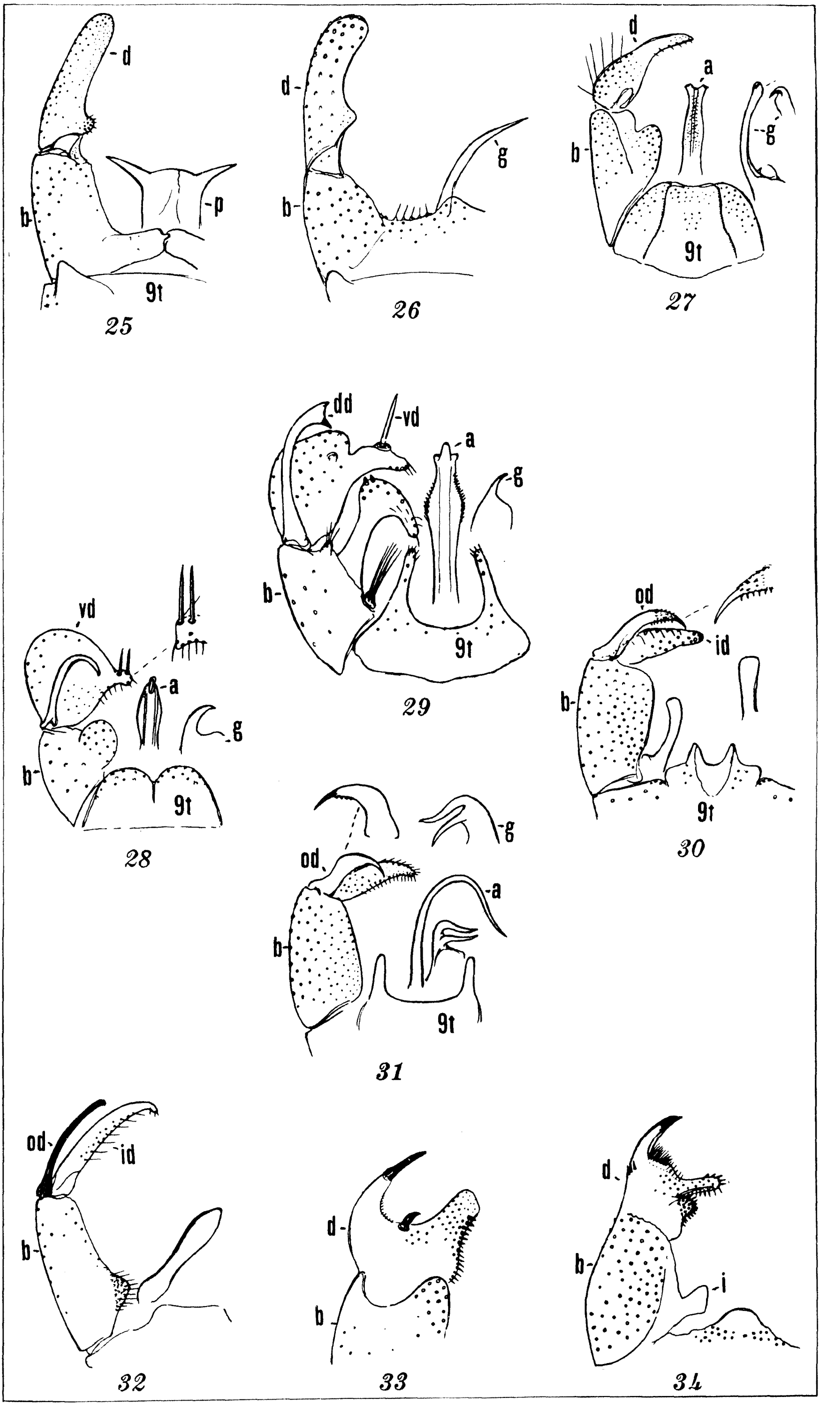


PLATE 2.

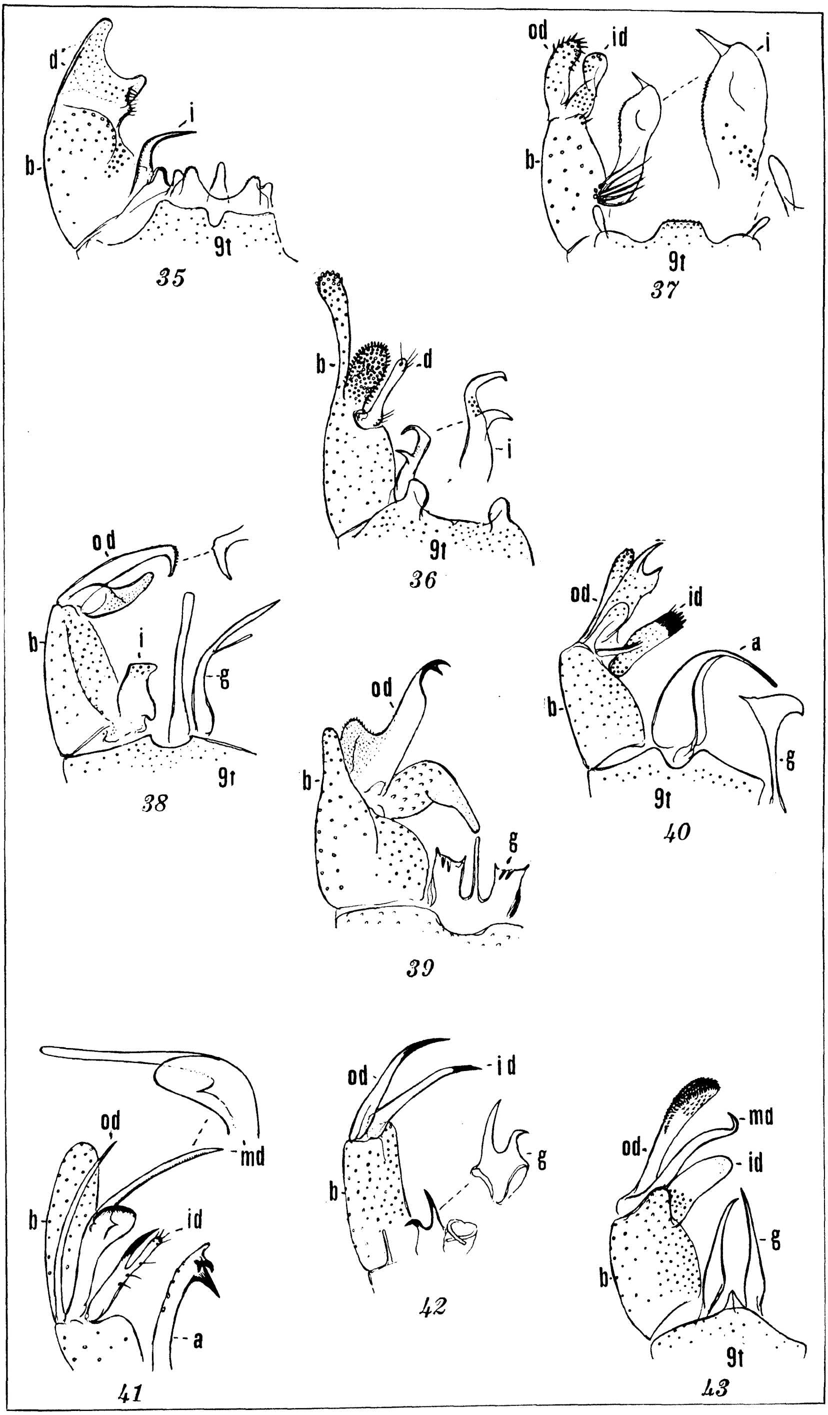

d
b
i
9t
35
od
id
i
b
9t
37
b
d
i
9t
36
od
b
i
g
9t
38
od
id
a
b
g
9t
40
od
b
g
39
od
md
b
id
a
41
od
id
b
g
42
md
od
id
b
g
9t
43

PLATE 3.

NOTES ON THE ALGAL FLORA OF NEW ZEALAND, I

FRESH-WATER DIATOMS FROM NEW ZEALAND

By B. W. Skvortzow

Of Harbin, Manchoukuo

ONE TEXT FIGURE

In this series I am going to publish various observations I have made on the Algæ of New Zealand, including lists and descriptions of species in smaller collections submitted to me for investigation, essays and observations on biological matters, and other data. During the past 70 years a considerable amount of work has been done on the fresh-water algæ of New Zealand, but our knowledge of their distribution throughout this area still remains very fragmentary and incomplete.

So little attention has been paid to New Zealand fresh-water diatoms hitherto, that only a few papers have as yet been published. As far as I know the first fresh-water diatom samples have been collected in New Zealand by Dr. W. Lauder Lindsay in 1861 in the Greensland district of Otago, around the station or farm of Faitfield, Saddlehill. The determinations of the collection have been made by Dr. R. K. Greville, of Edinburgh, and published by Dr. Lauder Lindsay in 1867.(6, 7) The Lauder Lindsay list contains 110 species, three of which, *Cymbella Lindsayana* Greville, *Stauroneis scaphulaeformis* Greville, and *Stauroneis rotundata* Greville, were described and figured by R. K. Greville.(4, 5) No descriptions and no figures are given in Lauder Lindsay's paper on New Zealand diatoms. As states P. T. Cleve,(2) *Cymbella Lindsayana* Greville [1] is closely connected with *Cymbella Hauckii* of Van Heurck, but the description and figures given by Greville are not sufficient for identification. I could not find the two new *Stauroneis* in the P. T. Cleve monograph, but they were figured in plates 72 and 73, figs. 30, 31, and 32 of the "Diatomaceentafeln zusammengestellt für einige

[1] Trans. Bot. Soc. Edinb. 8: 234, pl. 3, figs. 3–8.

Freunde.(3) These two diatoms, incompletely figured, are distinct species. *Stauroneis scaphulaeformis* Greville in its outline is very similar to *Stauroneis Playfairiana* Skvortzow, recently described as a fossil from neogene deposits in New South Wales, Australia.(10)

The next samples of fresh-water diatoms were collected in New Zealand by Dr. S. Berggren in 1874 and 1875, and distributed in microscopical slides as "Diatoms edited by P. T. Cleve and P. D. Möller" Port 2, Upsala (1898) No. 90, in which the following fossil fresh-water species from Arthur's Pass were published: *Amphora Berggrenii* Cleve, *Navicula rhomboides* Ehr. fo. *gracilis, Navicula Tabellaria* Ehr. fo. *curta, Navicula serians* Kütz. fo. *curta, Navicula firma* Kütz. var., and *Eucyonema gracile* (Ehr.) Rabh.

In 1881 P. T. Cleve published a paper with the description of 3 new diatoms from New Zealand, *Amphora Berggrenii* Cleve, *Stephanodiscus Novae Zealandiae* Cleve, recorded from Roto Rua Lake, and *Triceratium trifoliatum* Cleve, a curious diatom remarkable for its fresh-water habit, and which seems, according to P. T. Cleve, to be most nearly related to *Hydrosera* Wallich from Ganges River in India, but which is entirely different.(1) No diatoms are listed in the paper of Dr. Otto Nordstedt on fresh-water algæ of New Zealand.(8) In P. T. Cleve's monograph on Naviculoid Diatoms 71 different diatoms are reported from New Zealand, with descriptions of the new species *Diploneis subovalis* Cleve from Paeroa, *Gomphonema Berggrenii* Cleve from Waitangi and Roto Rua Lake, *Navicula Pusio* Cleve from Roto Rua Lake collected by S. Berggren, and *Navicula acrosphaeria* Breb. var. *laevis* Cleve.(2) In the paper of Tempere et Peragallo "Diatomees du Monde Entier" published in 1915 several lists of fresh-water diatoms are given from fresh-water deposits of Wangarei, from Roto Teia Lake, Korawara, Waitangi, Auckland, Pakaraka. *Eunotia inaequalis* M. Per. is reported as a new species without figure.(11) The next list of fresh-water diatoms was published by the late G. B. de Toni and Achille Forti in 1923; this material was collected by the reverend dott. Giuseppe Capra in Rotoreia Lake, Wakavareva, Ohinenum, and Port Chermens.(12) In the famous atlas "Dr. A. Schmidt Atlas Diatomaceenkunde" published by the late Dr. Fr. Fricke and now by Dr. Fr. Hustedt, from 1901 to 1914, few New Zealand diatoms were figured. Dr. Fr. Fricke's figures are of *Stephanodiscus Novae Zealandiae* Cleve, plate 225, figs. 33 to

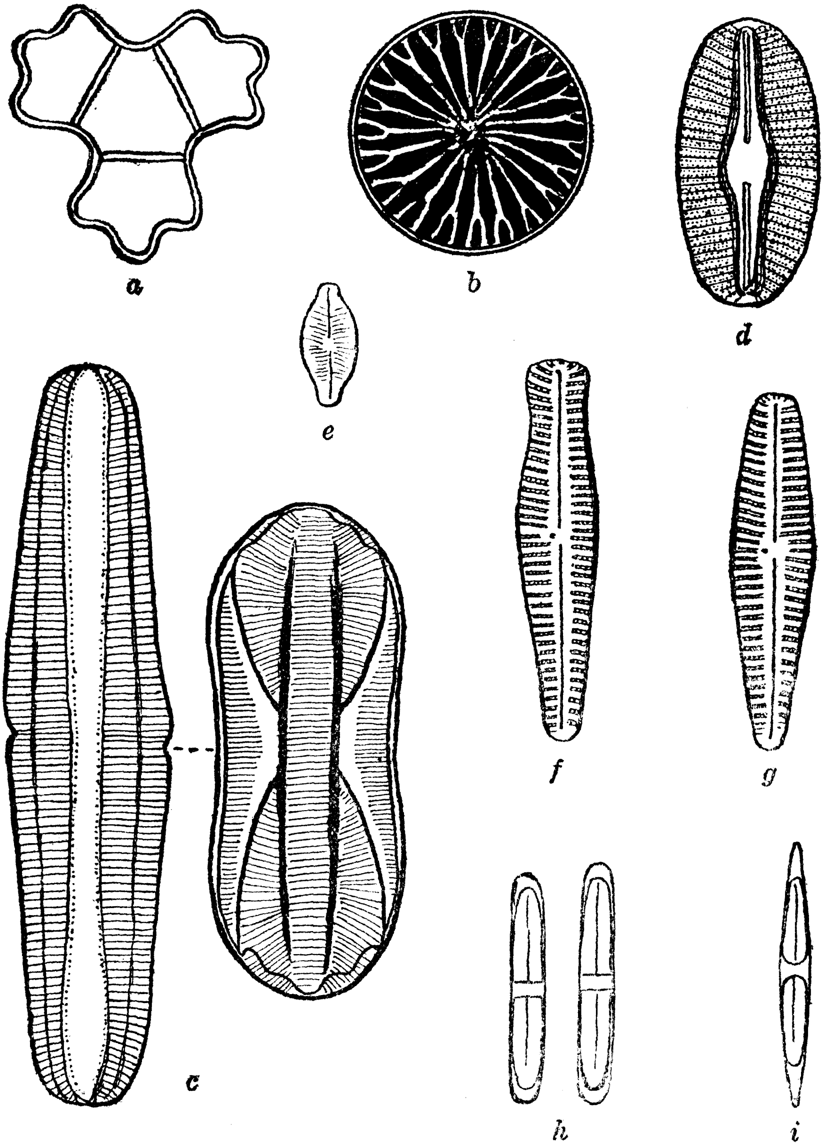


FIG. 1. *a*, *Triceratium trifoliatum* Cleve (after Cleve) ; *b*, *Stephanodiscus Novae Zealandiae* Cleve (after Cleve) ; *c*, *Amphora Berggrenii* Cleve (after Cleve) ; *d*, *Diploneis subovalis* Cleve (after Cleve) ; *e*, *Navicula Pusio* Cleve (after Cleve) ; *f*, *g*, *Gomphonema Berggrenii* Cleve (after Cleve) ; *h*, *Stauroneis rotundata* Greville (after Greville) ; *i*, *Stauroneis scaphulaeformis* Greville (after Greville).

35; *Gomphonema Berggrenii* Cleve, plate 240, figs. 26 to 30; *Gomphonema subclavatum* Grun., plate 240, figs. 31 and 32; *Gomphonema gracile* var. *lanceolata* Kütz., plate 236, figs. 25

to 28, and plate 237, fig. 10; *Gomphonema lanceolatum* Ehr., plate 236, fig. 33. In 1914 Dr. Fr. Hustedt published diagrams of *Eunotia eruca* Ehr., plate 290, fig. 8; *Rhopalodia Novae Zealandiae* Hust., plate 294, fig. 40; and *Synedra ulna* (Nitzsch.) Ehr., plate 301, fig. 11, and plate 302, fig. 2.

As the papers of R. K. Greville, P. T. Cleve, and others are scarce and rare I am giving an account of all fresh-water diatoms provisionally recorded from New Zealand, and several diagrams of rare species. The number after each species corresponds to the locality from which it was obtained. These localities and numbers are as follows: 1, Roto Rua Lake; 2, Korawara; 3, Waitangi; 4, Cabbage-tree swamp, Auckland, from fresh-water deposits; 5, Wangarei, from fresh-water deposits; 6, Auckland, from fresh-water deposits; 7, Pakaraka, from fresh-water deposits; 8, Wakavareva; 9, Ohinemutu; 10, Port Chalmers; 11, Paeroa; 12, Bluff; 13, New Zealand reported by P. T. Cleve; 14, Otago, by W. S. Lindsay. I have left the original nomenclature of the authors. This nomenclature has in many places grown old, and as all diatoms have not been figured in the reports it is impossible now to correct the names.

DIATOMS RECORDED FROM FRESH WATERS OF NEW ZEALAND

Triceratium trifoliatum Cleve, 13.
Melosira crenulata Kütz., 1, 3, 6, 7, 8.
Melosira crenulata var. *tenuis*, 3.
Melosira crenulata var. *ambigua* Grun., 2.
Melosira crenulata var. *valida* Grun., 6.
Melosira granulata (Ehr.) Ralfs, 5, 9.
Melosira granulata var. *decussata* (Ehr.) Grun., 1, 9.
Melosira laevis Ehr., 4.
Melosira Roeseana Rab. var., 4.
Melosira Roeseana var. *epidendron*, 4.
Melosira subflexilis Kütz., 14.
Melosira orichalcea Mert, 14.
Lysigonium varians de Toni, 1, 3, 8, 14.
Stephanodiscus Novae Zealandiae Cleve, 1, 8, 9.
Cyclotella steligera Cleve et Grun., 1, 8.
Cyclotella operculata Kütz., 14.
Cyclotella Kützingiana Thw.?, 14.
Cyclotella punctata Sm., 14.
Cyclotella minutula, 14.
Hyalodiscus subtilis Bail., 14.
Actinoptychus undulatus K., 14.
Denticula tenuis K., 14.
Odontidium mutabile Sm., 14.
Fragilaria capucina Desm., 14.
Meridion constrictum Ralfs, 3, 14.
Meridion circulare Grev., 14.
Synedra acus Kütz., 1.
Synedra ulna (Nitz.) Ehr., 1, 5, 8, 9, 14.
Synedra ulna var. *lanceolata* (Kütz.) Grun., 8.
Synedra ulna var. *oxyrhynchus* (Kütz.) Grun., 8.
Synedra ulna var. *oxyrhynchus* fo. *mediconstricta* Forti, 4.
Synedra ulna var. *longissima*, 4.
Synedra rumpens Kütz., 4.
Synedra rumpens var. *fragilaroides*, 4.

Synedra minutissima K., 14.
Synedra radians K., 14.
Synedra delicatissima Sm., 14.
Synedra tenera Sm., 14.
Synedra acuta Ehr., 14.
Synedra fasciculata Ag., 14.
Eunotia serpentina Ehr., 8.
Eunotia pectinalis (O. Müll.) Rabh., 8, 14.
Eunotia veneris Kütz., 1, 9.
Eunotia gracilis Sm., 14.
Eunotia impressa Grun., 3.
Eunotia inaequalis M. Per., 3.
Eunotia lunaris Grun., 3.
Eunotia lunaris var. *alpina*, 3.
Eunotia lunaris var. *major*, 3.
Eunotia lunaris var. *subarcuata*, 3.
Eunotia diodon Ehr., 1, 4, 6.
Eunotia ophidacampa Cleve, 1.
Eunotia Burkartii Ehr., 4.
Eunotia major Rab., 4.
Eunotia monodon Ehr., 4.
Eunotia monodon fo. *curta*, 4.
Eunota parallela Ehr., 4.
Eunotia praerupta var. *bidens*, 4, 7, 14.
Eunotia eruca Ehr., 6.
Dictomella Balfouriana Grev.
Cocconeis placentula Ehr., 1, 3, 5, 8, 9, 14.
Cocconeis pediculus Ehr., 14.
Achnanthes exilis K., 14.
Achnanthes inflata (Kütz.) Grun., 4, 7, 8.
Achnanthes Hauckiana Grun., 13.
Achnanthes lanceolata (Breb.) Grun., 4, 6, 7, 8, 14.
Achnanthes lanceolata var. *inflata* A. Mayer, 8.
Achnanthes exigua Grun., 13.
Achnanthidium lineare Sm., 14.
Achnanthidium coarctatum Breb., 14.
Achnanthidium trinode Arn., 14.
Rhoicosphenia curvata (Kütz.) Grun., 13.
Frustulia rhomboides Ehr., 1, 3, 8, 14.
Frustulia rhomboides var. *lanceolata* Ehr., 13.
Frustulia vulgaris Thw., 3, 8, 14.
Frustulia vulgaris var. *saxonica* Rabh., 13.
Gyrosigma Kützingii Grun., 13.
Gyrosigma acuminatum (Kütz.) Rab., 8.
Caloneis fasciata Lagerst., 13.
Caloneis silicula Ehr. var. *genuina* Cleve, 13.
Caloneis silicula var. *ventricosa* Ehr.) Donk., 4.
Neidium affine Ehr., 2, 4, 14.
Neidium affine Ehr. var. *amphirhynchus* Ehr. fo. *major*, 5, 13.
Neidium Hitchcockii Ehr., 13.
Neidium bisulcatum, 14.
Neidium dubium Ehr., 1, 8, 9, 13.
Neidium iridis, 14.
Diploneis elliptica Kütz., 1, 8, 14.
Diploneis subovalis Cleve, 11.
Stauroneis Frauenfeldiana Grun., 2, 13.
Stauroneis acuta W. Smith, 8, 13.
Stauroneis Fulmen Btw., 2, 13.
Stauroneis anceps Ehr., 1, 3, 8, 14.
Stauroneis anceps var. *gracilis* (Rab.) Brun., 8, 14.
Stauroneis anceps var. *linearis* Ehr., 14.
Stauroneis phoenicentron Ehr., 3, 5, 14.
Stauroneis javanicum Grun., 4.
Stauroneis scaphulaeformis Grev., 4, 14.
Stauroneis rotundata Grev., 14.
Stauroneis constricta Ehr., 14.
Stauroneis platystoma Ehr.
Pleurostauron inflatum (Heid.) de Toni et Forti, 8.
Mastogloia lanceolata Thw., 14.
Colletonema neglectum ? Thw., 14.
Navicula pupula Kütz., 1, 5, 9, 13.
Navicula bacilliformis Grun., 4.
Navicula pseudo-bacillum Grun., 13.
Navicula pusio Cleve, 1.
Navicula vulpina Kütz., 13.
Navicula salinarum Grun. var. *intermedia* Grun., 13.
Navicula lacunarum Grun., 4.
Navicula gastrum Ehr., 13.

Navicula gastrum var. *exigua* Greg., 13.
Navicula placenta Ehr., 13.
Navicula placentula Ehr., 5, 8, 13.
Navicula radiosa Kütz., 3, 14.
Navicula cuspidata Kütz., 2, 5, 13.
Navicula cuspidata var. *ambigua* Ehr., 13.
Navicula cuspidata var. *creticula*, 14.
Navicula rhynchocephala Kütz., 1.
Navicula rhynchocephala var. *amphiceros* (Kütz.) Grun., 8.
Navicula commutata Grun., 4.
Navicula peregrina Kütz., 5, 14.
Navicula mutica var. *Cohnii*, 7.
Navicula laevissima K., 14.
Navicula cocconeiformis Greg., 14.
Navicula claviculus Greg., 14.
Navicula inflata K., 14.
Navicula pusilla Sm., 14.
Navicula cryptocephala K., 14.
Navicula lanceolata Ag., 14.
Navicula tumida Breb., 14.
Pinnularia mesolepta Ehr., 8, 13, 14.
Pinnularia divergentissima Grun., 13.
Pinnularia Legumen Ehr., 13.
Pinnularia divergens W. Sm., 2, 3, 4, 13.
Pinnularia divergens var. *sublinearis* Cleve, 13.
Pinnularia episcopalis Cleve, 2.
Pinnularia episcopalis Cleve var. *brevis* Cleve, 13.
Pinnularia borealis Ehr., 3, 13, 14.
Pinnularia lata Breb., 1, 8, 13.
Pinnularia stauroptera Grun., 2.
Pinnularia stauroptera var. *interrupta* Cleve, 13.
Pinnularia stomatophora Grun., 13.
Pinnularia subsolaris Grun. var. *linearis* Cleve, 13.
Pinnularia hemiptera Kütz., 3, 6, 13.
Pinnularia acrosphæria Breb., 4.
Pinnularia acrosphæria Breb. fo. *maxima*, 13.
Pinnularia acrosphæria var. *laevis* Cleve, 13.
Pinnularia parva Greg., 3, 6, 8, 13.
Pinnularia parva var. *Novae Zealandiae* Cleve, 13.
Pinnularia major Kütz., 1, 2, 4, 6, 8, 13, 14.
Pinnularia viridis Nitz., 2, 4, 6, 8, 13, 14.
Pinnularia distinguenda Cleve, 13.
Pinnularia gibba, 3, 4, 6, 14.
Pinnularia gibba var., 3.
Pinnularia brevistriata Grun., 2.
Pinnularia legumen Ehr., 1.
Pinnularia appendiculata (Ag.) Cleve, 8.
Pinnularia appendiculata var. *budensis* Grun., 1.
Pinnularia dactylis Ehr., 8.
Pinnularia Hartleyana Grun., 8.
Pinnularia brevicostata Cleve var. *interrupta*, 4.
Pinnularia transversa AS., 4.
Pinnularia acuminata Sm., 14.
Pinnularia viridula Sm., 14.
Pinnularia stauroneiformis Sm., 14.
Pinnularia interrupta Sm., 14.
Pinnularia subcapitata Greg., 14.
Amphora ovalis (Breb.) Kütz., 8, 14.
Amphora ovalis var. *pediculus* Kütz., 13.
Amphora veneta Kütz., 13.
Amphora Berggrenii Cleve, 13.
Cymbella ventricosa Kütz., 3, 4, 6, 8, 13.
Cymbella cuspidata Kütz., 13, 14.
Cymbella cuspidata var., 2.
Cymbella affinis Kütz., 1, 13.
Cymbella anglica Lag., 1.
Cymbella gastroides Kütz., 1.
Cymbella amphicephala Naeg., 8.
Cymbella australica (A. Sch.) Grun., 8, 13.
Cymbella Cesatii (Rab.) Cleve, 8.
Cymbella parva (W. Sm.) Cleve, 8.
Cymbella pusilla Grun., 4.
Cymbella turgidum Grun., 4, 13.
Cymbella naviculiformis Auerst., 13.
Cymbella Jordani Grun., 14.
Cymbella gracilis Rabh., 13.
Cymbella sinuata Greg., 13.
Cymbella turgidula Grun., 13.

Cymbella aspera Ehr., 13.
Cymbella tumida Breb., 13.
Cymbella apiculata, 14.
Cymbella Lindsayana Grev., 14.
Cymbella obtusiuscula K., 14.
Cymbella Helactica K., 14.
Cymbella lanceolatum Ehr.
Gomphonema parvulum Kütz., 7, 8, 13.
Gomphonema gracile Ehr., 1.
Gomphonema gracile. var. *major* Grun., 13.
Gomphonema gracile var. *naviculacea* W. Sm., 13.
Gomphonema lanceolatum Ehr., 13.
Gomphonema acuminatum Ehr., 13.
Gomphonema Berggrenii Cleve, 1, 2, 3, 8.
Gomphonema constrictum Ehr., 13, 14.
Gomphonema intricatum, 6, 14.
Gomphonema intricatum var. *pumila*, 3.
Gomphonema subclavatum Grun, 4.
Gomphonema affine Kütz., 4.
Gomphonema vibrio Ehr., 4, 14.
Gomphonema curvatum K., 14.
Gomphonema cristatum Rab., 14.
Gomphonema augur Ehr., 14.
Gomphonema tenellum K., 14.
Gomphonema dichotomum K., 14.
Gomphonema aequale Greg., 14.
Epithemia sorex Kütz., 1, 3, 5, 8, 12, 14.
Epithemia turgida (Ehr.) Kütz., 8, 14.
Epithemia zebra (Ehr.) Kütz., 10, 14.
Epithemia musculus Kütz., 14.
Epithemia Westermanniae Ehr., 14.
Rhopalodia gibba (Ehr.) O. Müll., 1, 9, 14.
Rhopalodia ventricosa (Ehr.) O. Müll., 8.
Rhopalodia gibberula (Ehr.) O. Müll., 1, 3, 9.
Rhopalodia Novae Zealandiae Hust.[2]
Hantzschia amphioxys (Ehr.) Grun. 1, 6, 7, 9, 14.
Hantzchia amphioxys var. *intermedia* Grun., 12.
Nitzschia amphibia Grun., 1, 7, 9.
Nitzschia dubia W. Sm.
Nitzschia Frauenfeldii Grun., 1, 9.
Nitzschia linearis (Ag.) W. Sm., 1, 9.
Nitzschia obtusa W. Sm. var. *scalpelliformis* Grun., 1.
Nitzschia palea, 1.
Nitzschia sigma (Kütz.) W. Sm., 10, 12.
Nitzschia thermalis (Ehr.) Auer., 1, 9.
Nitzschia spectabilis Ralfs, 2.
Nitzschia acutiuscula Grun., 4.
Nitzschia sigmoidea W. Sm., 4, 14.
Nitzschia parvula Sm?, 14.
Nitzschia minutissima Sm., 14.
Nitzschia spathulata Breb., 14.
Triblionella gracilis Sm., 14.
Triblionella debilis Ryl., 14.
Triblionella angustata Sm., 14.
Triblionella levidensis Sm., 14.
Surirella gracilis Grun., 8.
Surirella ovalis Breb., 2, 3, 9.
Surirella ovalis var. *angusta* (Kütz.) Van Heur., 1, 8, 9.
Surirella ovalis var. *excelsa* O. Müll., 1.
Surirella ovalis var. *Kotschyana*, 3, 8, 13.
Surirella splendida (Ehr.) Kütz., 3, 8, 14.
Surirella linearis Sm., 14.
Surirella linearis var. *constricta*, 3.
Surirella minuta Breb., 3, 14.
Surirella ovata Kütz., 3, 14.
Surirella biseriata Breb., 14.
Surirella tenera Greg.
Surirella elegans, 14.
Campylodiscus cribrosus Sm.

[2] A Schmidt, Atlas Diatom. pl. 294, fig. 40.

This list contains 259 different diatoms reported from New Zealand of which 14 are endemic. Several forms seem to me brackish-water species.

LITERATURE CITED

1. CLEVE, P. T. On some new and little-known diatoms. Kongl. Svenska Vetenskaps-Akad. Handl. Stockholm (15) **18** (1881).
2. CLEVE, P. T. Synopsis of the Naviculoid Diatoms. Stockholm (1894–1895).
3. CLEVE, P. T. Diatomaceentafeln zusammengestellt für einige Freunde. New York, pls. 1–81.
4. GREVILLE, R. K. Descriptions of new genera and species of diatoms from the South Pacific, I–III. Trans. Bot. Soc. Edinb. **7, 8** (1863–1865).
5. GREVILLE, R. K. Descriptions of new and rare diatoms from the Tropics and the Southern Hemisphere. Trans. Bot. Soc. Edinb. **8** (1865) 1 pl.
6. LINDSAY, W. LAUDER. On the Diatomaceae of Otago, New Zealand. Journ. Linn. Soc. Bot. London **9** (1867).
7. LINDSAY, W. LAUDER. Ou the Protophyta (Diatomaceae) from New Zealand. Q. J. M. S. London **7** (1867).
8. NORDSTEDT, OTTO. Fresh-water algae collected by Dr. S. Berggren in New Zealand and Australia. Kongl. Svenska Vetenskaps-Akad. Handl. Stockholm (6) **22** (1888).
9. SCHMIDT, A. Atlas Diatomaceenkunde. Leipzig (1875–1931).
10. SKVORTZOW, B. W. Notes on fossil diatoms from New South Wales, Australia, I. Fossil diatoms from Comma diatomaceous earth. 2 Pl. Unpublished manuscript.
11. TEMPERE et PERAGALLO. Diatomees du Monde Entier. 2d ed. Giround (1915).
12. DE TONI, G. B., et A. FORTI. Alghe di Australia, Tasmania e Nuova Zealana reccolte dal rev. dott. Giuseppe Capra nel 1908–1909. Mem. Real. Inst. Veneto di Sci. Lett. ed Arti. Venezia (3) **29** (1923).

ILLUSTRATION

TEXT FIGURE

FIG. 1. *a, Triceratium trifoliatum* Cleve (after Cleve); *b, Stephanodiscus Novae Zealandiae* Cleve (after Cleve); *c, Amphora Berggrenii* Cleve (after Cleve); *d, Diploneis subovalis* Cleve (after Cleve); *e, Navicula Pusio* Cleve (after Cleve); *f, g, Gomphonema Berggrenii* Cleve (after Cleve); *h, Stauroneis rotundata* Greville (after Greville); *i, Stauroneis scaphulaeformis* Greville (after Greville).

THE FLYING-FISH INDUSTRY OF THE NORTHWESTERN AND SOUTHWESTERN COASTS OF CEBU

By CLARO MARTIN

Of the Fish and Game Administration, Bureau of Science, Manila

FOUR PLATES

The flying-fish industry of Cebu first came to the notice of the writer during his preliminary survey of the fisheries of Fishery District No. 8 (comprising Oriental Negros, Cebu, and Bohol Provinces) in May and June, 1936. The particulars obtained at that time were supplied exclusively by the fishermen. An opportunity to check up on this information came in November, 1936, when the investigation reported in the present paper was conducted.

The flying-fish fishery on the southeastern coast of Cebu has been in existence for about 40 years. It was originated by the Dalaguetnons (natives of the town of Dalaguete). Floating *bobos*, or fish pots, were first used. After years of observation of the habits of the flying fish the gill-net method was evolved. The gill net used is the *natural*.

The range of the flying-fish fishery in this part of Cebu is from San Fernando southward to Oslob. Fishing is most intensive in Dalaguete. It appears that years of unrestrictive fishing have caused the flying-fish fishery of this region to decline. This condition, together with the increase in the number of fishermen, made it necessary for the Dalaguetnons to look for new fishing grounds, and they were the first to fish the "voladors" (flying fish) in the towns of Balamban, Asturias, and Tuburan in northwestern Cebu, in southwestern Oriental Negros Province, and in southern Bohol Province. In 1936 many fishermen from Dalaguete went to fish in Leyte and Samar Islands, bringing their nests with them.

In places where this fishery exists, fishing for the more common commercial species is generally poor, for the coast line is abrupt and the water deep.

SPECIES TAKEN

This fishery is not confined to fishing for a single species. While the fishery is devoted primarily to flying fish, half-beaks are also caught in appreciable quantities. A few needle fish are also caught now and then.

The bulk of the catch of flying fish is made up of *baroñgoy*, There are two species that fall under the name of baroñgoy, *Cypselurus poecilopterus* and *Cypselurus olegolepis*. Flying fish over 20 centimeters long are called *bangse*. Of the two species of baroñgoy, *C. oligolepis* forms the major part of the catches. This is true in northwestern as well as in southwestern Cebu.

Mixed with the baroñgoy is another species of flying fish, with a much abbreviated pectoral, *Evolantia micropterus*, locally called *laniw*. In most cases laniw does not constitute even 1 per cent of the whole catch in Tuburan. Apparently the same is true in southwestern Cebu.

Cypselurus bahiensis, called *sirikinia*, is another species of commercial flying fish. This species can be distinguished from the others by its smaller and shorter head and its long pectoral, the tip of which when folded comes closer to the base of the caudal than those of any other species. Sirikinia is found mostly in southwestern Cebu, where it is caught by means of a special kind of net and fish pot or bobo.

Species other than the flying fish are also caught. There are times when as much as one third of the catch consists of halfbeaks, or *soacid*, *Hemiramphus far*. A few needlefish or *bao*, *Belone sp.*, are also caught.

The catch is generally segregated into three groups. Group 1 includes the large-sized flying fish, from 191 to 270 centimeters long. Group 2 includes fish from 141 to 190 centimeters long. To group 3 belong the small fish, from 91 to 140 centimeters long. If there are plenty of halfbeaks of group 1 or group 2 size they are segregated as group 4. However, if these are very few and are of the same size as those of the first two groups, they are just mixed with these respective groups according to size.

The percentage of group 1 in the catch ranges from 5 to 65. The group 2 size generally predominates in the catch, with a percentage range of from 70 to 90. When group 1 predominates, the percentage of group 2 may be as low as 27. However, this condition occurs only occasionally. For group 3 the range is 2 per cent to 9 per cent. Group 4, if it is represented at all in the catch, includes 4 per cent to 20 per cent of the fishes caught.

FISHING SEASON

In the towns of Balamban and Tuburan, in northwestern Cebu, the fishing season starts in August and ends in March. Although good weather prevails from April to July, fishing activities are suspended during these months. It has been observed that during this period the fish are generally of group 1 size. Although the fishing season starts in August, when the majority of the fish have attained group 2 size, fishing activities are limited at this time by unfavorable weather conditions due to the southwest monsoon. Brisk fishing begins in October and ends in March.

In the towns of Argao, Dalaguete, Bolhoon, and Oslob in southwestern Cebu, the fishing season for all kinds of flying fish falls within the period from June to March. Baroñgoy are plentiful during June, July, August, and September. Fishing activities, however, are limited during July and August by unfavorable weather due to the southeast monsoon. The fishing season for sirikinia lasts from October to December.

FISHING METHODS

Bobo.—Ordinarily the bobo, or fish pot, is used under water for catching bottom species. Fishermen in southeastern Cebu use the same trap, provided, however, with floats to catch the flying fish, which are surface species.

The bobo is a boxlike structure, made in the shape of a rectangle from mats of thin split bamboo, woven with an open hexagonal mesh of about 2 centimeters. On the top are fastened three 1-joint bamboo floats to keep the trap close to the surface of the water. The entrance is made on one of the sides in such a way that the fish cannot escape once it has entered the trap. At the side opposite the entrance a sort of door is provided to facilitate the removal of the fish inside the trap.

When the trap is taken out for fishing, small bunches of seaweeds, *samo,* are tied to the sides and top to simulate a bunch of floating seaweed to attract the flying fish, particularly the sirikinia. The trap is fastened to the baroto of the fishermen with a 50-meter line.

Gill net.—Two types of gill nets are used, the one-man gill net and the large gill net. Both types of net are called panirikinia.[1]

[1] Net for catching sirikinia.

The one-man type is a small gill net, 4 meters deep and 14 meters long. This net is home-made, woven from No. 40 thread with a 3.4 cm (stretched) mesh. This net is provided with floats, 4 cm in diameter, 14 cm long, and 30 centimeters apart. Stone weights set 45 centimeters apart are used on the lead line. The net is dyed light blue.

The other type of panirikinia is a large net, composed of 10 pieces of the same material and made like the one-man panirikinia. The pieces, measuring 7 meters each, are interlaced end to end.

The operation of this net requires seven to twelve *barotos.*[2] One of these barotos, called *pukutan,* is large, and manned by two men. The net is carried in this baroto. The other barotos are small and manned each by a single individual. One of these serves as the *lawitan,* the boat in which one end of the net is accommodated. In actual fishing the man on the lawitan takes charge of one end of the net. The rest of the men are called *abugan,* or drivers. There must be at least five abugan.

Fishing is done at daytime, always in the morning. The fishermen start for the fishing ground at dawn. At the fishing ground the net is spread across the current, which must not be very strong. One end of the net is dropped from the pukutan and picked up by one man on the lawitan, who ties it to the baroto. Then both the pukutan and the lawitan are steered in opposite directions until the entire length of the net is spread out. The abugan deployed in the form of a semicircle by this time are about a mile or more away from the net, moving toward the net and driving the flying fish toward it by throwing stones forward to scare the fish.

Pamaroñgoy.—The pamaroñgoy [3] is a purse seine. This seine varies in length from 230 to 300 meters and is 16 meters or more deep at the bunt. It is provided with a 7-mesh selvage of No. 40 [4] netting all around.

The net is composed of two parts, the wings, or *palispis,* and the bunt, or *siguin.* The length of the wing portion varies from 70 to 80 meters. The netting used in the wings is handwoven from No. 20 thread with a mesh of 2.5 centimeters. The bunt is composed of five parts. The middle portion is of No. 4 net-

[2] A narrow canoelike boat with a high sharp cutwater, provided with outriggers, and invariably fitted with a sail.

[3] Net for catching baroñgoy.

[4] The numbers of the twines and netting mentioned here are taken from the Aguinaldo Catalogue.

ting with a mesh of 1.7 centimeters. Next to this on each side is a strip of No. 21 netting of 1.5 centimeters mesh but of lighter twine. This strip is followed on the outer edge on each side by another of No. 29 netting of 2 centimeters mesh.

The middle portion of the bunt is the deepest part of the net—16 meters from the float line down to the lead line. From this portion the net narrows toward the end of the wing which is 6 meters wide. A wing briddle provided with a loop is fastened at the end of the wing. At the wings the floats are small, 6 centimeters in diameter and 7.5 centimeters long, and placed at intervals of 30 to 40 centimeters. At the bunt the floats are larger, 9 centimeters in diameter and 14.5 centimeters long. The floats are closer together at the middle portion of the bunt. Baked clay weights, 4 by 3 centimeters and spaced at intervals of 37 to 40 centimeters, serve as leads. Hanging by means of a strong twine 20 to 37 centimeters long from the lead line are the brass rings, 7 centimeters in diameter. There are altogether 54 of these brass rings, spaced at intervals of 1.40 meters to 1.65 meters. There are two purse lines, one end of each of which is fastened to the middle of the lead line. From there the two purse lines run in opposite directions, passing through the rings. The other ends of the purse lines are then tied each to the farthest ring directly fastened to the lead line about 30 meters from the end of the wing.

The operation of this net requires at least fifty men. One large sailboat (*banca*), a fast delivery sailboat (*tumuran*), a three-passenger baroto for lawitan, and at least twenty small barotos for abugan, are used. The banca, manned by ten men, is used to carry the net to the fishing ground. The men here include the leader of the entire outfit. The tumuran is included among the barotos used by the drivers. Speed is the important characteristic of a tumuran for delivering the catch to the shore. The lawitan is the baroto used by three men who take care of one end of the net when spread.

At about 2.30 A. M. the leader of the outfit begins to sound the call for his men with his shell (*turbo*) trumpet, locally called *budiong*. Each outfit has its distinctive call notes. After half an hour the banca and the lawitan leave the shore for the fishing grounds. The banca is equipped with a signal lamp for the abugan to follow, and the leader keeps sounding the outfit's call on the shell trumpet to keep the rest of the outfit aware of the banca's position.

The drivers in their respective barotos leave the shore usually about an hour later, when the banca is already quite far away. Before the sun rises, or even earlier, the drivers, arranged in a large semicircle, advance toward the position of the banca. They then begin to drive the unseen fish by throwing stones sideways and forward as they advance.

At the sight of the approaching drivers the leader orders the spread of the net. Two men pay out the piled net while one sees to it that it is not twisted. As the net is paid out, the banca is rowed forward and steered into a position that will not interfere with the spread of the net. The other end of the net is taken by a man in the lawitan who ties the *bahan,* or scare line, to the loop of the bridle line. The bahan is a 0.5-inch hemp rope about 100 meters long, with bury palm fronds inserted through the strands at intervals of about 1 meter. The other end of this scare line is fastened to the base of the mast of the lawitan. Before the other end of the net is let out, one end of the other scare line is fastened to the loop of the bridle line and the other end to the base of the mast of the banca. In the resulting position the net takes the shape of an arc, with the banca at one end and the lawitan at the other. Stones are thrown every now and then in the direction of the scare line and the gap between the men and the approaching leader of the drivers. As the drivers advance towards the net, they close and complete the circle. The circle is made smaller and smaller as the drivers advance toward the net to take hold of the float line. Others tie their barotos to the scare line and take to the water with their diving goggles to see to it that the fish do not escape. Meanwhile the banca and the lawitan approach each other. A 10-meter rope from the lawitan is fastened to the prow of the banca. The scare lines by this time are being pulled in. When the bridle line is reached at the lawitan this end of the net is passed to the men at the prow of the banca, where it is hauled in; the other end is collected at the middle portion of the banca. When the ends of the purse lines come to hand they are unfastened from the ring and slipped through the pursing blocks of the purse weight or tom (*lingote*). The latter is then immediately lowered and suspended from a purse weight line about 8 meters below the banca. As soon as this is done the purse lines are pulled in while the ends of the net are hauled in. When the bottom of the bunt is already pursed, the purse lines and the purse-weight line are pulled together to bring the lead line of the bunt to the banca. The bunt is made smaller and smaller as the net is collected on the banca. The flying fish are dipped from the bunt right into jute sacks. A small portion is left for the fishermen to divide among themselves.

As soon as the fish are placed in the sacks, these are placed on the tumuran which rushes them to the shore. If another haul of the net is made, the second fastest sailboat in the outfit delivers the catch to the shore.

HANDLING AND MARKETING

As it takes but a short time—an hour to an hour and a half—for the tumuran to get to the shore, the fish is subjected to no special handling in transit.

Upon arrival at the shore the tumuran is met by the women retail vendors who vie with each other in the acquisition of the fish first landed, as these command a higher price on the market.

The sacks in which the fish are carried are not uniform in size; they range from the smallest, with a capacity of about 2,000 flying fish of group 2 size, to the largest, with a capacity of about 3,000.

When the catch is abundant, the fish are sold by the sack, but if it is meager they are sold by the hundred. The price ranges from 5.50 pesos [5] to 6 pesos per sack of 1,900 to a little over 2,000 fish. During scarcity the price per hundred goes up to 50 centavos, and the fish are retailed 8 fish of group 2 for 5 centavos and 3 fish of group 1 for 5 centavos. During the peak of the catch in 1935 the price level is said to have gone down to as low as 40 centavos per petroleumcanful, about one-fourth the capacity of one sack of the kind ordinarily used.

When the catch is plentiful the fish are shipped to neighboring towns.

PRESERVATION

When the catches are not entirely disposed of by 3 P. M. the surplus is preserved in various forms.

Pinakas.—In this method of preservation the fish is split on the back from the mouth down to the base of the tail, and the entrails removed. Then, after the fish has been washed, it is salted and laid flat on the belly in layers in a container. The following day and thereafter the salted fish are dried under the sun.

[5] One peso equals 50 cents United States currency.

Tinabal.—In this method the fish are thoroughly mixed with salt, and placed in gasoline or petroleum cans with a thick layer of salt on top. The fish are thus allowed to remain in their own pickle.

Tinapan.—According to the tinapan method the fish are washed and strung through the eyes with rods about 1 meter long. Each rod carries 25 to 28 fish.

The strung fish are then placed over smoldering coconut fuel to be roasted. The arrangement is changed at least 4 times in order to give the fish a uniform cooking and coloration. It takes an hour or less to complete the cooking.

The process renders the fish hard and practically dry. The product is known to keep for a week at most.

NOTES ON THE SPAWNING HABITS OF FLYING FISH

In Tuburan fishermen have observed that in April, May, and June the flying fish caught are generally small—10 centimeters long at most. These fingerlings are probably hatched about December or January. In November adults (group 1) of *Cypselurus* in Tuburan were found to have mature ova, and the ova of group 2 fish are in the process of development. November 18, 1936, while taking measurements of the pamaroñgoy net, the writer in several parts of the net came across clusters of eggs entangled in a mass of long tough filaments. Upon close examination these eggs were found to bear close resemblance to those found and described by Hornell from Coromandel Coast.[6] He says:

> The proof was plain; the branches and leaves of the shrub were full of tangled-up multitudes of tiny colourless eggs with innumerable glassy threads, tough and elastic, attaching them in mosses to one another and also the leaves and branches of the plant. The eggs were devoid of colour, transparent save at one pole, where a tiny opaque white disk, the blastoderm area, was distinguishable.

A detailed microscopic examination and observation of the development of the eggs by Hornell were made by Nayadu [7] who gave the following:

> They are almost spherical, 1.75 to 1.8 mm. in diameter, and are very tough and resilient, rebounding like an indiarubber ball when struck against any hard surface.

[6] Hornell, James. The Flying-fish Fishery of the Coromandel Coast. Bull. No. 15, Fishery Reports for 1922, Madras Fish. Dept. (1923) 99–108.

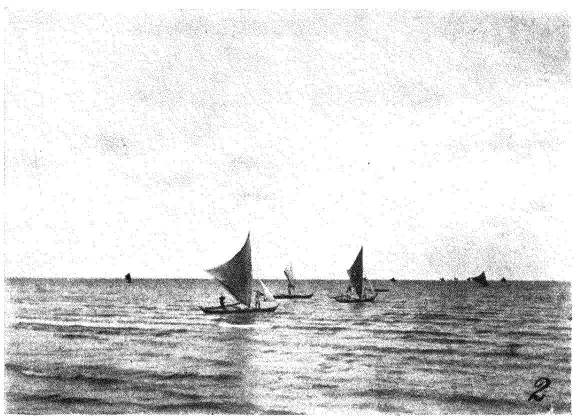
[7] Nayadu, M. Ramaswani. A note on the eggs and early embryonic development of *Cypselurus*. Ibid., 109–112.

They are attached to floating objects and to one another by means of hyaline filaments issuing from the surface of the egg membrane. These filaments are of three kinds; first, one single filament, the stoutest and the longest, which is the egg's main anchoring cable; second, a tuft of 7 to 16 tiny thin short ones exactly at the opposite pole, and third, 4 to 6 medium-sized ones which form side stays. The function of the tuft of tiny filaments is not known as in all the eggs examined they were free and unattached. The egg is very slightly elongated towards the pole from which the stout long filament issues. When the eggs are attached only to one another the main and the side stays are plaited together to form a stout central cord of considerable length, consisting of several thin filaments, from which the eggs project on all sides in the manner of grapes in a bunch in which case the stem of the bunch will represent the stout central cord of the mass of eggs.

Cypselurus species in southwestern Cebu are also observed to bear eggs in November, December, and January. While examining a bobo panirikinia December 18 the writer again came across clusters of eggs very similar to those seen in Tuburan attached to seaweeds fastened to the sides of the bobo. From June to as late as September a large quantity of flying fish fingerlings, locally called *aliponghoc,* are caught mixed with the commercial catch.

ILLUSTRATIONS

PLATE 1.



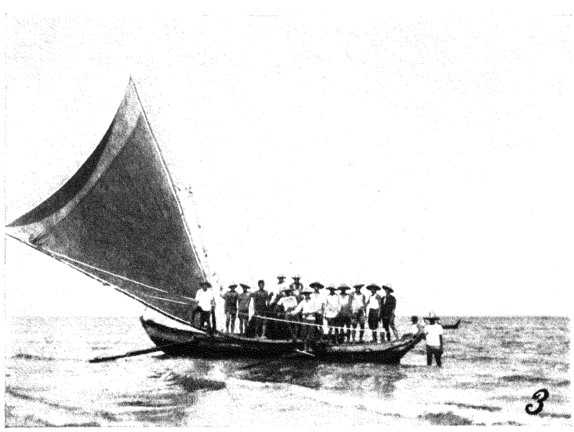
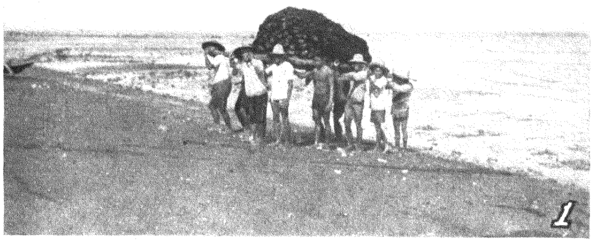


PLATE 2.



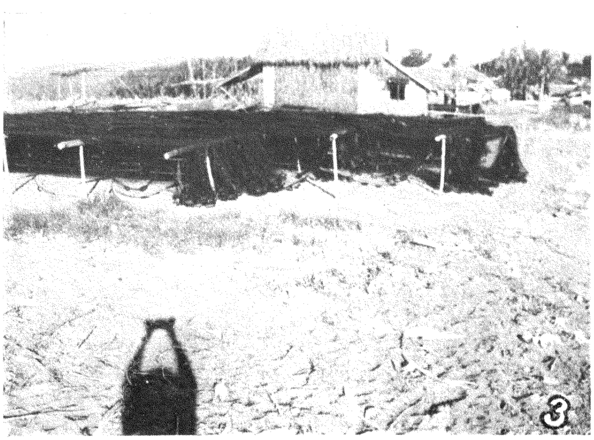


PLATE 3.

PLATE 4.

TUNA FISHERY AND LONG-LINE FISHING IN DAVAO GULF, PHILIPPINES

By CLARO MARTIN

Of the Fish and Game Administration, Bureau of Science, Manila

SEVEN PLATES AND TWO TEXT FIGURES

The possibilities of the tuna fishery of Davao Gulf have long been known to a few old resident Japanese fishermen, one of whom possesses a good knowledge of the tuna fishing grounds and the source of herring for bait in southern Mindanao as far as Zamboanga Province. In 1929 an enterprising American who saw conditions in the locality went to San Diego, California, to induce tuna packers there to finance a tuna canning plant in the town of Malita, Davao Province; however, nothing has been heard of this man since. In 1934 the Philippine Packing Corporation by means of the expensive modern fishing boat "Defender" made a survey of the Gulf as a possible source of tuna for their plant at Bogo, Misamis Oriental Province. In the same year the "Shonan Maru," the experimental fishing boat of the Formosa Government Fishery Experimental Station, touched the port at Davao in its survey of the tuna fisheries of the Celebes Sea. Information obtained from the technical men in the boat by the Japanese fishermen opened the eyes of the latter to the potentialities of the fishery. The exploitation of the fishery, however, did not begin until December, 1936, with the operation of the launch of Davao Fishery, Incorporated. The attention of other Japanese fishermen was drawn to the new fishery, and now several launches are operating.

Since the fishery is new in the locality, and the fishing methods employed are also new in the Philippines, both are described in the present paper.

SPECIES TAKEN

There are two principal commercial species of tuna caught in Davao Gulf. The skipjack, locally called *tuliñgan* (*Katsuwonus pelamis*), is the most abundant of the three, and therefore may be regarded as the most important. It is caught by pole and line. The other species is the yellowfin, or *bareles* (*Neo-*

thunnus macropterus). The yellowfin caught in Davao Gulf has the second dorsal and anal much elongated. This variety, according to Kishinouye,[1] is known in Japan as *itoshibi,* and is a variety of the true yellowfin. Jordan and Evermann,[2] however, regarded this variety as a new and distinct species and named it *Neothunnus itoshibi.* The yellowfins are caught both by pole and line, and by long line. One species of bonito (*Euthynnus yaito*) is also caught in good quantities, in fish corrals and by large beach seines.

While long-line fishing is principally intended for the yellowfins, spearfish, sailfish, large mackerels, and sharks are also caught, and comprise the by-product of the fishery. The spearfish (*Tetrapterus* sp.) and the sailfish (*Istiophorus* sp.) have not been definitely identified to the species. Two distinct species of mackerels (*Cybium commerson* and *Acanthocybium solandri*) are sometimes caught. Two species of sharks of the genus *Carcharinus* are often caught.

FISHING SEASON

Davao Gulf is within latitudes below the typhoon zone and is not much affected by the change of the monsoons. The period from July to October, however, is considered unfavorable for fishing, although all the tuna fishing motorboats have been operating continuously during those months, and the activities of the tuna fishermen are not stopped unless the gulf is disturbed by choppy seas caused by unusually strong winds.

The record of catch of the motorboat "Nena" shows that this boat has been in continuous operation from December, 1936, to December, 1937. From a peak of 14,513 kilograms in June the amount of catch has fallen to 8,976 in July, 7,966 in August, and 5,453 in September; and recovered a little in October with 8,501 kilograms. Poor fishing most often is caused by failure to catch herring for bait. During the period from July to October herring are quite scarce in the vicinity of Davao. The same record also shows that there are much more small yellowfins caught mixed with the striped tunas in March and April than in any other month. Big yellowfins were also being caught continuously since February by long-line outfits.

[1] Contributions to the comparative study of the so-called scomberoid fishes. Journ. Coll. Agric. (3) 8 (1923) 293–475.

[2] A review of the giant mackerel-like fishes, tunnies, spearfishes and swordfishes. Occ. Papers Calif. Ac. Sci. (12) (1926) 5–72.

As the fishery is still in its infancy and the data are very meager, it seems premature to draw conclusions as to the season for tuna fishing.

FISHING GROUNDS

Definite portions of the Gulf of Davao have been found by the tuna fishermen to yield good catches of each of the two principal species of tunas found in the Gulf (text fig. 1). The skipjack is found in the waters north, south, and west of Samal Island. Although large schools of skipjack are frequently seen north of Samal Island, the large tuna outfits, using pole and line with live baits, do not operate in this portion of the Gulf. It is claimed by these fishermen that it is hard to chum the fish in this part, due to comparatively heavy traffic there which tends to make the fish watchful and wild. This place, however, is the main fishing ground of the troll-line fishermen from Samal Island. The western half of the Gulf from south of Talicod and Samal Islands to north of Malita constitutes the main fishing ground for skipjack. Small immature yellowfins from 3 kilograms to about 15 kilograms in weight are also caught in the same fishing ground with the skipjack.

The main fishing ground for yellowfins is the eastern two-thirds of the entrance to the Gulf from off Monserrat to within twenty miles south of Cape San Agustin. The western part of the entrance of the Gulf did not prove to be a good fishing ground for yellowfin. It was found that more yellowfin could be caught further outside the Gulf, but on account of the size of the craft the operation is limited to within a radius of twenty miles from Port San Agustin.

Together with the yellowfins, spearfish, sailfish, and several species of sharks are caught in the same fishing ground.

THE TUNA FISHING MOTORBOATS

There are two kinds of fishing motorboats used in tuna fishing in Davao Gulf. The motorboats used in pole-and-line fishing for striped tuna are provided on the foredeck with compartments used for live well. The bottom of these compartments is provided with holes for the entrance and circulation of sea water when the fish are in. The live well is also used for stowing the catch when fishing is over. Fitted along the larboard side of the boat from bow to stern is a 1-inch pipe line. This is connected to a pump placed on the top of the engine house

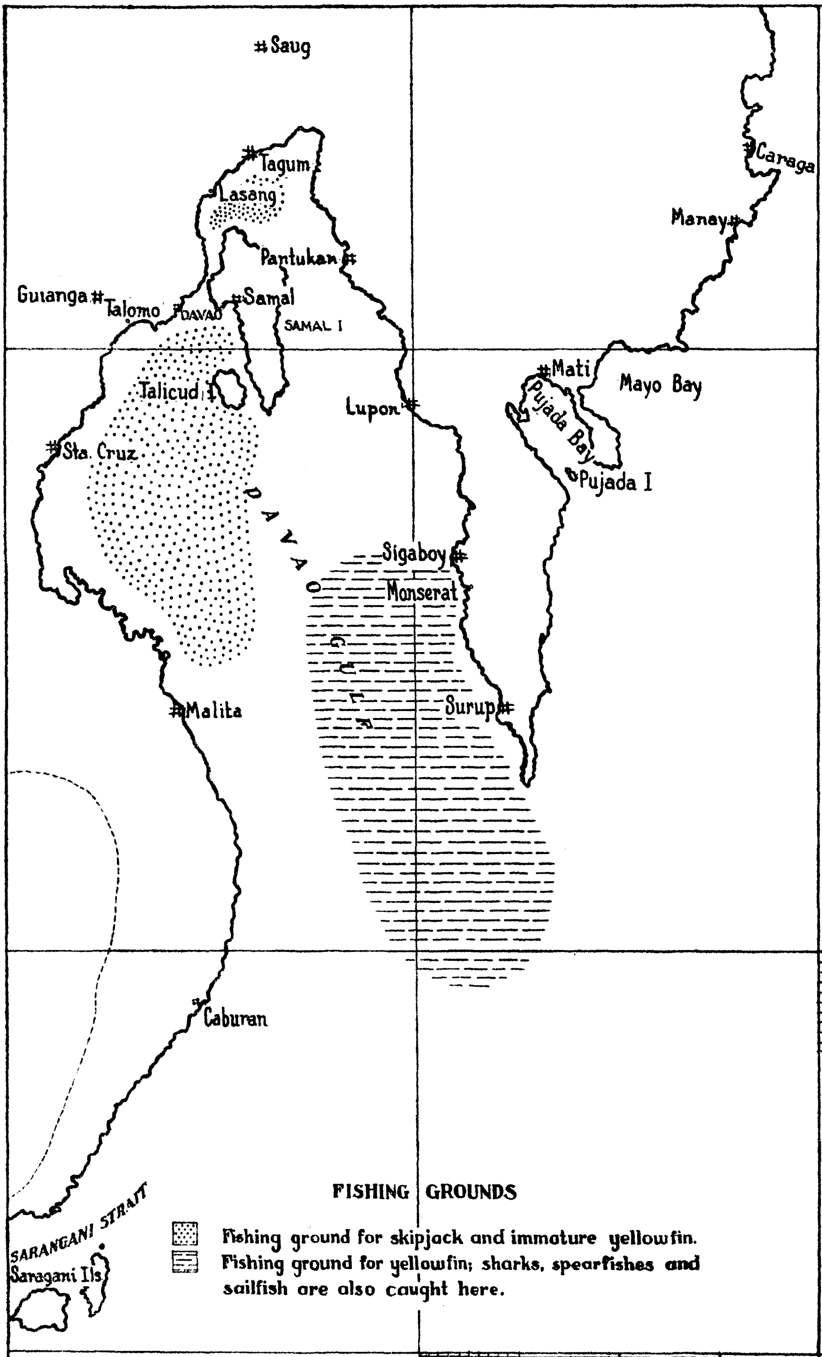


FIG. 1. Fishing grounds of the tuna fishery of Davao Gulf.

and geared to the main engine. The pipe line is tapped at several places at the bow and stern portions and fitted with spraying fixtures. The pump and the tapped pipe line serve to create the water spray, water being pumped from the live well during actual fishing.

The crew of a pole and line fishing motorboat is composed of one *patron* (or boat master), one engineer, and 12 to 18 men. This number is, however, dependent upon the tonnage of the boat.

The long-line tuna motorboats are all small craft of below three tons gross, powered by at least a 20-H. P. engine. The foredeck is clear and provided with an insulated hold. The insulation consists of sawdust and tar paper. In this hold is deposited the crushed ice that serves as refrigeration for the bait as well as for the catch. In all the newly constructed boats the baskets for long-line fishing are placed on the foredeck; the rest of the space, covered with tarpaulin in the evening, furnishes sleeping space for the fishermen. The crew usually consists of six men, one acting as engineer and the rest fishermen.

All motorboats except one, the "Lamidan," are Japanese-owned. Most of the fishermen are Japanese, although a few are Filipinos, natives of Bohol. The Japanese fishermen are paid on partition basis. After all running expenses and maintenance costs have been paid, 60 per cent of the net income goes to the fishermen and 40 per cent to the owner of the outfit. The Filipino fishermen are paid from 12 pesos [3] to 18 pesos a month with free food.

TABLE 1.—*Tonnage, measurements, and methods of fishing of various fishing motorboats.*

Boat.	Gross tons.	Net tons.	Length.	Width.	Depth.	Method of fishing.
			m.	*m.*	*m.*	
"Nena"	23.03	12.68	14.60	2.90	1.90	Pole and line.
"Meding"	2.78	1.89	8.00	1.82	0.90	Long line.
"Mabine"	2.94	2.00	8.53	1.96	0.83	Pole and line.
"Mayon"	2.97	2.02	7.92	1.95	0.92	Long line.
"Mucho"	1.47	1.00	10.03	1.95	0.83	Long line.
"Lamidan"	4.41	3.00	10.31	2.23	1.10	Pole and line.[a]
"Bareles"	2.97	2.02	9.75	1.80	0.80	Long line.
"Padada"	2.96	2.02	10.38	2.32	0.58	Pole and line.
"Talomo"	2.28	1.55	10.70	2.00	0.94	Long line.

[a] Changed to long-line method in November.

[3] One peso equals 50 cents United States currency.

FISHING METHODS

Troll line.—Troll-line fishing for striped tunas is engaged in by a number of fishermen from Samal Island, Bunawan, and Talomo, using small one-man craft especially built for speed, having sharp bottoms and outriggers. The fishermen follow the school of fish in their boats and drag their baited hooks and lines in the midst of the school (sometimes to the annoyance of the pole-and-line fishermen).

Fish corral.—Stray and mostly small, immature striped tunas and bonitos are also caught in shallow-water fish corrals. A large deep-water fish corral specially for catching tuna has just recently been constructed at Talomo by a professional Batangas corral fisherman; it is about 12 fathoms deep, and the style is *kinorona.*[4]

Seines.—The bonitos and small striped tunas that come close to shore are also caught in large beach seines having a length of more than 100 meters. The Davao Fishery, Incorporated, is contemplating to use a purse seine for catching bonito.

Pole and line.—Pole-and-line fishing for both striped tunas and small yellowfins is carried on by means of launches ranging from about 3 to 23 gross tons.

In this method of fishing each of the fishermen—numbering from twelve to fifteen—is provided with a pole 3.5 meters long. To the distal end of the pole are fastened two lines about three meters long. These two lines each carry different barbless hooks. The shank of one of the hooks is provided with solid tin molded in the shape of a small fish, dressed with white feathers in the hind portion. The other hook is a simple angular one. A piece of gunny sack is rolled around the portion about 1 foot above the lower end of the pole to provide a good hold and for sticking the hooks when not in use.

The launch leaves the shore before dawn. The first thing done is the securing of live herring to be used as bait; these are bought from the herring fishermen who keep them in large floating dip nets for the pole-and-line fishermen. The live herring are received and kept in the live well of the launch.

As soon as the bait is obtained, when the sun is just rising, the launch starts cruising to locate the schools of fish in the fishing ground. About two hundred meters from the sighted school one man starts to throw bait, one or two herring at a

[4] Same as *linati,* described by Talavera and Montalban. Philip. Journ. Sci. 48 (1932) 459.

time, to attract the fish, increasing the amount, though sparingly, as the fish are attracted. The boat is stopped but the engine is kept on to run the pump; the water spray is turned on and the fishermen already at their posts begin fishing using first the feathered hook. The fall of the water spray serves to simulate the commotion of a school of small fish, and also serves as a screen to hide the activity of the fishermen from the fish. As soon as the fish are noticed not to bite the feathered hook anymore, the fishermen change to the plain hook baited with fresh herring. When a large school is encountered, a ton of fish can be landed in a half hour. Fishing goes on as long as there is bait and as long as the school of fish does not leave. When fishing is over the launch is turned homeward. The fish are washed of blood and slime on deck and stowed in the live well; the holes of the latter are plugged at this time.

Long line.—Before leaving for the fishing ground for long-line fishing, the hold of the motorboat is filled with crushed ice. The bait, which may be small mackerel (*Rastrelliger chysozonus*) or small milkfish (*Chanos chanos*) contained in wooden slat trays are stowed in the ice hold.

Strong, stout, cotton twine, ¼ inch in diameter, is used in long-line fishing. The twine is dyed with *tañgal* (*Ceriops tagal*) bark. Each fishing motorboat carries 10 to 14 baskets of long line (text fig. 2). The long line in one basket varies in length in different boats from 475 to 915 meters. Being a drift line, it is supported by float lines, commonly four in number, 18 to 25 meters long and fastened to either a cylindrical wooden float or a spherical glass buoy. The float lines generally divide the long line into three sections. Usually three gangings, each ranging in length from about 45 to about 62 meters, are suspended from each section. The lower end of the ganging to which the hook is fastened is stranded (19 strands) steel wire 2 to 3 meters long. Two kinds of hooks are used, one rounded, the other ellipsoidal. Flags to determine the location of the line and for identification are also indispensable accessories of the long line. Extra hooks and line, butchering implements, and a small harpoon are also taken along in the boat. The small harpoon is used in case the catch is a big fish, a shark, or a spearfish, which are difficult to land.

During the entire period of the trip, which takes from three to five days, the boats stay always at sea. As there is no anchorage on the shores close to the fishing grounds, the fisher-

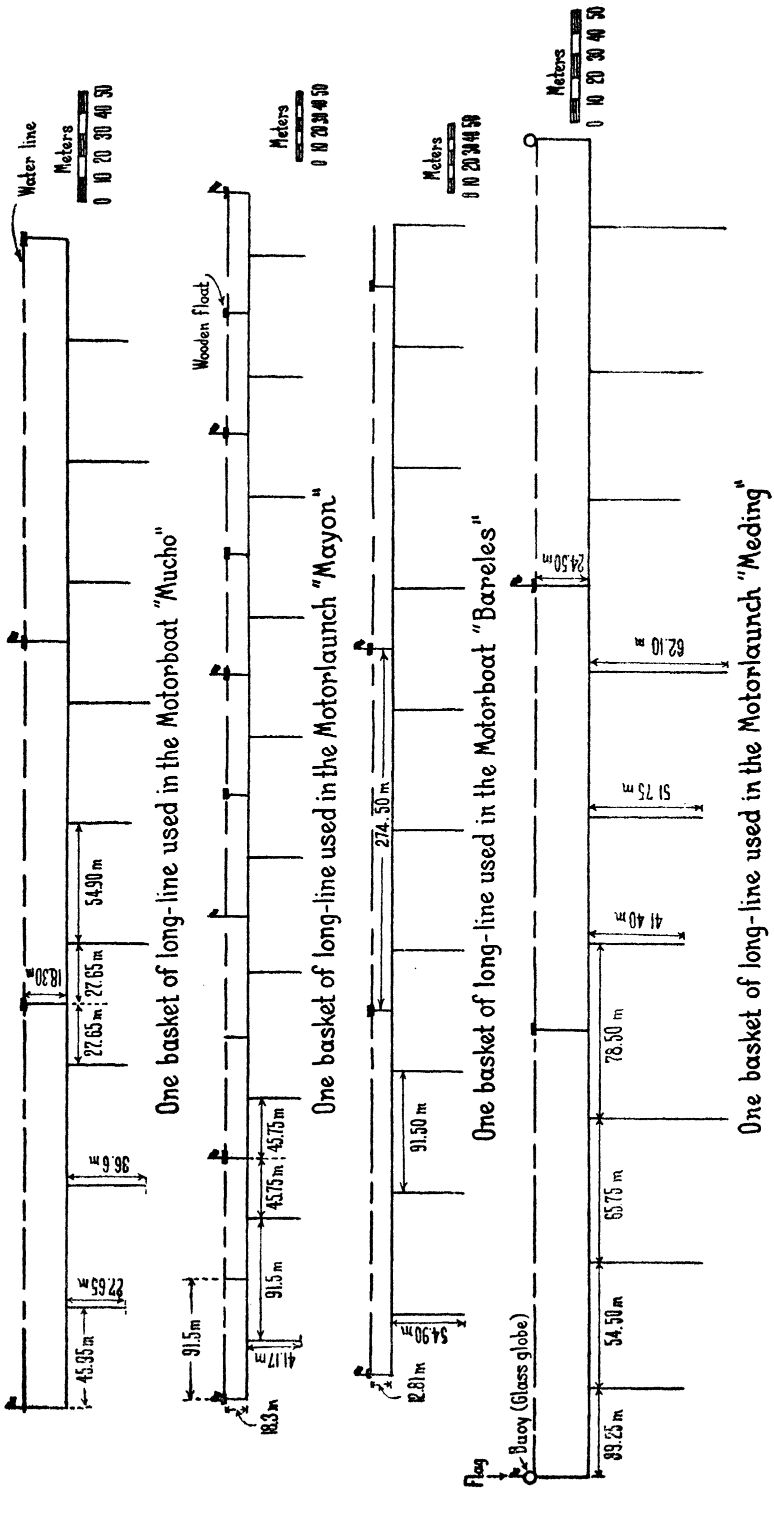


FIG. 2. Arrangement of long lines.

men pass the night with the boat drifting some distance from the shore.

The fishermen start the boat early to the fishing ground. At sunrise setting of the long line begins. By this time the boat is about seven to eight miles off the nearest coast, or even farther. The line is set east to west or east to southwest and across the flow of the current at the entrance of the Gulf.

The setting of the line is done on the stern. The engine is run at half speed. A flag and a glass buoy are fastened to one end of the main line of the first basket and thrown overboard. The line is paid out as the boat runs. A fisherman takes charge of paying out the main line. One fisherman takes charge of baiting the hooks of the branch line. Another takes charge of fastening the floats and flags to the float line. The branch line carrying the hook, dressed with the bait, is thrown on the left side and the float line on the right, both at the proper time. Not all floats or buoys are provided with flags. If the first buoy carries a flag, the one following is without, and so on, alternating one with and one without. The line of one basket is joined end to end to that of another until all the lines are set in a continuous long line of several miles. The setting of the long line takes about one and a half hours. After this operation the boat is steered windward more than a mile from the set line. The line is gone over for the catch two times in the morning, and once in the afternoon, and then hauled in for coiling in the baskets at 3 P. M. or 4 P. M. The hauling in of the line consumes four and a half hours at most.

In going over the line for the catch the boat is steered from one end of the long line to another. A float or buoy submerged or partly submerged due to the weight or the pull of the catch is a sign for the boat to stop. The particular float or buoy is pulled to bring the main line on deck. The end of the line which pulls heavily suggests the direction in which the catch is to be found. The hauling of the line and the landing of the catch is done on the bow.

HANDLING AND MARKETING

Fish caught by the pole-and-line outfits are not iced on the boat, as the fishing ground is not very far from Davao, the home port of all tuna fishing motorboats and the distributing center of fish in the northwestern part of the Gulf. On arrival at the landing the boat is met by retailers. Fish that are not disposed of are kept iced in large ice boxes with three to five compartments. The ice boxes are made by the fishermen themselves. A square opening wide enough for a man to pass through is cut on top of each compartment. The insulation is of sawdust and tarred paper. Galvanized sheet iron is used as the lining inside. Fish can be kept five days at most in these boxes, although the fish are disposed of before this time is reached, as they soften on the fourth or fifth day and constitute a loss.

In long-line fishing large-sized fish, weighing from 30 up to more than 200 kilograms, constitute the catch. The yellowfins and spearfish are butchered and cleaned soon after landing. The fins are cut off, the head severed, and the belly eviscerated. The head, although not sold, is saved for the table of the fishermen. It is parted in two, its gills removed, and washed clean. The butchered fish and heads soon after cleaning are stowed in the insulated hold, laid side by side, and packed well with crushed ice. Not infrequently yellowfins half-eaten up by sharks are landed. In this case the fish is not thrown away and what parts are utilizable are saved. Usually sharks are caught primarily for the fins. Sometimes, however, the meat is cut into narrow strips which are salted. These salted strips of shark meat are placed in sacks, which, however, are not stowed in the hold as the strong fishy odor of the shark meat might impair the quality of the other fish in the hold.

Upon return to port the fish are transferred to the cold storage warehouse of the Davao Ice Plant Company, whence they are disposed of to the retail vendors.

Skipjacks are sold to the vendors in the round and by weight. Some vendors sell their fish in the market stalls, others peddle them on their shoulders. The peddler always carries a bolo for cutting the fish into slices, and a balance for weighing the slices. Ordinarily skipjacks are bought by the vendors at from 15 to 20 centavos a kilogram and retailed at from 20 to 30 centavos. Yellowfin tuna and spearfish are bought by the vendors at from 30 to 35 centavos per kilogram, and retailed at from 50 to 60 centavos a kilogram.

REMARKS

Nowhere in the Philippines except in Zamboanga Province, where there is a small tuna canning plant, is the tuna fishery as important as in Davao Gulf, due to the fact that all the catch is disposed of in the fresh-fish markets. Approximately 80 per cent of the skipjacks, yellowfins, and spearfish landed in Davao are consumed by Japanese residents.

ILLUSTRATIONS

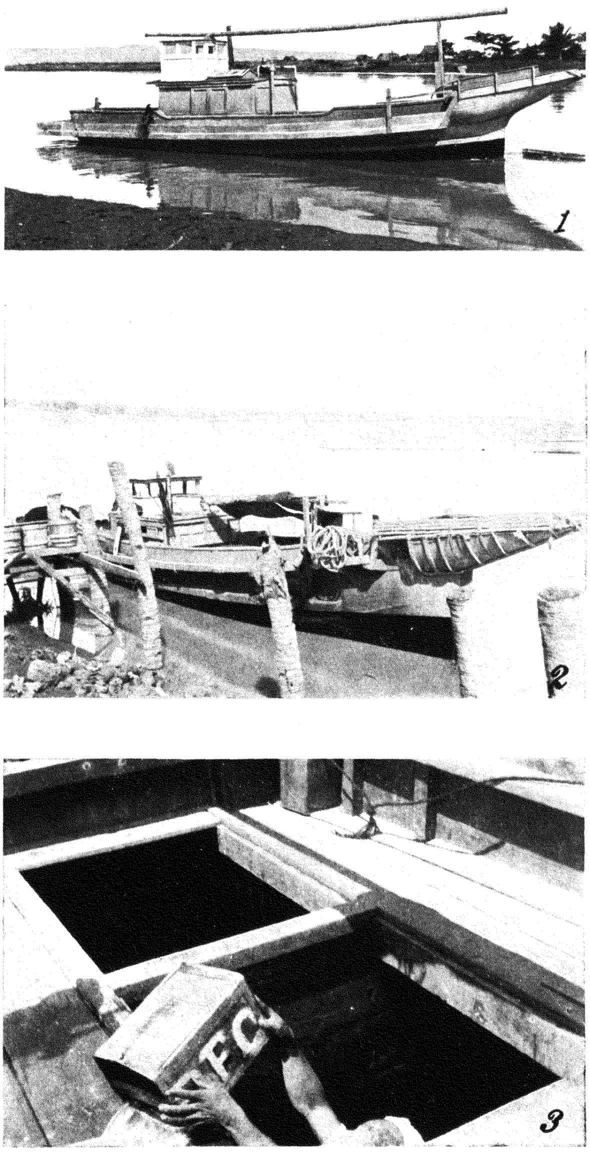


PLATE 1.

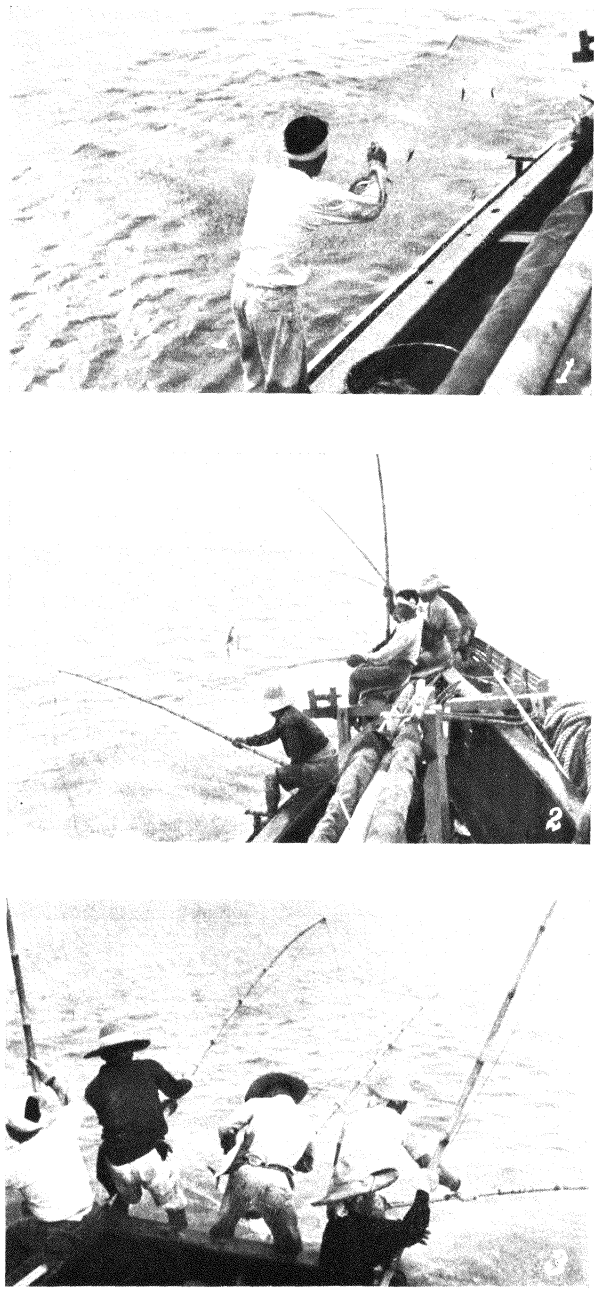
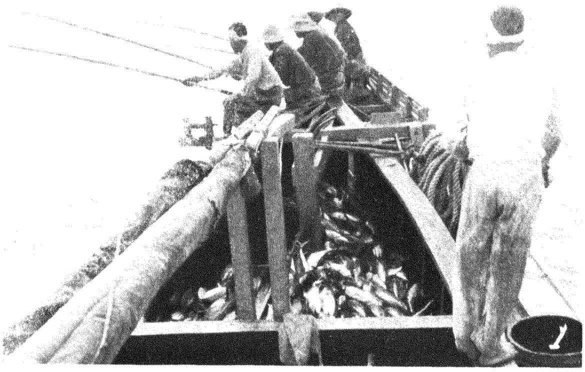


PLATE 2.



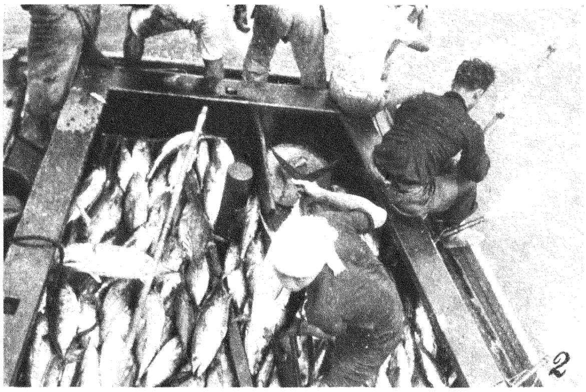


PLATE 3.

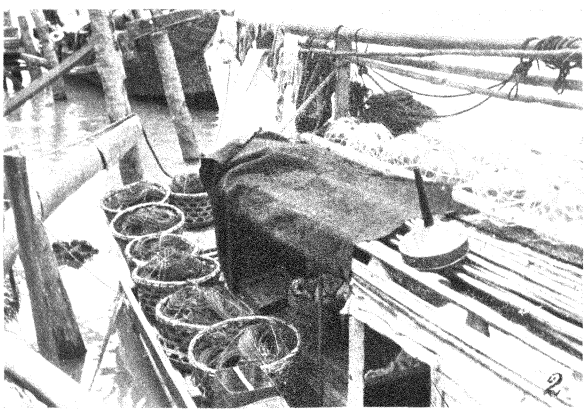


PLATE 4.

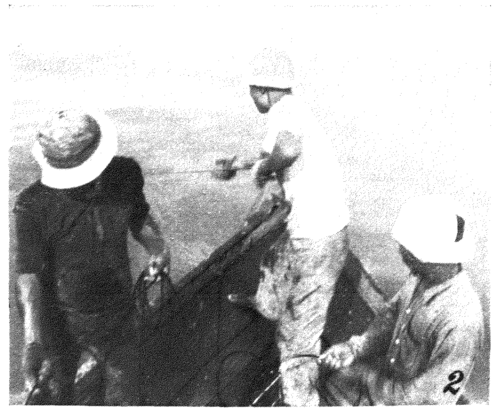


PLATE 5.

PLATE 6.

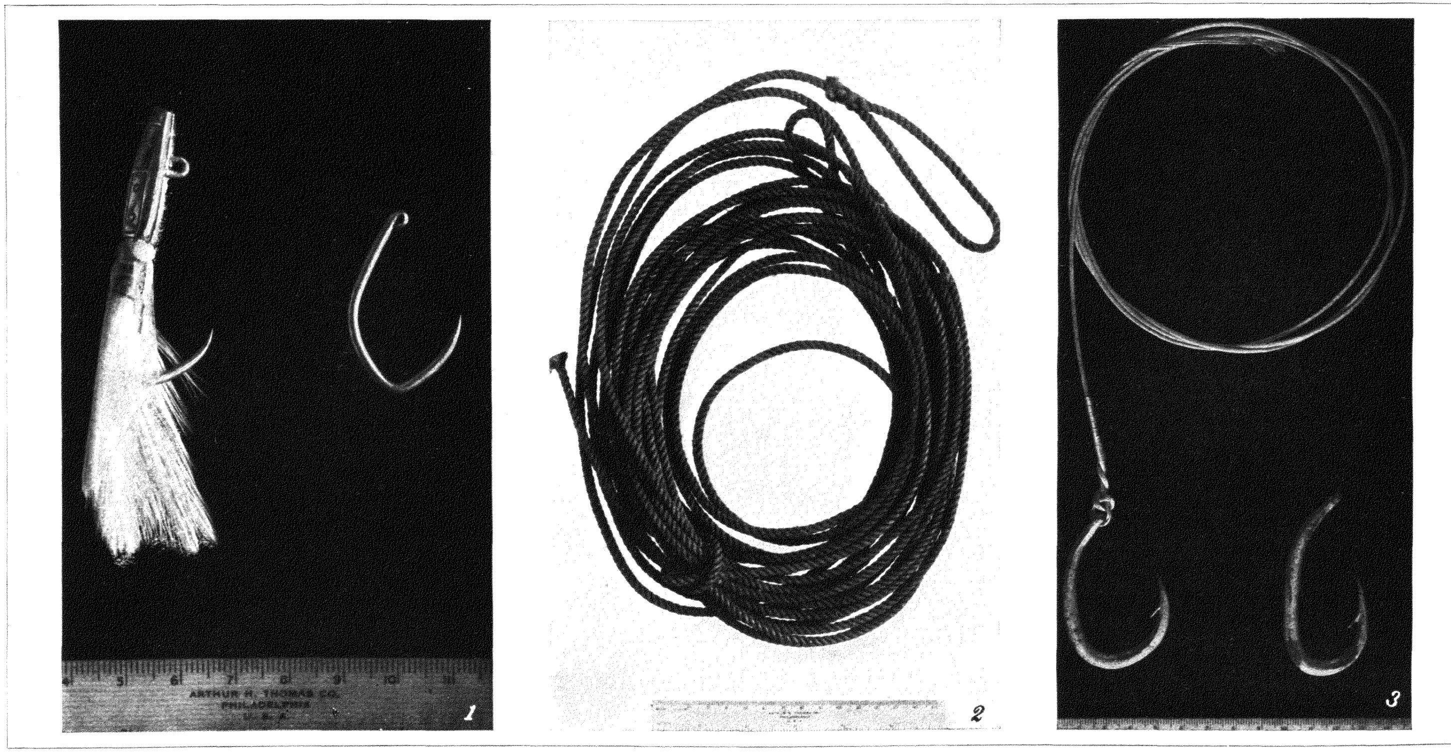


PLATE 7.

A NEW SPECIES OF PALÆMON FROM NORTHERN LUZON

By GUILLERMO J. BLANCO

Of the Fish and Game Administration, Bureau of Science, Manila

ONE PLATE

In this paper is given the description of a new macrurus crustacean, *Palæmon luzonensis* sp. nov. This commercial shrimp, known in Iloko as *aramang*, is taken in large quantities at the mouth of Cagayan River from August to January. A small drag seine (*bannuar*) is used in catching the aramang with the aid of a small boat (*balasiang*).

The shrimps are usually dried in the sun along the beach, but during the rainy season they are generally salted and fermented into *bagoong*. The value of dried and salted products from the aramang fishery of Cagayan is estimated at 10,000 to 15,000 pesos [1] annually. Dried aramang is packed in boxes or sacks and shipped to Manila and the Ilocos provinces, mostly by Chinese but also by a few Filipino dealers. From September to December, 1937, about 720 cavanes, or 54,000 liters [2] of aramang, valued at 4,320 pesos, were shipped to Manila and the Ilocos provinces. So far there is no record of the value of dried aramang and bagoong made of aramang sold in the interior towns of Cagayan Valley.

Genus PALÆMON Fabricius

Rostrum well developed, laterally compressed, toothed above and below. Carapace smooth, furnished with antennal and branchiostegal spines. Pterigostomian spine wanting. Mandible with three-jointed palp.

PALÆMON LUZONENSIS sp. nov. Plate 1, figs. 1 to 11.

Carapace provided with an antennal and branchiostegal spine; supraorbital and hepatic spine absent; pterigostomian angle rounded, without spine. Rostrum long, thin, distinctly curved upwards, laterally compressed; distal tip reaching beyond end

[1] One peso equals 50 cents United States currency.

[2] One cavan equals 25 gantas or 75 liters.

of antennal scale; dorsal border above orbital notch armed with six to seven teeth; four to five teeth on carapace, two on declining ridge, one near tip; ventral border with four widely spaced teeth (Plate 1, fig. 1). Eyes slender, two times as long as wide; breadth of cornea 2.5 times dorsal length of eye; ocellus well marked (Plate 1, fig. 2). Basal segment of first antennular peduncle with well-developed terminal spine (Plate 1, fig. 3). Outer antennular flagellum bifid, shorter branch unsegmented. Flagella of first antennæ 1.75 times as long as entire length of shrimp. Antennal scale (Plate 1, fig. 4), three times as long as wide, not tapering; outer margin straight, terminating in an acute spine which does not reach beyond end of lamella. Mandible with strong molar and incisor process and 3-jointed palp (Plate 1, fig. 5). Maxillule cross-shaped, distal margin of outer lacinia with hairs; endopodite with a thumblike apical process terminating in long setæ (Plate 1, fig. 6). Third maxilliped usually with five articulations and reaching beyond merus of first leg; terminal joint with long hair process (Plate 1, fig. 8). First pair of peræopods chelate (Plate 1, fig. 9), reaching beyond antennal scale; chela, carpus, and merus unequal in length. Fingers 1.5 times as long as palm, with tufts of hairs. Second pair of peræopods chelate (Plate 1, fig. 10), robust, two times as long as first, reaching beyond rostrum by length of chela. Fingers curved at tips, with straight cutting edges provided with several minute teeth. Fingers 1.75 times as long as palm; carpus 2.66 in merus, no spines on their distal border.

Body slightly compressed laterally, dorsally rounded.

Third, fourth, and fifth legs similar in form and proportion; fifth longer than preceding two; dactylus terminating in hairlike structure. Pleopods long and foliaceous. Sixth abdominal somite narrow, width two times in length. Telson (Plate 1, fig. 11) tapering, without spines on dorsal side; terminal border with two spines of equal length; in between with a pair of setæ.

Type locality.—Aparri, Cagayan Province, Luzon. Specimens were caught in bannuar drag net.

Live specimens transparent yellowish, with pink eggs in female. Preserved specimens in alcohol, yellowish.

Several male and female specimens collected from Aparri, Cagayan, September 10, 1937, range from 44 mm to 80 mm from tip of rostrum to tip of telson.

Palæmon luzonensis can be distinguished from other known described species of *Palæmon* by the character of its thin upwardly turned rostrum, its slight laterally compressed body, its tapering telson without dorsal spines, and the character of its weak third, fourth, and fifth walking legs. Males and females similar. Morphological dimorphism apparently lacking.

REFERENCES

BLANCO, G. J. The Atyidæ of the Philippines. Philip. Journ. Sci. 56 (1935) 29–39, pls. 1–3.

BLANCO, G. J., and FELIX J. ARRIOLA. Five species of Philippine shrimps of the genus Penæus. Philip. Journ. Sci. 64 (1937) 219–227, pls. 1–3.

COWLES, R. P. Palæmons of the Philippine Islands. Philip. Journ. Sci. § D 9 (1914) 319–403, pls. 1–3.

ESTAMPADOR, E. P. A check list of Philippines crustacean decapods. Philip. Journ. Sci. 62 (1937) 488, 489.

KEMP, ST. Fauna of the Inlet Lake (Crustacea Decapoda) of the Inlet Lake basin. Rev. Ind. Mus. 14 (1918) 81–102, pls. 24, 25.

RATHBUN, M. J. The Brachyura and Macrura of Porto Rico. Bull. U. S. Fish. Comm. 20 (1902).

RATHBUN, M. J. Decapod Crustacea of the northwest coast of North America. Harriman, Alaska Expedition (1904).

ILLUSTRATION

[Drawings by the author.]

PLATE 1. PALÆMON LUZONENSIS SP. NOV.

1, Male, lateral view, × 4; *2*, eye, lateral view, × 60; *3*, antennule with portion of flagella, ventral view, × 60; *4*, antennal scale, × 60; *5*, mandible with palp, × 60; *6*, maxillule, × 60; *7*, maxilla, × 60; *8*, terminal joint of third maxilliped, × 60; *9*, chela of first peræopod, × 100; *10*, chela of second peræopod, × 60; *11*, apex of telson, × 100.

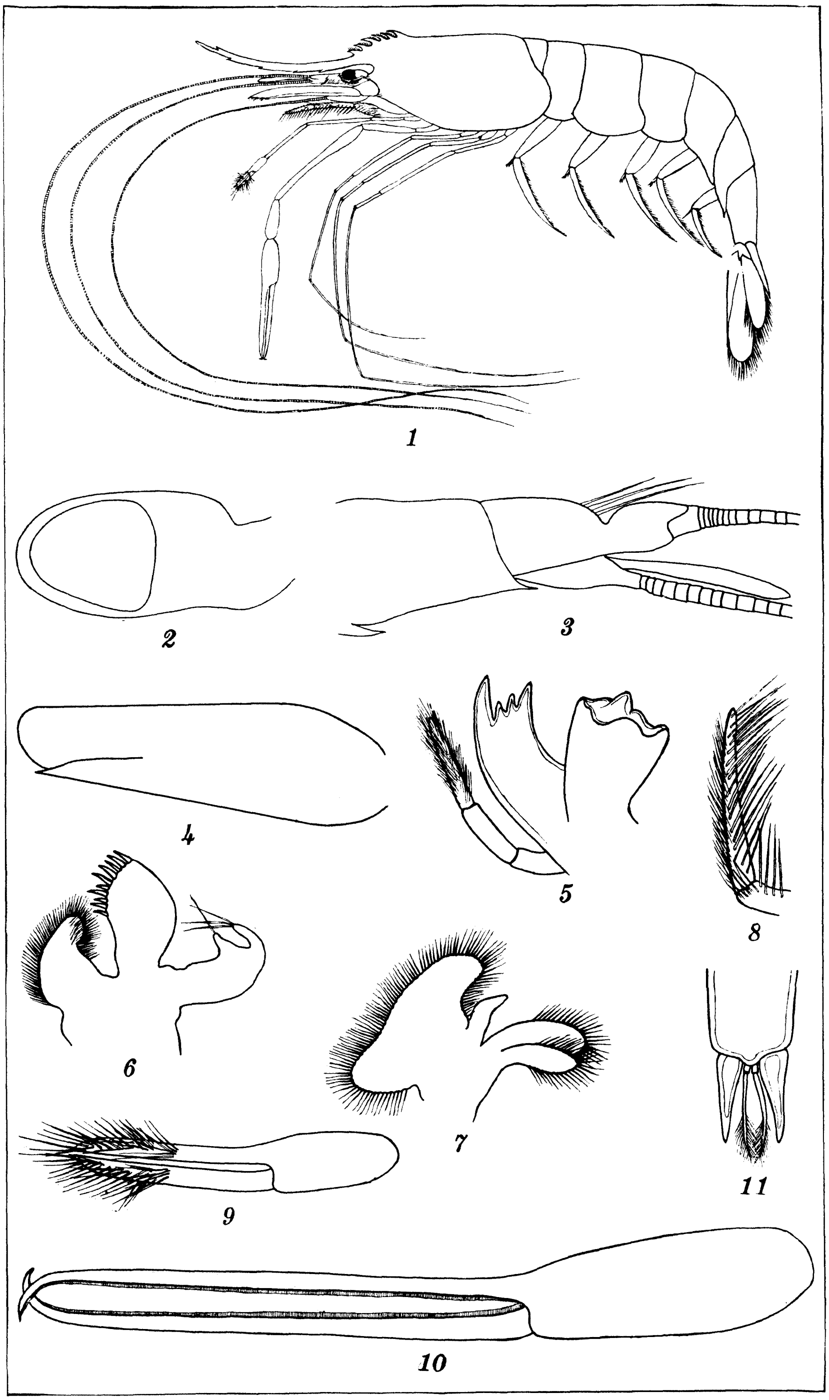


PLATE 1. PALÆMON LUZONENSIS SP. NOV.

A REVIEW OF PHILIPPINE HOLOCENTRIDÆ

By JOSE R. MONTILLA

Of the Fish and Game Administration, Bureau of Science, Manila

FIVE PLATES

This paper contains a review of species of the family Holocentridæ known to inhabit Philippine waters. The material used is in the collection of the Fish and Game Administration, Bureau of Science, Manila.

The soldier fishes (Holocentridæ) are shore fishes generally inhabiting rocky banks in tropical seas. They are active, carnivorous, and quarrelsome fishes, and take the hook readily. Hence they are considered game fishes.

The flesh of the Holocentridæ is firm; their scales are very hard, large, and with very rough edges. Their coloration is almost always brilliant, characteristic of fishes of coral reefs. These fish are caught in large numbers and are valued as food.

Body oblong, or rather elevated and compressed. Head moderate; eye large, lateral; mouth moderate, cleft more or less oblique, extending to the sides of the muzzle; both jaws, vomer, palatines, and sometimes ectopterygoid with bands of small teeth; bones of head grooved or with strong ridges, ending in short or long spines and forming a posterior serration, especially in opercular series. Dorsal with ten to eleven spines; anal four, third usually very long; ventrals thoracic, with a spine and 5 to 8 soft rays; caudal forked. Scales moderate, ctenoid, very strong, absent on head. Pyloric appendages numerous or moderate in number.

Key to the Philippine genera of the Holocentridæ.

a^1. A long spine at edge of preoperculum .... *Holocentrus*.
a^2. No long spine at edge of preoperculum .... *Myripristis*.

Genus HOLOCENTRUS Gronow, 1763

Oblong or more or less elongate, compressed, back more or less arched. Branchiostegals eight. Eyes large. Mouth moderate. Jaws of equal length, or lower slightly longer; snout of moderate length. Bands of small teeth on premaxillaries, vomer, palatines, ectopterygoids, and lower jaw. Opercles and suborbitals serrated; opercle with two spines, generally a large spine at angle of preopercle. Posterior and inferior border of preoperculum, operculum, and suboperculum with a row of parallel spines, less developed on interoperculum. Orbitals serrated. Preorbital with a row of generally large spines along its lower border and often similar spines along a median ridge. Dorsal beginning a short distance behind head, separated by a deep notch into a longer anterior spiny part and a shorter posterior soft part. Dorsal spines commonly eleven, strong, depressible in a groove; anal opposite to soft dorsal, with four spines, third longest, enormously developed, provided at its back with a groove to fit last, slenderer, and shorter spine; caudal forked; pectorals with a weak short spine. Ventral fins with a slender spine and seven soft rays. Scales ctenoid, of moderate size. No scales on skull, which is provided with divergent bony ridges. Lateral line continuous. Pyloric appendages numerous. In life always brilliant red, with lines or stripes of black, white, or golden. Fins often with black and white markings.

Habitat.—Tropical seas. On rocky banks near the shore.

Key to the Philippine species of Holocentrus.

a^1. Last dorsal spine longer than penultimate. Lower jaw more prominent.
  b^1. Membrane of spinous dorsal never black, sometimes a black spot between first spines. Anal IV 7 to 8 .... *H. sammara.*
  b^2. Membrane of spinous dorsal black with a white band. Anal IV 8 to 10 .... *H. opercularis.*

a^2. Last dorsal spine shortest. Jaws equal or upper jaw slightly prominent.
  b^1. Two and a half rows of scales between spinous dorsal and lateral line.
    c^1. Membrane of spinous dorsal blackish, crossed by a white band. *H. diadema.*
    c^2. Membrane of spinous dorsal not black or without crossed band.
      d^1. Lateral line 50 or 51. Nasalia not rounded. A silvery patch below posterior part of spinous dorsal .... *H. bleekeri.*
      d^2. Nasalia rounded in front. Eight or nine rows of scales on preoperculum.
        e^1. Lateral line 42 to 44. Nasalia rounded in front, without spines. *H. lacteo-guttatus.*
        e^2. Nasalia ending with deviated spines. Lateral line 33 to 41.
          f^1. Snout much shorter than eye. No silvery patch on superior part of caudal peduncle.
            g^1. Nasal opening without spines .... *H. ruber.*
            g^2. Nasal opening with spines .... *H. cornutus.*
          f^2. Snout more pointed, equal to eye or nearly equal. Oftentimes a silvery patch on superior part of caudal peduncle. Nasal opening with spines.

g^1. Lateral line 34 to 37. Membrane of spinous dorsal scarcely incised .... *H. violaceous.*

g^2. Lateral line 41. Membrane of spinous dorsal incised. *H. caudimaculatus.*

b^2. Four rows of scales between spinous dorsal and lateral line. Lateral line 43 or 44 .... *H. spinifer.*

HOLOCENTRUS SAMMARA (Forskål). Plate 1, fig. 1.

Sciæna sammara FORSKÅL, Descript. Anim. (1775) 48, 49.

Labrus angulosus LACÉPÈDE, Hist. Nat. Poiss. 3 (1802) 430.

Holocentrus samara RÜPPELL, Atl. Reise N. Afrika (1826–1831) 85.

Holocentrus sammara CUVIER and VALENCIENNES, Hist. Nat. Poiss. 3 (1829) 216; BLEEKER, Journ. Ind. Arch. 2 (1848) 636; Nat. Tijdschr. Ned. Ind. 3 (1852) 555; GÜNTHER, Cat. Fish. Brit. Mus. 1 (1859) 46; BLEEKER, Ned. Tijdschr. Dierk. 4 (1873) 213; GÜNTHER, Südsee Fische 1 (1873–1875) 100; DAY, Fishes of India 4° (1878–1888) 173; SAUVAGE, Poiss. Madagas. (1891) 31; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 5 (1929) 233–235.

Holocentrus sammara JORDAN and SEALE, Bull. U. S. Bur. Fish. 25 [(1905) 1906] 227.

Holocentrus fuscostriatus SEALE, Occ. Papers B. P. Bishop Mus. Hawaii 1 (1901) 69.

Holocentrus microstomus FOWLER, Proc. Acad. Nat. Sci. Phila. 53 pt. 2 (1901) 325 (nec. Günther).

Flammeo sammara JENKINS, Bull. U. S. Fish. Comm. 22 [(1902) 1904] 440; JORDAN and EVERMANN, Bull. U. S. Fish. Comm. 23 [(1908) 1905] 155.

Dorsal X, I, 12; anal IV, 8; pectoral 14; ventral I, 7; lateral line 40 to 42; transverse line 12.

Elongate, dorsal profile sloping down in a gently curved line from dorsal to snout. Height of body 3 to 3.3; head 2.7 to 3; eye 2.5 to 3 in head; snout 3.5 to 4 in head. In young, eye slightly less than snout. Interorbital space 1.3 to 1.5 of eye. Maxillary reaching or not reaching to below anterior half of eye; nasal opening rounded or obtusely pointed in front without spine; lower jaw prominent; nasal opening without spines; teeth villiform. Preorbital with a row of subequal numerous spines; postorbital narrow, serrated along hind border; limbs of preopercle serrated in entire extent, length of preopercular spine equal to about one third diameter of eye. External edges of all opercles more or less serrated; opercle with two spines, upper as large as preopercular, lower rather smaller. Preorbital denticulation strong; suborbital serrated. Predorsal scales 6 or 7. Second and third dorsal spines longest, about equal to fourth spine but shorter than snout and eye together. After fourth spine preceding spines decreasing in size, second to last shortest; last dorsal spine slightly longer than preceding spine, about equal to half diameter of eye; second dorsal highest anteriorly, rather higher than highest dorsal spine. Pectoral nearly equal to head excluding snout. Ventrals and pectorals subequal, as long as eye and snout. Ventral spine somewhat longer than postorbital part of head, reaching halfway to the anal. Least height of caudal peduncle 1.1 to 2.2 in its length. Caudal forked, lobes rounded. Third anal spine strongest and longest, equalling from 3.5 to 4 in length. Scales six to seven rows between occiput and base of dorsal fin, seven along preopercle.

Body with or without longitudinal violet bands, which may be composed of spots. Black spot may be present on either cheek. Usually a black spot between first four dorsal spines, sometimes a light mark at bases and at tips of first ten spines. Anterior edge of soft dorsal and anal, also usually upper and lower edge of caudal, violet.

Distribution.—Red Sea, east coast of Africa, seas of India to Malay Archipelago and beyond.

The above description is based on specimen No. 12212, 115 mm, collected from Tambo, Ambil Island, Mindoro Province, August 30, 1925.

LUZON, Ilocos Norte Province, Burgos, No. 14773, 67 mm, October 29, 1936: Manila, No. 27424, 142 mm, 1911. MINDORO, Mindoro Province, Puerto Galera, No. 7195, 131 mm, 1912; Tambo, Ambil Island, No. 12212, 113 mm, August 30, 1925. PALAWAN, Palawan Province, Carigara, No. 12612, 81 mm, No. 27426, 35 mm, November 7, 1925. MINDANAO, Sulu Province, Bungau, No. 11504, 121 mm, No. 27423, 125 mm, August 27, 1924; No. 13652, 113 mm, No. 27428, 104 mm, No. 27430, 120 mm, No. 27429, 121 mm, No. 16356, 134 mm, No. 12612, 97 mm, April 15, 1926; No. 11109, 102 mm, June 18, 1921; Tubigan Island, No. 27427, 153 mm, No. 13512, 131 mm, January to March, 1926; Sitankai, No. 16353, 78 mm, June 17, 1921: Zamboanga Province, No. 27422, 144 mm, No. 10699, 136 mm, May, 1921.

GUAM, No. 7081, 42 mm, No. 7082, 45 mm.

HOLOCENTRUS OPERCULARIS Cuv. & Val. Plate 1, fig. 2.

Holocentrum operculare CUVIER and VALENCIENNES, Hist. Nat. Poiss. 7 (1831) 377; QUOY and GAIMARD, Voy. Astrol. Poiss. 3 (1834) 676; BLEEKER, Nat. Tijdschr. Ned. Ind. 2 (1851) 233; Ned. Tijdschr. Dierk. 4 (1873) 211; GÜNTHER, Cat. Brit. Mus. 1 (1859) 47; Fische der Südsee 1 (1873–1875) 100, pl. 66, fig. *a;* SEALE, Occ. Papers B. P. Bishop Mus. Hawaii 1 (1901) 68; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. (1929) 232–234.

Holocentrus opercularis JORDAN and SEALE, Bull. U. S. Bur. Fish. 25 [(1905) 1906] 227.

Dorsal X, I, 13; anal IV, 9; pectoral 14; ventral 1.7; lateral line 38 to 40; transverse line 12.

Body elongate, dorsal profile practically straight from dorsal spine to snout. Height 3.5 in length without caudal. Head 2.9 in length. Eye 3.3, about equal snout. Maxillary reaching to below middle half of eye. Nasal opening round, without spines. Lower jaw more prominent. Lower border of preorbital with spines, directed backwards. Postorbital bone narrow, serrated. All parts of opercular and preopercular bone serrated along posterior borders. Operculum with two spines, upper spine longest. Preopercular spine broad and long, not reaching to gill opening. Seven transverse rows of scales on preoperculum. Origin of dorsal separated by 7 scales from occiput. Fourth dorsal spine longest, second, third, and fifth of practically same length; tenth spine shorter than eleventh, which is shorter than half diameter of eye. Membrane between spines incised. First anal spine small, third broad, strong and long, almost equal to head without snout, with a deep furrow behind to fit fourth spine, which is slender and equal to postorbital part of head. Ventrals and pectorals equal to head without snout. Lobes of caudal equal, 5.6 long.

Preserved specimen in alcohol silvery, each scale brownish with a silvery border. Fins yellowish pink. Membrane of spinous dorsal black, with sawlike subbasal longitudinal band and a white upper margin, biggest immediately behind each spine.

Distribution.—Tahiti, New Ireland, Samoa, Guam, Philippine Islands.

The above description is based on specimen No. 721, 160 mm, collected from Puerto Galera, Mindoro Province.

MINDORO, Mindoro Province, Puerto Galera, No. 7228, 170 mm, March, 1912.

HOLOCENTRUS LACTEO-GUTTATUS (C. V.) M. Weber. Plate 1, fig. 3.

Holocentrum lacteo-guttatum CUVIER and VALENCIENNES, Hist. Nat. Poiss. 3 (1829) 160; WEBER, Fische Siboga-Exped. (1913) 183; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 5 (1929) 240–242.

Holocentrum argenteum CUVIER and VALENCIENNES, Hist. Nat. Poiss. 7 (1831) 377; QUOY and GAIMARD, Voy. Astrol. Poiss. 3 (1834) 677.

Holocentrum punctatissimum BLEEKER, Nat. Tijds. Ned. Ind. 4 (1853) 248; Ned. Tijds. Dierk. 4 (1873) 215; JORDAN and EVERMANN, Bull. U. S. Fish. Comm. 23 [(1903) 1905] 162; JORDAN and SEALE, Bull. U. S. Bur. Fish. 25 [(1905) 1906] 224.

Holocentrum diploxiphus GÜNTHER, Fische der Südsee 1 (1873–1875) 97.

Holocentrum gladispinis FOWLER, Proc. Acad. Nat. Sci. Phila. 56 (1904) 225.

Holocentrus lacteoguttatus JORDAN and SEALE, Bull. U. S. Bur. Fish. 25 [(1905) 1906] 225; JORDAN and RICHARDSON, Bull. U. S. Bur. Fish. (1908) 247.

Dorsal XI, 13; anal IV, 9; pectoral 15; ventral 1.7; lateral line 44; transverse line 12.

Body oblong. Height of body 2.9 to 3 in length without caudal. Head 3 in length, compressed, upper profile more convex than lower; snout 1.75 to eye, short, convex, upper jaw projecting a little; eye large, 2.5 to 2.8 in head; interorbital space 1.4 to eye. Mouth rather small; maxillary small, slipping below narrow preorbital; teeth minute, pointed, in band in jaws, on palatines, and a small patch on vomer. Nostrils close to front rim of orbit, anterior inconspicuous but posterior part with large cavity. Interorbital space broad, slightly concave medially. Lower border of preorbital with a strong spine anteriorly, directed backwards and followed by a series of smaller spines. Postorbital bone narrow, serrated. Preopercle armed below at its angle with a broad daggerlike spine equal to half diameter of eye. Two superior spines of operculum enlarged, equal to or shorter than preopercular spine. Gill opening extending forward opposite middle of orbit.

Scales somewhat small, imbricated. Scales at base of spinous dorsal forming a sheath, each scale ending in a backwardly directed spine. Two and a half rows of scales between spinous dorsal and lateral line. Eight transverse rows of scales on preoperculum. Origin of dorsal separated by 8 scales from occiput. Spinous dorsal inserted over origin of pectoral, fourth spine longest, next two nearly subequal. First spine about equal ninth, eleventh shortest, equal to half eye. Membrane between dorsal spines deeply incised. First anal spine very small, third longest, as long as pectoral. Pectoral rather long, equal to head without snout, slender, upper rays longest. Ventral spine slender, a little over two-thirds length of fin. Least height of caudal peduncle 1.6 in its length.

Specimen in alcohol faded brassy brown, with more or less developed lighter longitudinal bands, corresponding with rows of scales. Above lateral line through longitudinal pale whitish bands along each series of scales. Below, seven bands, those just below lateral line broadest. Spinous dorsal with a small white blotch behind each spine.

Distribution.—Java, Celebes, Ceram, New Guinea, Philippines.

The above description is based on specimen No. 12339, 88 mm, September 22, 1925. Collected from Sialat point, Catanduanes, Albay, the only specimen in our collection.

GUAM, No. 10993, 87 mm, August, 1912.

HOLOCENTRUS RUBER (Forskål). Plate 2, fig. 1.

Sciæna rubra FORSKÅL, Descript. Anim. (1775) 48.

Perca rubra BLOCH, Schneider, Syst. Ichth. (1801) 90.

Holocentrus orientale CUVIER and VALENCIENNES, Hist. Nat. Poiss. 3 (1829) 147–150.

Holocentrum marginatum CUVIER and VALENCIENNES, Hist. Nat. Poiss. 3 (1829) 161.

Holocentrum laticeps CUVIER and VALENCIENNES, Hist. Nat. Poiss. 3 (1829) 157; 7 (1831) 376.

Holocentrum rubrum GÜNTHER, Cat. Brit. Mus. 1 (1859) 35; PLAYFAIR, Fish. Zanzibar (1866) 52; BLEEKER, Ned. Tijdschr. Dierk. 4 (1873) 224; GÜNTHER, Fische der Südsee 1 (1873–1875) 96; DAY, Fishes of India 4° (1878–1888) 172; MACLEAY, Descr. Cat. Austr. Fish. 1 (1881) 149; SAUVAGE, Poiss. Madagas. (1891) 35; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 5 (1929) 244–246.

Holocentrus alboruber JORDAN and FOWLER, Proc. U. S. Nat. Mus. 26 (1902) 15.

Holocentrus albo-ruber FOWLER, Proc. Acad. Nat. Sci. Phila. 56 (1904) 235.

Holocentrus praslin JORDAN & SEALE, Bull. U. S. Bur. Fish. 25 [(1905) 1906] 225; JORDAN and STARKS, Proc. U. S. Nat. Mus. 32 (1907) 494.

Holocentrus ruber JORDAN and SEALE, Proc. Dav. Acad. Sci. 10 [(1905) 1907] 5; JORDAN and RICHARDSON, Bull. U. S. Bur. Fish. (1908) 248; JORDAN and STARKS, Ann. Carnegie Mus. 11 (1917) 447; FOWLER and BEAN, Proc. U. S. Nat. Mus. 62 (1922) 18.

Dorsal XI, 12 to 13; anal IV, 9 or 10; pectoral 14; ventral I, 7; lateral line 33 to 36; transverse line 9 to 9.5.

Body oblong; head blunt, its upper profile curved and rather abruptly descending from occiput to snout; height of body 2.5 to 2.9. Head 2.8 to 3; eye large, 2.5 to 2.6 in head, interspace between eyes one-fifth length of head and about twice as long as snout; jaws nearly equal, upper jaw scarcely projecting; bony ridges bordering groove; maxillary reaching not quite to below middle of eye; nasal opening without spines. Lower border of preorbital with a series of irregular blunt spines, preorbital ridge with smaller spines directed outwards, first somewhat longer. Operculum with two strong prominent spines, upper longer and stronger than lower. Preopercular spine less than eye. Preoperculum with six or seven rows of scales, about six between occiput and dorsal. Third and fourth dorsal spines longest, last shortest; soft dorsal fin rather higher than spinous dorsal. Membrane between dorsal spines rather deeply incised. Third anal spine as long as head without snout; ventrals longer than pectorals, ventral spine equal to snout and eye, rather longer than pectorals. Least height of caudal peduncle, 1.3 to 1.5 in its length. Scales scarcely striated.

Red, with eight whitish longitudinal bands; outer edges of caudal blackish; ventrals whitish. Upper part of membrane between dorsal spines blackish, as well as that between third and fourth anal spines and first soft ray. A longitudinal darkish streak on edge of ventral rays and on upper and lower lobe of caudal.

Distribution.—East coast of Africa, Red Sea, coasts of India and Ceylon, to the Philippines and Japan, north and west coasts of Australia, eastward to Samoa.

The above description is based on specimen No. 1753, 125 mm, collected from Cagayan, Oriental Misamis Province, Mindanao, September 12, 1907.

LUZON, Pangasinan Province, Alaminos, No. 9673, 115 mm, 1921: Zambales Province, Iba, No. 9740, 143 mm, December, 1921: Cavite Province, Monja Island, No. 9767, 165 mm, April 23, 1922: Batangas Province, Nasugbu, Barrio Papaya, No. 13292, 155 mm, January 13, 1926: Tayabas Province, Polillo, No. 16036, 145 mm, March 28, 1928. MINDORO, Mindoro Province, Calapan, No. 9353, 115 mm, January, 1923. PALAWAN, Palawan Province, Culion, No. 10275, 145 mm, No. 27420, 136 mm, October 1, 1922. PANAY, Antique Province, Guimaras, No. 9924, 172 mm, June 4, 1922. CEBU, Cebu Province, Cebu, No. 9410, 82 mm, December, 1908. MINDANAO, No. 4308, 178 mm, June 3, 1908. Oriental Misamis Province, Cagayan, No. 1573, 126 mm, September 12, 1907: Zamboanga Province, Zamboanga, No. 2811, 180 mm, April 8, 1908: Sulu Province, Jolo market, No. 16268, 150 mm, January 30, 1930.

HONGKONG, No. 6459, 120 mm, No. 6396, 167 mm, August, 1910.

HOLOCENTRUS CORNUTUS Bleeker. Plate 2, fig. 2.

Holocentrum cornutum BLEEKER, Nat. Tijdschr. Ned. Ind. 5 (1853) 240; Ned. Tijdschr. Dierk. 4 (1873) 222; WEBER, Fische Siboga-Exped. (1913) 182; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 5 (1929) 243, 244.

Holocentrum melanospilos BLEEKER, Negende bijdrage Visch-fauna van Amboina, Act. Soc. Scient. Indo-Neerl. 3 (1858) 2.
Holocentrum melanospilus BLEEKER, Ned. Tijds. Dierk. 4 (1873) 226.
Holocentrus cornutus EVERMANN and SEALE, Bull. U. S. Bur. Fish. 24 (1906) 60.

Dorsal XI, 13; anal IV, 9; pectoral 12 or 13; ventral I, 7; lateral line 33 to 36; transverse line 10.

Body oblong, head blunt, its upper profile curved and rather abruptly descending from occiput to snout. Depth 2.8 to 3 in length. Head 3; eye large, 2.3 to 2.6 in head, about double length of snout; interorbital space about 1.5 in eye; jaws equal in front; maxillary reaching to below middle of eye; anterior nasal end and posterior part of nasal opening spiny. Lower border of preorbital with a series of irregular blunt spines, preorbital ridge with a large blunt spine in front. Opercular bones strongly denticulated. Two strong spines in upper part of operculum, upper longer and stronger than lower. Preopercular spine about equal eye. Preoperculum with six to seven transverse rows of scales, 6 or 7 scales between occiput and dorsal. Third and fourth dorsal spine longest, last shortest. Membrane between dorsal spines somewhat deeply incised. Third anal spine about length of head without snout; pectorals shorter than ventrals; ventral about equal head without snout. Ventral spine less than snout and eye. Least height of caudal peduncle 1.6 to 2 in its length. Scales firm, large, strongly ctenoid.

Alcoholic specimens light or dark brown, with longitudinal silvery bands along rows of scales; a dark blotch at base of caudal and on soft dorsal and anal present or absent; membranes between dorsal spines partly blackish, as also that between second and third anal spines and first soft ray of anal. Outer margins of caudal dark.

The above description is based on specimen No. 14067, 118 mm, collected from Sibutu Island, Sulu Province, April 27, 1926.

LUZON, Sorsogon Province, Bulan, No. 3928, 132 mm, 1904. MINDORO, Mindoro Province, Calapan, No. 12333, 138 mm, January, 1924; No. 14192, 132 mm, 1926; Puerto Galera, No. 7194, 117 mm, No. 7210, 115 mm, 1912. ROMBLON, Romblon Province, Romblon, No. 10469, 129 mm, August 1, 1921. NEGROS, Negros Oriental Province, Siquijor Island, No. 13484, 170 mm, March 10, 1926. CEBU, Cebu Province, Bantayan Island, No. 5741, 128 mm, May 1909. MINDANAO, Davao Province, Tifunod River, No. 10700, 102 mm, May 28, 1921: Sulu Province, Lumbian Island, November 10, 1927; Sibutu Island, No. 27417, 66 mm, No. 27418, 118 mm, April 27, 1926; Sibuud, Lapak, No. 15657, 88 mm, No. 27414, 94 mm, November 8, 1927; Bungao Island, No. 11364, 118 mm, July 15, 1924; Sitankai, No. 10696, 98 mm, No. 27413, 102 mm, June 17, 1921.

HOLOCENTRUS VIOLACEUS Bleeker. Plate 2, fig. 3.

Holocentrus violaceum BLEEKER, Nat. Tijdschr. Ned. Ind. 5 (1853) 335; GÜNTHER, Cat. Brit. Mus. 1 (1859) 43; BLEEKER, Ned. Tijdschr. Dierk. 4 (1873) 221.

Holocentrus violaceus JORDAN and SEALE, Bull. U. S. Bur. Fish. 25 [(1905) 1906] 223.

Dorsal XI, 14 or 15; anal IV, 9; pectoral 13; ventral I, 7; lateral line 34 to 38; transverse line 10.5.

Body oblong, dorsal profile sloping in a gentle convex curve to snout; height 2.5 to 2.6. Head 2.6 to 3. Eye 3.3; length of snout not much less than diameter of eye; jaws nearly equal in front; maxillary reaching to below anterior half of eye; nasal opening at anterior part with spines, posterior part with 3 spines. Preorbital with a large spine in front, directed downwards, followed by several smaller spines pointing in same direction. Postorbital serrated along its hind border. Opercular bones strongly serrated with two flat spines, lower spine smaller. Preopercular spine long, slender, about equal to diameter of eyes. Preoperculum with seven transverse rows of scales, seven scales between occiput and origin of dorsal. Third, fourth, and fifth dorsal spines longest, last shortest; first anal spine small, third longest, about 1.75 of head; ventrals practically equal to pectorals, which are equal to head without snout; ventral spine longer than eye, equal to part of head without snout and eye. Least height of caudal peduncle 1.3 to 1.5 in its length.

Alcohol specimens dark purplish brown, each scale with a broad silvery subterminal longitudinal band; upper end of operculum with a black blotch; upper side of caudal peduncle with a silvery patch immediately behind dorsal. Fins hyaline, spinous dorsal dusky.

Distribution.—New Guinea, North Australia, Fiji Islands, Samoa, Philippines.

The above description is based on specimen No. 7175, 134 mm, collected from Puerto Galera, Mindoro Province, March to May, 1912.

MINDORO, Mindoro Province, Puerto Galera, No. 7206, 155 mm, March to May, 1912. MINDANAO, Davao Province, Samal

Island, No. 3884, 117 mm, May 2, 1908. PANAY, Iloilo Province, Iloilo, No. 14432, 132 mm, June or July, 1923.

HOLOCENTRUS CAUDIMACULATUS Rüppell. Plate 3, fig. 1.

Holocentrus spinifer RÜPPELL, Atlas Reise Nördl. Afrika, Fische (1828) 86, pl. 23, fig. 1.

Holocentrum spiniferum CUVIER and VALENCIENNES, Hist. Nat. Poiss. 3 (1829) 206; 7 (1831) 347.

Holocentrum caudimaculatum RÜPPELL, Atlas Reise Nördl. Afrika, Fische (1828) 97; GÜNTHER, Cat. Brit. Mus. 1 (1859) 41; KNER, Fische Novara-Exped. (1865–1867) 8; PLAYFAIR, Proc. Zoöl. Soc. London (1867) 855; BLEEKER, Ned. Tijdschr. Dierk. 4 (1873) 219; GÜNTHER, Fische der Südsee 1 (1873–1875) 95; DAY, Fishes of India 4° (1878–1888) 172; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 5 (1929) 247–249.

Holocentrus caudimaculatus JORDAN and SEALE, Bull. U. S. Bur. Fish. 25 [1905 (1906)] 223.

Dorsal XI, 14; anal IV, 9; pectoral 14; ventral 1.7; lateral line 41 or 42; transverse line 12.

Body oblong, dorsal profile slightly arched; height 2.5. Head 2.6 to 2.8; eyes 3, longer than snout; interorbital space 1.75 in diameter of eye; maxillary reaching to below middle of eye; bony ridges bordering groove for peduncle of premaxillaries ending in a blunt bifid spine in front; front margin of nasal opening with one or more spines in old specimens; jaws equal. Preorbital serrated, anteriorly with a large blunt spine pointing downward and followed by small spines directed backward. Postorbital serrated. Opercular bones serrated, upper opercular spine longest; preopercular spine as long as or longer than orbit. Preoperculum with seven transverse rows of scales. Shoulder bone serrated. Intranasal spines 2. Eight scales between occiput and base of dorsal. Teeth villiform. Fourth dorsal spine longest, equal to about 2.3 of height of body, but shorter than soft dorsal. Dorsal interspinous membrane rather deeply emarginate. Third anal spine longest and strongest, longer than fourth dorsal spine and equalling about 1.3 of height of body; ventrals about equal to pectorals; ventral spine about equal to fourth dorsal spine, shorter than eye and snout. Least height of caudal peduncle 1.5 in its length. Caudal forked.

Preserved specimens in alcohol brownish, a conspicuous silvery patch on upper part of free portion of tail just behind end of soft dorsal fin; a reddish brown band along base of dorsal and anal.

Distribution.—Red Sea, Seas of India, and the Malay Archipelago.

The above description is based on specimen No. 12152, 131 mm, collected from North Ubian, Sulu Province.

MINDANAO, Sulu Province, Jolo Island, No. 2351, 132 mm, February, 1908; Lumbian Island, No. 15694, 130 mm, November 10, 1927.

HOLOCENTRUS DIADEMA Lacépède. Plate 3, fig. 2.

Holocentrus diadema LACÉPÈDE, Hist. Nat. Poiss. 5 (1803) 372–374; RÜPPELL, Atlas Reise N. Afrika, Fische (1826–1831) 84; CUVIER and VALENCIENNES, Hist. Nat. Poiss. 3 (1829) 213; BLEEKER, Nat. Tijdschr. Ned. Ind. 3 (1852) 259; GÜNTHER, Cat. Brit. Mus. 1 (1859) 42; Fische der Südsee 1 (1873–1875) 97; DAY, Fishes of India 4° (1878–1888) 171; SAUVAGE, Poiss. Madagas. (1891) 33; SEALE, Occ. Papers B. P. Bishop Mus. Hawaii 1 (1901) 68; JORDAN and EVERMANN, Bull. U. S. Fish. Comm. 23 [(1903) 1905] 150; WEBER, Siboga-Exp. Fische (1913) 180; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 5 (1929) 238–240.

Dorsal XI, 13 or 14; anal IV, 9; pectoral 14; ventral I, 7; lateral line 46 to 48; transverse line 12.

Body oblong, dorsal profile from snout to dorsal with slight curve; height of body 2.2 to 2.5. Head 3 to 3.4; eye 2.6 to 2.8, about 1.5 of snout; interorbital space 1.5 of eye; maxilla reaching to below anterior third of orbit. Opercles, preorbital, and suborbitals denticulated, as is also posterior half of upper edge of orbit. Lower edge of preorbital serrated and with a strong blunt spinate projection directed downwards and forwards. Operculum with two prominent spines, upper spine stronger, nearly equal in size to preoperculum. Preopercular spine stout, equal to snout. Preoperculum with eight transverse series of scales, 7 or 8 scales between origin of dorsal and occiput. Fourth to sixth dorsal spines longest, equal to about half height of body, interspinous membrane deeply cleft; two dorsal fins about same height. Third anal spine as long as head without snout; ventral longer than pectorals, longer than head without snout; ventral spine about equal to snout and eye. Least height of caudal peduncle 1.5 in its length.

Preserved specimens in alcohol reddish, with ten white bands along body, corresponding to longitudinal rows of scales. Membrane of spinous dorsal black; crossed by a white band from lower portion of first dorsal spine to sixth and by a similar band near upper margin from sixth to last dorsal spine. Membrane between third and fourth anal spines darkish.

The above description is based on specimen No. 13624, 98 mm, collected from Bungau Island, Sulu Province, April 17, 1926.

CATANDUANES, Albay Province, Sialot Point, No. 17278, 110 mm, September 22, 1925. MINDANAO, Sulu Province, Lumbian Island, No. 15612, 120 mm, No. 17271, 122 mm, No. 17272, 113 mm, No. 17273, 108 mm, No. 17274, 108 mm, No. 17275, 114 mm, No. 17276, 105 mm, November 10, 1927; Siasi Island, No. 27412, 80 mm, No. 16355, 88 mm, June 21, 1921; Bungau Island, No. 13624, 97 mm, No. 17269, 76 mm, No. 17270, 67 mm, April 17, 1926; Lubian Island, No. 15598, 69 mm, November 10, 1927; Bato, Tawitawi Island, No. 13648, 103 mm, April 5, 1926.

HOLOCENTRUS BLEEKERI M. Weber. Plate 3, fig. 3.

Holocentrum argenteum BLEEKER, Act. Soc. Sc. Ind. Neerl. 111 10° Bijdrage Vischfauna Amboina (1858) 1; Ned. Tijdschr. Dierk. 4 (1873) 208 (nec. C. V.).

Holocentrum bleekeri WEBER, Fische Siboga-Exped. 65 (1913) 181; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 5 (1929) 237, 238.

Dorsal XI, 13; anal IV, 9; pectoral 15; ventral I, 7; lateral line 50 or 51; transverse line 12.

Body oblong, dorsal profile ascending to about 22.5 degrees from snout to dorsal fin, thence descending nearly straight to end of spinous dorsal; height 3.3 to 3.5. Head 2.9 to 3 in length; eye large, diameter longer than snout; interorbital space 1.5 of eye; maxillary not reaching below middle of eye; nasal opening without spines; jaws equal. Lower border of preorbital with a series of irregular blunt spines, preorbital ridges with a large blunt spine in front and directed downward, followed by a few similar but much smaller spines. Postorbital finely serrated. Operculum strongly serrated along free border. Preopercular spine strong and moderately long, about one-half diameter of eye. Two enlarged spines on upper part of operculum. Preoperculum with eight transverse rows of scales, eight scales between occiput and dorsal. Fifth dorsal spine longest, about as long as eyes and snout together, last spine shortest. Membrane between dorsal spines deeply incised. First anal spine very small, third strongest and about as long as height of body; pectorals shorter than ventral; ventral spine equal to or more than half length of head. Least height of caudal peduncle 2 in its length.

Alcoholic specimens reddish brown with silvery longitudinal bands along rows of scales; silvery band above lateral lines with a brighter silvery path below posterior half of spinous dorsal. Fins yellowish.

Distribution.—New Guinea, Pacific Islands, Philippines.

The above description is based on specimen No. 16357, 142 mm, collected from Manila.

HOLOCENTRUS SPINIFER (Forskål). Plate 4, fig. 1.

Sciæna spinifera FORSKÅL, Descript. Anim. (1775) 49.

Holocentrum leo CUVIER and VALENCIENNES, Hist. Nat. Poiss. 3 (1889) 153–155; BLEEKER, Nat. Tijdschr. Ned. Ind. 7 (1854) 355; SAUVAGE, Poiss. Madagas. (1891) 28.

Holocentrum spiniferum GÜNTHER, Cat. Brit. Mus. 1 (1859) 39; KNER, Fische Novara Exped. (1865–1867) 7; BLEEKER, Ned. Tijdschr. Dierk. 4 (1873) 205; GÜNTHER, Fische der Südsee 1 (1873–1875) 94; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 5 (1929) 235–237.

Holocentrum andamense DAY, Proc. Zoöl. Soc. (1870) 686; Fishes of India 4° (1878–1888) 172.

Holocentrus spinifer FOWLER, Proc. Acad. Nat. Sci. Phila. (1899) 483; JORDAN and EVERMANN, Bull. U. S. Fish. Comm. 23 [(1903) 1905] 161; JORDAN and SEALE, Bull. U. S. Bur. Fish. 25 [(1905) 1906] 223.

Dorsal XI, 15; anal IV, 10; pectoral 15; ventral I, 7; lateral line 43 or 44; transverse line 14.

Body oblong, dorsal profile running in a straight line from dorsal to snout, with a hump at nape. Head, 2.6 in length; eye 3.6 in head, about same as snout; interorbital space narrow, twice in eye and 7.5 to 8 in head; maxillary reaching below anterior of eye; lower jaw more prominent; opening without spines. Preorbital with several slender spines. Preopercular spine large and stout, reaching to branchial opening. Preoperculum with seven transverse rows of scales. Operculum with four flat spines, two upper spines smaller; opercular spines followed by numerous smaller spines, arranged in a parallel row. Origin of dorsal separated by about 9 scales from occiput. Second, third, and fourth dorsal spines longest, about same length as third anal spine; first and third spines slenderer than second and fourth; dorsal spines decreasing in size, last shortest, only one-third of eye. Soft dorsal fin about equal in height to spinous; first anal spine minute, third very stout, equal to eye and snout, with a deep furrow posteriorly to receive the fourth spine which is shorter and slenderer than third anal spine; ventrals about equal to pectorals which are equal to head without snout. Caudal forked, lobes pointed.

Rose-colored, with a deep-red spot behind eye, another deep-red spot above roof of pectoral, spinous dorsal deep red; other fins yellow.

Distribution.—Eastern coast of Africa through Indian Ocean to Pacific Ocean.

The above description is based on specimen No. 7107, 147 mm, collected from Puerto Galera, Mindoro Province, March to May, 1912. PALAWAN, Palawan Province, Cuyo Island, No. 15525, 265 mm, June 18, 1927.

GUAM, No. 7085, 110 mm, September, 1911.

Genus MYRIPRISTIS Cuvier, 1829

Oblong, back more or less arched. Caudal peduncle slender, caudal forked. Eyes generally large. Mouth moderate. Lower jaw more prominent. Villiform teeth in both jaws, on vomer and on palatine bones. Teeth of the outer series in upper jaw generally larger. Branchiostegals eight (exceptionally seven). Orbital and opercular bones serrated; operculum generally with a spine, preoperculum without spine. Dorsal beginning a short distance behind head, two dorsal fins scarcely united, first with ten to twelve spines, second with one spine and twelve or more soft rays. Dorsal spines depressible in a groove; ventrals with a long slender spine and seven rays; pectoral with a flexible spine and fourteen to sixteen soft rays. Caudal forked. Anal with four spines. Scales large, strongly ctenoid. No scales on skull. Lateral line continuous. In life generally bright red, with golden and silvery reflections or longitudinal bands.

Distribution.—Tropical seas of both hemispheres.

Key to the Philippine species of Myripristis.

a^1. Two patches of strong tubercular teeth on chin, two other patches on upper jaw. Lateral line 27 or 28.............................. *M. melanostictus.*

a^2. Two patches of tubercular teeth on chin and upper jaw not very prominent. Lateral line 28 to 40.

b^1. Lateral line 36 to 40. Snout 3 to 3.25 in eye; maxillary reaching below hind margin of pupil.. *M. pralinius.*

b^2. Lateral line 28 to 30. Snout 2.5 to 3 in eye.

c^1. Snout 2 to 2.5 in eye. About 3 round strong teeth on each side of upper jaw .... *M. murdjan.*

c^2. Snout 2.5 to 3 in eye. Upper jaw with a few pointed teeth. *M. schultzei.*

MYRIPRISTIS MELANOSTICTUS Bleeker. Plate 4, fig. 2.

Myripristis hexagonus BLEEKER, Nat. Tijdschr. Ned. Ind. 3 (1852) 262; Enum. Spec. Piscium (1859) 3 (nec. C. & V.).

Myripristis melanostictus BLEEKER, Ned. Tijdschr. Dierk. 1 (1863) 237; 4 (1873) 187; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 5 (1929) 258, 259.

Myripristis botche KNER, Fische Novarra Exped. 1 (1865) 5, 6.

Myripristis macrolepis BLEEKER, Ned. Tijdschr. Dierk. 4 (1873) 195; EVERMANN and SEALE, Bull. U. S. Bur. Fish. 26 [(1906) 1907] 60; SNYDER, Proc. U. S. Nat. Mus. 42 (1912) 495; WEBER, Fische Siboga-Exped. (1913) 186.

Myripristis melanostigma BLEEKER, Atl. Ichth. 9 (1877) pl. 355, fig. 3 (errore).

Dorsal X, 14; anal IV, 12; pectoral I, 14; ventral I, 7; lateral line 27 or 28; transverse line 10.5.

Height 2.2 to 2.4. Head 2.6 to 2.9. Eye 2.2 to 2.3. Interorbital space about one-half of eye, 4.5 to 5 in head; maxillary reaching to below posterior edge of pupil of eye. Lower border of posterior edge of maxillary with a series of rounded teeth; teeth in upper jaw enlarged and rounded at tip, the rest less pointed and more granular; a strong rounded tooth on each side of symphysis of lower jaw, and another strong rounded tooth on each side of chin, below the one mentioned; tongue without teeth. Dorsal separated by 8 or 9 scales from occiput; third and fourth dorsal spines longest, more or less equal to diameter of eye; third anal spine longest and strongest; pectoral and ventral spines about equal, shorter than head without snout; ventral spine longer than pectoral spine, equal to diameter of eye. Least height of caudal peduncle more than half of eye. Caudal deeply forked.

Alcoholic specimens yellowish brown with golden reflections and with more or less distinct silvery broad longitudinal bands on the body, corresponding to the rows of scales.

Alcoholic specimens reddish with golden or silvery reflections. Fins yellowish.

Distribution.—Celebes, Japan, Philippines. The above description is based on specimen No. 1625, 115 mm, collected from Cagayan, Oriental Misamis Province, Mindanao, September 13, 1907.

MINDORO, Mindoro Province, Calapan, No. 1012, 141 mm, August 27, 1907. MINDANAO, Oriental Misamis Province, Cagayan, No. 1568, 91 mm, No. 1570, 105 mm, No. 1640, 94 mm, September 13, 1907; No. 1567, 101 mm, September 12, 1907: Sulu Province, Bungau Island, No. 13595, 62 mm, April 17, 1926.

MYRIPRISTIS MURDJAN (Forskål). Plate 4, fig. 3.

Sciæna murdjan FORSKÅL, Descript. Anim. (1775) 48.

Perca murdjan BLOCH and SCHNEIDER, Syst. Ichth. (1801) 85; LACÉPÈDE, Hist. Nat. Poiss. 4 (1802) 396, 418.

Myripristis murdjan RÜPPELL, Atlas Reise N. Afrika Fische (1826–1831) 86; CUVIER and VALENCIENNES, Hist. Nat. Poiss. 3 (1829)

177; BLEEKER, Nat. Tijdschr. Ned. Ind. 3 (1852) 109; GÜNTHER, Cat. Brit. Mus. 1 (1859) 21; KNER, Fische Novara Exped. (1865–1867) 4; BLEEKER, Ned. Tijdschr. Dierk. 4 (1873) 188; GÜNTHER, Fische der Südsee 2 (1873–1875) 92; DAY, Fishes of India 4° (1878–1888) 170; SAUVAGE, Poiss. Madagas. (1891) 20; SEALE, Occ. Papers B. P. Bishop. Mus. Hawaii 1 (1901) 67; JORDAN and EVERMANN, Bull. U. S. Fish. Comm. 23 [(1903) 1905] 152; JORDAN and SEALE, Bull. U. S. Bur. Fish. 25 [(1905) 1906] 220; Evermann and Seale, Bull. U. S. Bur. Fish. 26 [(1906) 1907] 60; JORDAN and RICHARDSON, Bull. U. S. Bur. Fish. 27 [(1907) 1908] 247; TANAKA, Fishes of Japan 4 (1911) 53; WEBER, Fische Siboga-Exped. (1913) 186; JORDAN and STARKS, Ann. Carnegie Mus. (3–7) 11 (1917) 447; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 5 (1929) 259–262.

Myripristis parvidens CUVIER and VALENCIENNES, Hist. Nat. Poiss. 3 (1829) 173; BLEEKER, Nat. Tijdschr. Ned. Ind. 3 (1852) 260; WEBER, Fische Siboga-Exped. (1913) 185.

Myripristis violaceus BLEEKER, Nat. Tijdschr. Ned. Ind. 2 (1851) 234; Ned. Tijdschr. Dierk. 4 (1873) 192.

Myripristis microphthalmus BLEEKER, Ned. Tijdschr. Dierk. 4 (1873) 191; JORDAN and SEALE, Bull. U. S. Bur. Fish. 25 [(1905) 1906] 220; EVERMANN and SEALE, Bull. U. S. Bur. Fish. 26 [(1906) 1907] 60; WEBER, Fische Siboga-Exped. (1913) 186.

Myripristis adustus BLEEKER, Ned. Tijdschr. Dierk. 4 (1873) 193; JORDAN and SEALE, Bull. U. S. Bur. Fish. 25 [(1905) 1906] 220.

Myripristis botche DAY, Fishes of India 4° (1878–1888) 169; Suppl. 788.

Dorsal X, I, 14; anal IV, 12; pectoral 15; ventral I, 7; lateral line 28 to 30; transverse line 10.

Height 2.2 to 2.6. Head 2.5 to 3. Eye 2.5. Interorbital space twice in eye; snout 3 in eye; lower jaw slightly longer, with a rough, nipplelike projection on either side of symphysis; maxillary reaching to below posterior border of eye with blunt denticulations on its front near its lower end; teeth villiform in jaws, an external row of widely separated teeth which are larger and rounded; tongue without teeth; undersurface of lower jaw furrowed by ten or twelve grooves; maxillæ, pre-, sub-, and interopercles also grooved. Preopercle serrated in its whole extent. Opercle with a short strong spine, denticulated above this spine and along the whole of its outer margin, serrated below. Shoulder scale serrated. Upper surface of head with four raised lines subdividing each branch terminating in a small spine. Origin of dorsal separated by 7 to 9 scales from occiput. Dorsal spines increasing in length to third, third of equal length as sixth; interspinous membrane rather deeply emarginate; third anal spine strong but generally not much longer than fourth spine, equal to eye; pectorals longer than ventrals, a little less than head without snout; ventral spine equal to or longer than eye. Least height of caudal peduncle more than half diameter of eye. Caudal forked.

Alcoholic specimens yellowish brown; posterior membrane of operculum blackish; gill openings deep brownish black, axil of pectorals often black; a dark vertical band through eye, often confined to above pupil; dorsal, anal, and caudal fins with milky outer edges; a dark stripe present or absent at highest points of soft dorsal and anal fins, also at tip of caudal; seldom a dark mark along first dorsal; outer edge of ventral fins white.

Distribution.—Red Sea, east coast of Africa, Malay Archipelago, Philippines.

The above description is based on specimen No. 14066, 130 mm, collected from Sibutu Island, Sulu Province, April 27, 1926.

BATANES, Batanes Province, Santo Domingo de Basco, No. 12539, 165 mm, No. 27463, 140 mm, November 3, 1935. LUZON, Zambales Province, Subic, No. 12013, 155 mm, February 20, 1920: Manila, No. 10979, 131 mm, No. 10981, 155 mm, No. 17277, 135 mm, No. 27444, 131 mm, 1911: Sorsogon Province, Bacon, No. 3227, 126 mm, No. 3723, 170 mm, 1904. MINDORO, Mindoro Province, Calapan, No. 15786, 80 mm, 1927; Puerto Galera, No. 7122, 122 mm, No. 7123, 112 mm, No. 7124, 133 mm, No. 7125, 145 mm, No. 7126, 134 mm, No. 7196, 118 mm, No. 7197, 118 mm, No. 7211, 120 mm, No. 7212, 115 mm, No. 7213, 105 mm, No. 7218, 115 mm, No. 7224, 130 mm, No. 7671, 133 mm, No. 7674, 103 mm, No. 9227, 135 mm, March to May, 1912. CEBU, Cebu Province, Bantayan, No. 57367, 95 mm, No. 5772, 80 mm, May, 1909. PALAWAN, Palawan Province, No. 12651, 38 mm, No. 27443, 51 mm, November, 1925. MINDANAO, Zamboanga Province, Zamboanga, No. 4173, 148 mm, May 26, 1908; No. 4248, 133 mm, 1908: Sulu Province Jolo, No. 2362, 93 mm, February, 1908; Mabajoc Point, No. 15661, 87 mm, No. 27480, 100 mm, No. 27481, 80 mm, No. 27482, 80 mm, No. 27483, 101 mm, No. 27484, 90 mm, No. 27485, 83 mm, No. 27486, 70 mm, No. 27487, 71 mm, No. 27488, 112 mm, No. 27489, 100 mm, No. 27490, 96 mm, November 10, 1927; Lubian Island, No. 15611, 130 mm, No. 15649, 130 mm, No. 15682, 85 mm, No. 27467, 95 mm, No. 27468, 102 mm, No. 27469, 98 mm, No. 27490, 112 mm, No. 27471, 117 mm, No. 27473, 118 mm, No. 27474, 90 mm, No. 27475, 108 mm, No. 27476, 86 mm, No. 27477, 90 mm, No. 27478, 112 mm, No. 27479, 122 mm, No.

27491, 124 mm, No. 27492, 114 mm, No. 27493, 112 mm, No. 27494, 130 mm, No. 27495, 106 mm, No. 27496, 113 mm, No. 27497, 116 mm, No. 27498, 125 mm, No. 27499, 131 mm, No. 27500, 113 mm, No. 27501, 135 mm, No. 27502, 131 mm, November 10, 1927; South Ubian Island, No. 14120, 71 mm, April 13, 1936; Sibaud, Lapak, No. 15617, 96 mm, No. 27458, 82 mm, No. 27459, 84 mm, No. 27460, 72 mm, No. 27461, 94 mm, No. 27462, 80 mm, November 8, 1927; No. 27445, 93 mm, No. 7446, 90 mm, No. 27447, 100 mm, No. 27448, 89 mm, No. 15757, 102 mm, November 8, 1927; Sibutu Island, No. 14068, 136 mm, No. 27449, 58 mm, No. 27450, 90 mm, No. 27451, 97 mm, No. 27452, 96 mm, No. 27453, 135 mm, April 27, 1926; No. 13722, 50 mm, No. 27442, 54 mm, April 26, 1926, No. 27440, 50 mm, No. 13693, 45 mm, No. 14066, 128 mm, April 27, 1926; Bungau Island, No. 13568, 122 mm, No. 27454, 83 mm, No. 27455, 49 mm, No. 27456, 91 mm, No. 27457, 90 mm, April 16, 1926, No. 11913, 73 mm, August 13, 1924, No. 14433, 155 mm, July 15, 1924: Davao Province, Samal Island, No. 3806, 70 mm, No. 3602, 75 mm, No. 3695, 130 mm, May 1, 1908.

HONOLULU, No. 27463, 140 mm.

MYRIPRISTIS SCHULTZEI Seale. Plate 5, fig. 1.

Myripristis schultzei SEALE, Philip. Journ. Sci. § D 4 (1909) 504–505.

Dorsal X, I, 15; anal IV, 13; pectoral 15; ventral I, 6; lateral line 28 to 30; transverse line 10.

Height 2.3 to 2.6; head 3 to 3.1. Eye 2 to 2.2, snout 7.5. Interorbital space about 3.3 in head; maxillary 1.80, posterior tip ending on a line with posterior margin of pupil, width of distal end about 2 in eye; pectorals 1.3. Ventrals 1.45 to 1.5.

Body oblong, somewhat compressed, greatest width at origin of dorsal. Upper and lower profiles of body about equal. Length of caudal peduncle 0.23 in head, its depth 3.2. Depth of head about equal to its length; interorbital space flat, with 4 longitudinal ridges. Anterior outline of head bent abruptly down in front of eyes, making a short blunt snout, the length of which is 2 in its width; maxillary reaching to below hind margin of eye.

Opercular bones denticulate, opercle with a single spine on its posterior margin, maxillary with small teeth on lower posterior border. Mouth large, oblique, lower jaw slightly longer, lower jaw with four distinct pores, two anterior front and two at bottom of tip. Teeth in jaws, vomer, palatine, and on hyoid portion of tongue; two groups of four teeth each at tip. Gill opening very large, carried forward to below anterior margin of pupil. Gillrakers long, longest 2 in eye. Pseudobranchia present. Scales large, toothed; body fully scaled; head naked except about 3 rows of scales on checks. Fourth dorsal spine longest, 1.9 in head; anal and soft dorsal practically equal, anal rays a little longer. Origin of ventrals midway between anal and anterior margin of eye. Caudal forked.

Alcoholic specimens yellowish white with some bronze reflections, darker above; fins uniform yellowish white; no opercular blotch; inner axil of pectorals deep black.

Distribution.—Philippine Islands.

The above description is based on the type specimen, No. 3899, 128 mm, collected from Samal Island, Gulf of Davao, May 4, 1908.

MYRIPRISTIS PRALINIUS Cuvier and Valenciennes. Plate 5, fig. 2.

Myripristis pralinius CUVIER and VALENCIENNES, Hist. Nat. Poiss. 3 (1829) 170; BLEEKER, Nat. Tijdschr. Ned. Ind. 2 (1851) 234; 3 (1852) 262; GÜNTHER, Cat. Brit. Mus. 1 (1859) 20; SAUVAGE, Poiss. Madagas. (1891) 17; JORDAN and SEALE, Bull. U. S. Bur. Fish. 25 [(1905) 1906] 222; WEBER and DE BEAUFORT, Fish. Indo-Austr. Arch. 5 (1929) 253-256.

Myripristis seychellensis CUVIER and VALENCIENNES, Hist. Nat. Poiss. 3 (1829) 128, 129; SAUVAGE, Poiss. Madagas. (1891) 12.

Myripristis bleekeri GÜNTHER, Cat. Brit. Mus. 1 (1859) 20; BLEEKER, Ned. Tijdschr. Dierk. 4 (1873) 179.

Myripristis indicus BLEEKER, Ned. Tijdschr. Dierk. 4 (1873) 183; WEBER, Fische Siboga-Exped. (1913) 187.

Myripristis multiradiatus GÜNTHER, Fische der Südsee 1 (1873-1875) 93; JORDAN and EVERMANN, Bull. U. S. Fish. Comm. 23 [(1903 1905] 149.

Dorsal X, I, 17; anal IV, 15; pectoral 15; ventral 1.7; lateral line 36 to 40; transverse line 10.5.

Height 2.3 to 2.5. Head 2.75 to 3. Eyes 2.1 to 2.3. Snout equal to third of eye; interorbital space 1.75 of eye, one fourth in head; maxillary reaching to below hind margin of pupil, posterior edge with coarse distant spines, height posteriorly equal to half eye; tongue generally without teeth. Origin of dorsal separated by 8 or 9 scales from occiput; third dorsal spine longest, a little longer than diameter of eye, about twice as long as spine of second dorsal; third anal spine longest, equal to length of pectoral spine; pectorals equal to head without snout, longer than ventrals; ventral spine equal to diameter of eye, about two times as long as pectoral; caudal deeply forked. Least height of caudal peduncle about two times in diameter of eye.

In life crimson red with golden reflection and with more or less distinct longitudinal bands on body, corresponding to rows of scales; lower part of scales rosy; opercular spot and base of pectoral dark brown, fins bright rose, dorsal, caudal, and ventral all edged with white; first dorsal deep red, paler at base.

Distribution.—Madagascar, New Guinea, Red Sea, Ceylon, Ireland, Samoa, East Indies, Philippines.

The above description is based on specimen No. 15693, 98 mm, collected from Mabohoc Point, south coast of Jolo, November 10, 1927.

LUZON, Sorsogon Province, Bacon, No. 3223, 128 mm, 1904. MINDANAO, Sulu Province, Mabohoc Point, south coast of Jolo, No. 27464, 83 mm, November 10, 1927.

ILLUSTRATIONS

[Drawings by A. Lagman. The scale given with each figure equals 1 cm, except that in Plate 4, fig. 1, which equals 2 cm.]

PLATE 1

FIG. 1. *Holocentrus sammara* (Forskål).
2. *Holocentrus opercularis* (Cuvier & Valenciennes).
3. *Holocentrus lacteo-guttatus* (Cuv. & Val.) M. Weber.

PLATE 2

FIG. 1. *Holocentrus ruber* (Forskål).
2. *Holocentrus cornutus* (Bleeker).
3. *Holocentrus violaceus* Bleeker.

PLATE 3

FIG. 1. *Holocentrus caudimaculatus* Rüppell.
2. *Holocentrus diadema* Lacépede.
3. *Holocentrus bleekeri* M. Weber.

PLATE 4

FIG. 1. *Holocentrus spinifer* (Forskål).
2. *Myripristis melanostictus* Bleeker.
3. *Myripristis murdjan* (Forskål).

PLATE 5

FIG. 1. *Myripristis schultzei* Seale.
2. *Myripristis pralinius* Cuvier and Valenciennes.

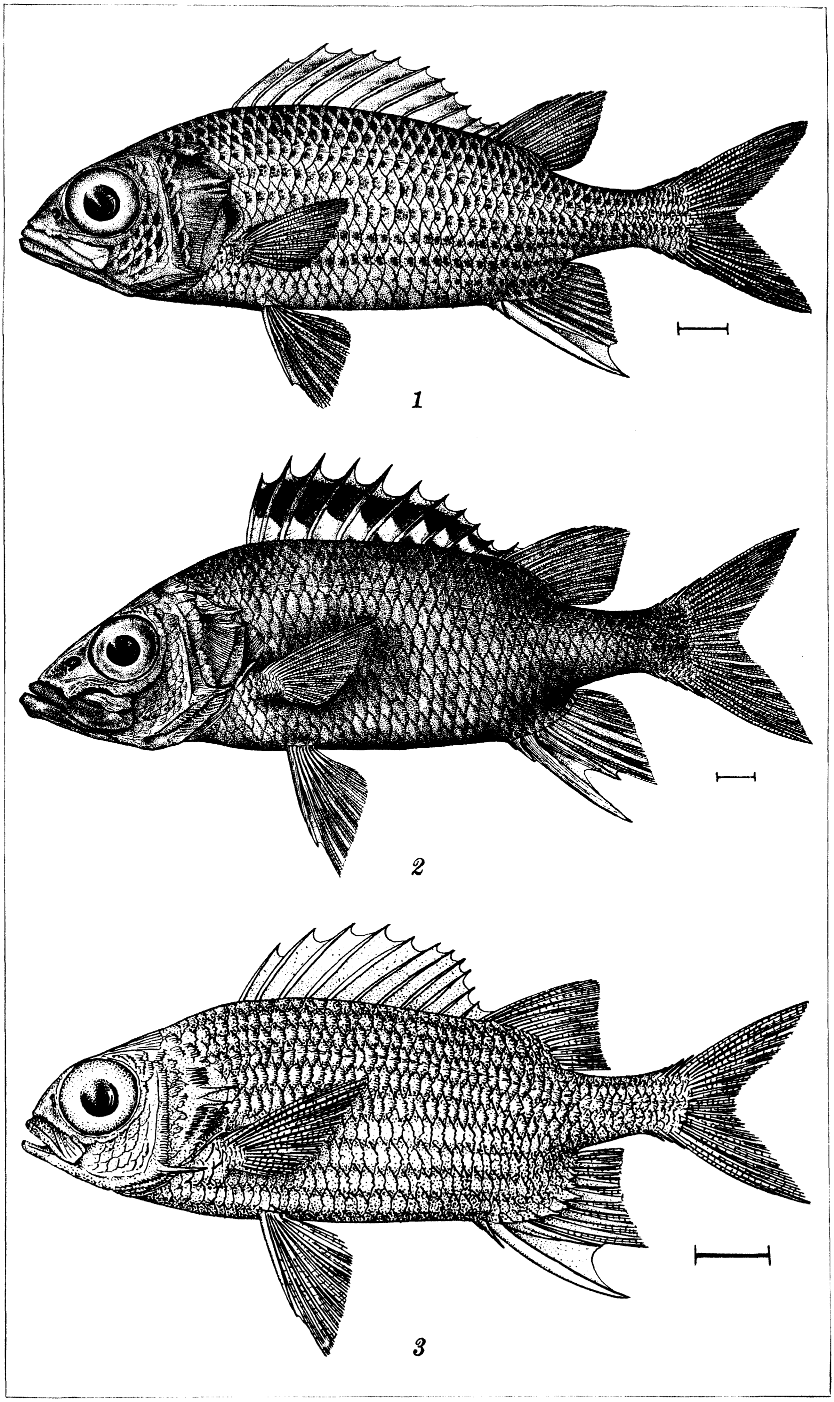


PLATE 1.

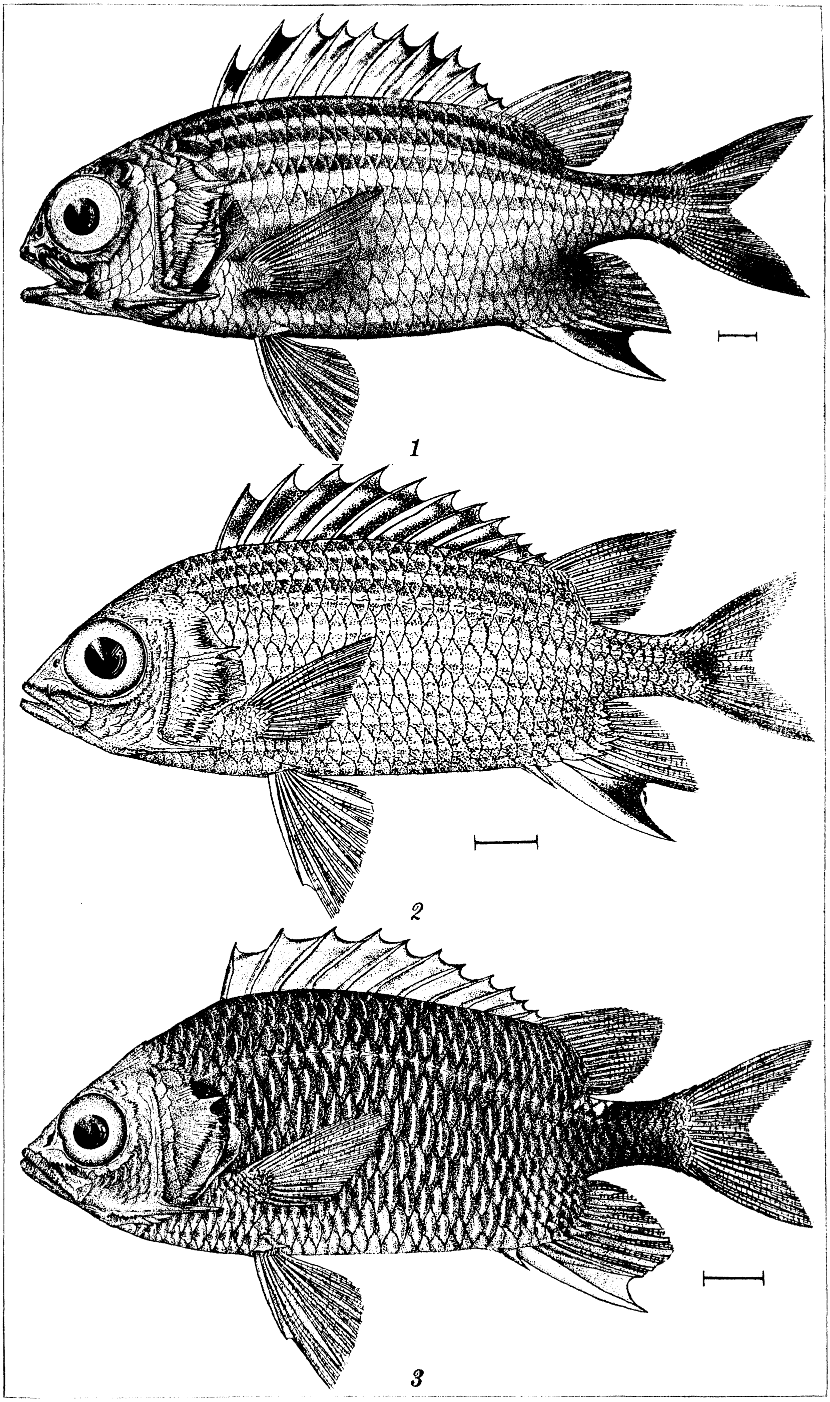


PLATE 2.

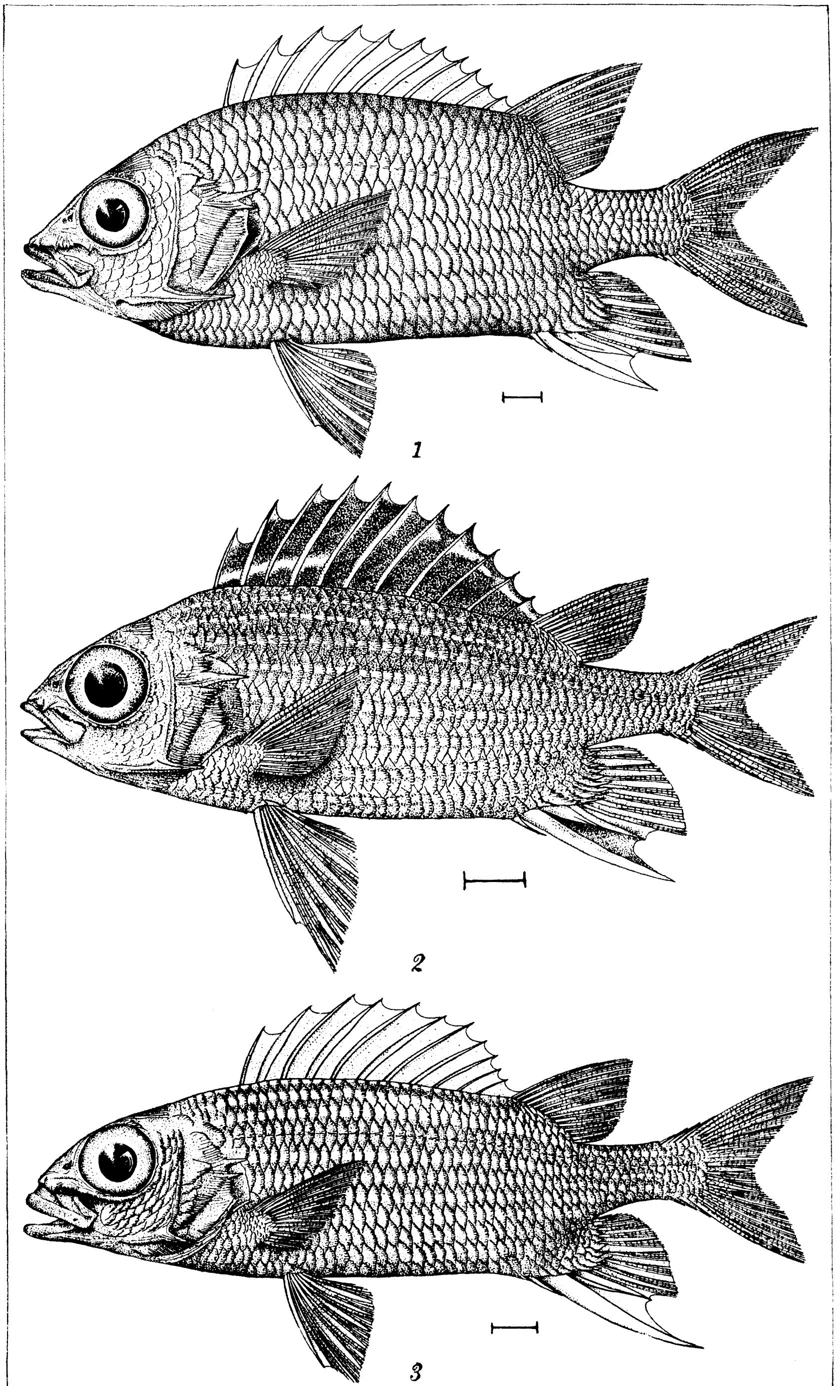
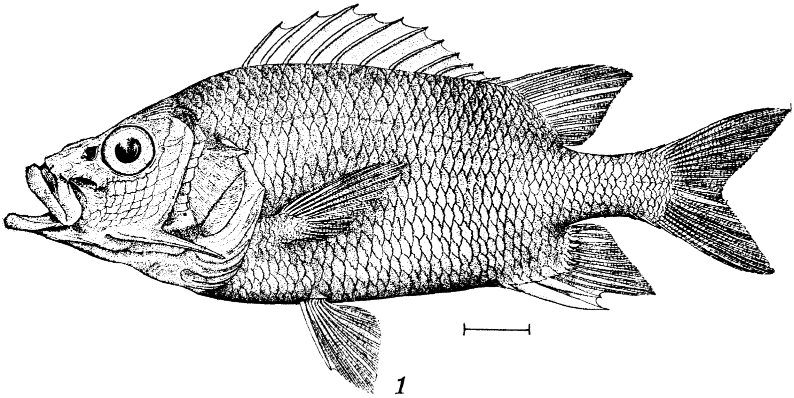
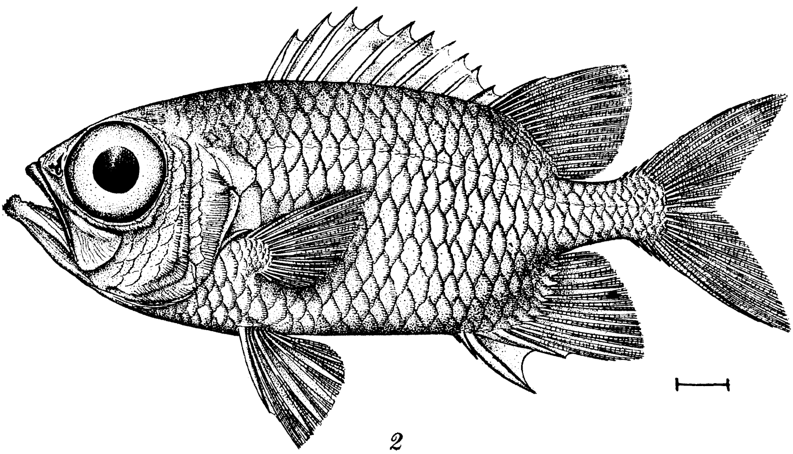


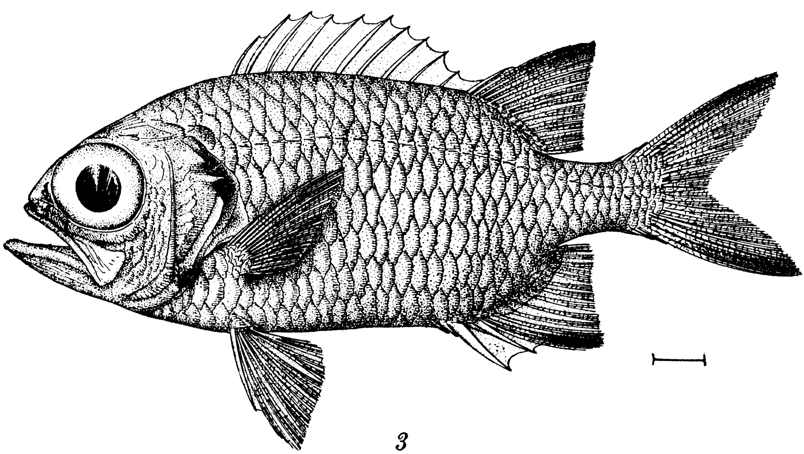
PLATE 3.



1

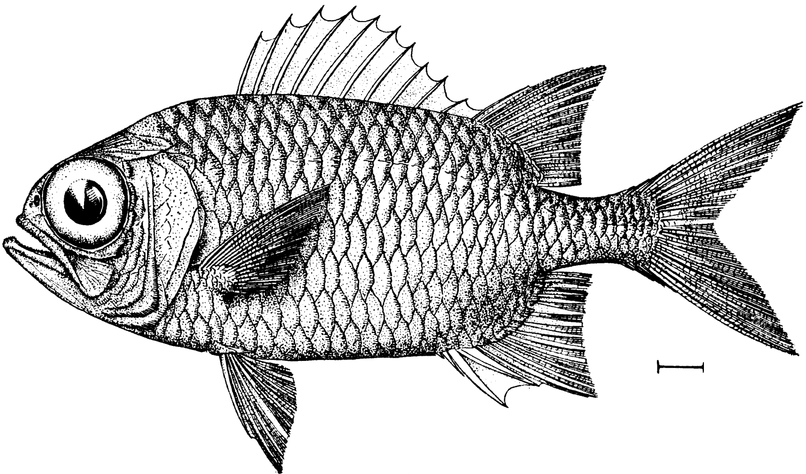


2

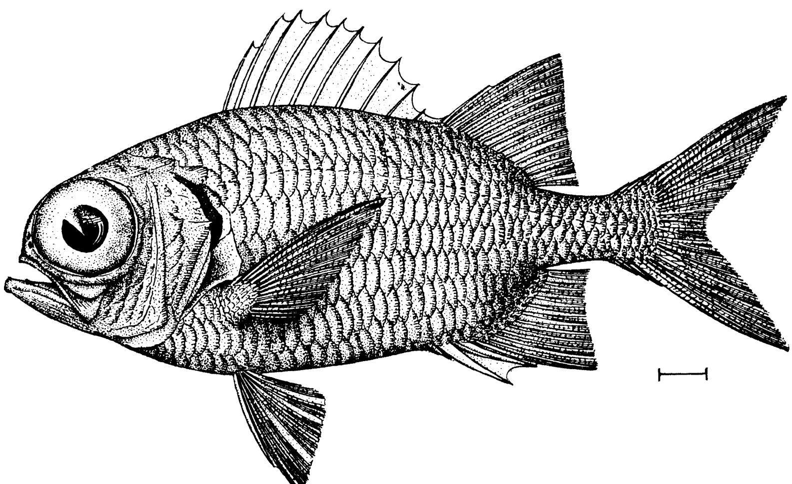


3

PLATE 4.



1



2

PLATE 5.

BOOKS

Acknowledgment of all books received by the Philippine Journal of Science will be made in this column, from which a selection will be made for review.

RECEIVED

American Kennel Club. Blue book of dogs, 1938. Published for the American kennel club by Garden City Publishing co., inc. Garden City, New York, 1938. 159 pp., illus.

CLARK F. LE GROS, and L. NOEL BRINTON. Men, medicine and food in the U. S. S. R. London, Lawrence and Wishart, 1936. 173 pp. Price, 5s.

CUFF, NOEL B. Child psychology. Louisville, Kentucky, The Standard Printing co. 1937. 299 pp., illus.

DEMPWOLFF, OTTO. Vergleichende Lautlehre des Austronesischen Wortschatzes. IIIer Band, Austronesisches Wörterverzeichnis. Berlin, Dietrich Reimer (Andrews & Steiner), 1938. 192 pp.

Great Britain. Ministry of Health. Report of an investigation into maternal mortality. Presented by the Minister of Health to Parliament by command of His Majesty, April, 1937. London, His Majesty's Stationery Office, 1937. 353 pp., maps, diagrams. Price, 5s 6d.

HENTIG, HANS VON. Punishment; its origin, purpose and psychology. London, William Hodge and Company, ltd. 1937. 239 pp. Price, 12s. 6d.

LAWRENCE, W. J. C. Practical plant breeding. London, George Allen & Unwin, ltd. 1937. 155 pp., illus. Price, 5s 6d.

League of Nations. Health organization. The treatment of malaria. Study of synthetic drugs, as compared with quinine, in the therapeutics and prophylaxis of malaria. Fourth general report of the Malaria Commission, and appendices. Geneva, League of Nations, 1937. 558 pp., illus. Price, $0.65.

A symposium on cancer. Addresses by Leiv Kreyberg, Clarence C. Little, Madge T. Macklin, Edgar Allen, Howard B. Andervont, James Ewing, Gioacchino Failla, Henri Coutard, Warren H. Lewis, Stanley P. Reimann, James B. Murphy, and Emil Novak. Given at an Institute on Cancer conducted by the Medical School of the University of Wisconsin. Madison, University of Wisconsin press, 1938. 202 pp., illus., graphs. Price, $3.

TYRER, ALFRED HENRY. Sex satisfaction and happy marriage. By the Reverend Alfred Henry Tyrer. Foreword by Robert L. Dickinson. New York, Emerson Books, inc., 1938. 160 pp., illus. Price, $2.

VERRILL, A. HYATT. Foods America gave the world. Boston, L. C. Page & Company, c1937. 289 pp., illus. Price, $3.

WALKER, DESMOND GREER. The construction of vulcanite applicators for applying radium to lesions of the buccal cavity, lips, orbit and antrum. Foreword by W. Warwick James. London, Published for the Middlesex Hospital Press by John Murray, 1938. 61 pp., plates. Price, 5s.

REVIEWS

Personality and the Cultural Pattern. By James S. Plant. New York, The Commonwealth Fund, 1937. 432 pp. Price, $2.50.

One of the most recent books dealing with personality is that of a physician and psychiatrist, Dr. James S. Plant, Director of Essex County Juvenile Clinic, Newark, New Jersey. Medical men are more and more concerned with personality problems. This task used to be left to psychologists, who are usually without medical training, or to psychiatrists with very little psychological insight. Doctor Plant appears to be not only a psychiatrist, but also a psychologist and a sociologist.

The book presents a new approach to the problem of personality. Formerly attention was directed largely to the inner motives of individuals and less to their environment, for it was thought that an individual may change his environment. In discussing the changing concepts of the personality, Doctor Plant reverses the approach with the hypothesis of psychoösmosis, which "is that the 'wall' about the personality is highly permeable and that there flow into the personality currents of enviromental influence which continually affect the existing content." The view presented therefore is "that environmental forces can change the personality."

The view is not, however, entirely new. Such an approach to the study of personality was suggested long ago by the behaviorists, though for some reason the psychologists have not taken the cue very seriously. Credit is given to Doctor Plant for having formulated definitely this new approach to the understanding of personality. As the title of the book suggests, personality is the result of the interplay between the individual and his environment or his cultural pattern.

The book itself is a discussion of the structure of personality, and the conflicts between personality needs and the environmental pressures. It discusses such topics as the effect upon personality development of the family pattern, urban and suburban life, school, church, law, medicine, industry, and education. Space prevents the reviewer from presenting the salient facts brought out by Doctor Plant. The readers, however, will do well to read this very interesting book not only once but several times if they want to get the most out of it.

In this country, where we are just awaking to the needs of our developing personalities presented in our youths, where we begin to feel concern for our juvenile delinquents, and where we bewail the lack of religious and moral education of our children, it would indeed be very profitable for us to read Doctor Plant's illuminating book. Psychiatrists, psychologists, sociologists, mental hygienists, educators, and a host of others interested in personality development should find this book very delightful reading.—S. G. P.

The American Kennel Club Blue Book of Dogs, 1938. Published for the American Kennel Club by the Garden City Publishing Co., Inc. Garden City, New York. 159 pp.

This volume lists the outstanding canines on bench shows as well as racing, field trials, and obedience work of some eighty breeds of dogs during 1937. The pedigree, the owner, and a brief description of each champion animal are given. The book is profusely illustrated, and serves as the latest photo news of the best specimens of dogdom. This work is specially valuable to breeders and owners of dogs, and to some extent to veterinarians as well. It is produced on good quality paper.—L. M. Y.

Materia Medica, Toxicology and Pharmacognosy. By William Mansfield. St. Louis, The C. B. Mosby Company, 1937. 707 pp., illus. Price, $6.75.

This volume is a text and reference book on the therapeutics, toxicology, pharmacognosy, and posology of drugs that are officially listed in the United States Pharmacopoeia XI and the National Formulary VI. There are twenty chapters devoted to the materia medica and pharmacognosy of vegetable drugs or their products, classified according to the parts used or the kind of plant product; one chapter pertains to drugs of animal origin; five chapters contain discussions of poisons classified mainly into caustics, irritants, and systemic poisons, and one chapter deals with posology. A glossary of medicinal and botanical terms is appended.

The introductory discussions in each chapter, the inclusion of pharmacognostical information essentially required of each drug, and the excellent figures make the volume a valuable handbook.

The doses of U. S. P. and N. F. drugs, arranged both from the lowest to the highest and alphabetically, should prove of value.—P. V.

Strange Reptiles and Their Stories. By A. Hyatt Verrill. Boston, L. C. Page & Company, c1937. 195 pp., frontispiece, illus. Price, $2.50.

This book is intended primarily for youthful and adult readers interested in the general aspects of the subject, so that technical terms have been avoided and no attempt has been made to classify or arrange the reptiles in their scientific groupings. The interesting ways and habits of reptiles are featured. Selection has been made of the commoner and more noteworthy species and those of particular importance. Facts about these animals are given, to do away with many popular fallacies, and the strange and ridiculous beliefs and superstitions connected with them. Included are a number of narratives of personal experiences of the author, together with incidents and anecdotes of other well-known travelers, explorers, and scientists. Exceptionally good and quite accurate drawings of a good number of the reptiles included in the book serve as a guide in the identification of reptiles.

The book should prove of great interest and help to laymen, especially those who because of lack of scientific training would find treatises written in highly technical and scientific terminology difficult.—D. V. V.

Manual of Rubber Planting (Malaya). Compiled by A. T. Edgar. Kuala Lumpur, F. M. S., The Incorporated Society of Planters, 1937. 411 pp., illus. Price, $8 (Straits Currency).

This book presents a comprehensive guide for the convenience of rubber growers. It embraces all conceivable phases of rubber planting, manufacturing and shipment of rubber, and similar vital information on a number of subjects that rubber growers find very useful.

Part 1 deals with land tenure in the Federated Malay States; how to select rubber land, with descriptive sketches on the different types of soil and altitudes where rubber should be grown in Malaya; the opening up of an estate, including the clearing of jungle and cogonal lands, such as felling, burning, clearing, and the like; sites for buildings, such as factories and employees and laborer's quarters; laying of the land; soil conservation; selection, breeding, and propagation of planting materials; upkeep of young as well as old rubber plantations; manuring; control of pests and diseases; tapping and collection of latex; preparation of smoked sheets, spray, rubber, and crêpes.

Particular mention should be made of Sections 4, 5, 7, 8, and 12 of the manual, wherein the author discusses with thorough-ness the advantages and disadvantages of budgrafting, the improved clones of Para rubber and the subsequent care of same, the high-yielding clones of which are now revolutionizing the rubber industry in Java, Sumatra, and Malaya. A list is given of clones that are suitable for planting in certain sections in Malaya. The author claims that the production of seeds by crossing is inadvisable on a commercial scale, due to the disappointment experienced by the planters in planting clonal seeds.

Section 7 discusses at length the tapping systems in vogue in Malaya, and the advantages and disadvantages of each on young as well as on old Para rubber trees. In Section 8 the names of the different pests and diseases attacking Para rubber are listed, including pointers on how to identify them in the field, together with the necessary control measures. In Section 12 the manufacturing of raw rubber, including the descriptions of smoke houses, the production of standard smoked sheets and crêpe and spray rubber; and the preservation and testing of latex for export purposes are clearly outlined in detail.

Part 2 embraces some notes on estate sanitation for planters and laborers, such as housing, the collection of waste, water supply, sewage disposal and purification, and the prevention of some diseases. This part of the manual includes also the first-aid measures necessary for snake and dog bites; labor conditions and laws; organization of coöperative societies; estate records; road making, construction of buildings; use of concrete, survey instruments, and equipment; and weights and measures and their equivalents, which are all essential in farm practice.

The manual would certainly be useful as a guide not only for the rubber growers or those contemplating to engage in this industry but also for the planters of other crops.—F. G. G.

Butter and Oleomargarine: An Analysis of Competing Commodities. By W. R. Pabst. New York, Columbia University Press, 1937. 112 pp. Price, $1.50.

The purpose of this book according to the author is to investigate the interrelationships of butter and oleomargarine "in the light of recent theoretical work and through the application of modern statistical technique."

The competition between butter and oleomargarine dates back to 1870, when an oleomargarine factory established in Paris started the commercial production of oleomargarine. The dairy industry, especially the production of butter, is being continually threatened by the competition of artificial butter made from vegetable oil. By the end of the nineteenth century the oleomargarine industry had already established itself in the United States and offered stiff competition to the butter industry. Not all the oleomargarine produced in the United States at present, however, is manufactured by the oleomargarine industry; a substantial amount of this product is manufactured as a secondary product in the meat-packing industry and as a by-product in other industries.

Because of the keen competition of oleomargarine with butter, the dairy industry has been continually agitating for the enactment of laws that would restrain competition and handicap the producers of oleomargarine. Even during the latter part of the nineteenth century state laws were passed against oleomargarine, as a part of the legislation against fraud. The fraudulent sale of oleomargarine and its use in the adulteration of butter have greatly affected the butter industry, so that nothing short of a federal law was needed to establish fair competition between these two industries.

The increased consumption of oleomargarine during the World War has greatly stimulated the industry. The dislocation of agriculture in the United States was attributed partly to the oleomargarine industry, and there has been increased agitation on the imposition of high tariff on butter. The tariff on butter had also the effect of increasing the price of oleomargarine and indirectly benefited the manufacturers of this product. The use of coconut oil in the manufacture of oleomargarine has increased the opposition of the butter producers who claim that oleomargarine made out of coconut oil is a foreign product, and they resent the competition of the "Philippine cow" with the American variety.

Dr. W. R. Pabst, in Chapter III of this treatise, gives the very interesting relationship between butter and oleomargarine as competing commodities. The use of diagrams would have greatly improved the presentation of this aspect. The butter producers led by the National Coöperative Milk Producers' Federation are continually advocating the imposition of higher taxes on all kinds of oleomargarine as well as the imposition of an excise or processing tax on all imported fats and oils used in the United States. As a result of this agitation, coconut and other imported oils are now subjected to excise or processing taxes, and to taxes on oleomargarine containing foreign oils. In the Revenue Act of 1934 the United States imposed a tax of

5 cents on coconut oil coming from foreign countries and 3 cents on Philippine coconut oil. As a result of the imposition of this tax, cottonseed oil, which is a domestic product, is being used increasingly in the manufacture of oleomargarine. The effects of the tax on oleomargarine to equalize competition with butter cannot be determined accurately, and the author points out that it would tend not to equalize competition but to distort it further.

Those who have preconceived ideas about protecting the butter industry by imposing taxes and other restrictions on the manufacture of oleomargarine would do well to examine this important work on the subject. There is a good bibliography with court decisions at the end of the book.—A. V. C.

Ceramic Data Book Featuring Equipment and Materials Catalogs, Also Buyer's Directory. 10th ed. Chicago, Industrial Publications, Inc., 1938. 292 pp., illus. Price, $5.

As stated in the foreword, this book is "the engineering and purchasing handbook of the ceramic and clay products industries. It is published annually and distributed to all plants in these industries, with the sole purpose of placing accurate, up-to-date information before the operating executives in a handy and readily available form."

The book is divided into three sections. The catalog section contains the buyers' directory, and equipment and materials. The editorial section includes a review of important developments in the glass, enamel, whiteware, clay products, and refractories industries. The handbook and data section gives a compilation of tables, charts, definitions, and data that ceramic manufacturers and technologists have frequent occasion to use. The book has a detailed index at the end. The index to firms represented in the catalog section is at the front of the book. A list of books on the subject is given at the back.—F. D. M.

Qualitative Analysis and Chemical Equilibrium. By T. R. Hogness and Warren C. Johnson. New York, Henry Holt and Company, c1937. 417 pp., illus. Price, $2.75.

This book is an important addition to the long list of qualitative chemistry textbooks.

It gives a brief yet clear exposition of the properties of solids, liquids, and solutions which are necessary for the proper understanding of reactions in solutions. The schematic and graphical treatment of certain points, as polarity of molecules, law of mass action, and the like, is very effective. The emphasis on chemical equilibrium and experimental technique involving the use of small quantities of substances fills the modern need in modern qualitative work for reorientation as regards subject matter and object. The procedure differs from the system of Fresenius only in that it starts with the soluble group.

The trend in analysis of using small amounts of materials should be welcomed, as it is conducive to rapid analytical work; also care and neatness in the carrying out of procedures. It still remains to be seen, however, whether the change from the micro- to semimicro technique is desirable for elementary courses.

The book may be suitable as a textbook for students who have taken a brief course, say a semester, of general chemistry.

—F. L. R.

Basic German for Science Students with Vocabulary and English Translations of the German Passages. By M. L. Barker. 3d. ed. Cambridge, England, W. Heffer & Sons Ltd., 1937. 186 pp. Price, 6s.

This book is primarily designed for "reading knowledge" of German or ability "to give in English the gist" of writings in German on scientific subjects. It appears that all that is required for this ability is knowledge of German grammar reduced to an "absolute minimum" and familiarity with "a vocabulary of approximately 650 of the first thousand basic German words."

Part 1 consists of general passages, with six introductory lessons and exercises covering the special "grammar" study regarded as necessary. The plan of each lesson is consistent. At the head of each lesson come a few verses from chapter 1 of Genesis, the first "general passage," with the German and English texts opposite each other on the same page. In the selection of the basic vocabulary from the verse passages the arrangement is identical in all lessons. First are listed nouns, then verbs, prepositions, adjectives, and miscellaneous words; the nouns are given with their articles in all forms and the verbs are classified and presented with their principal parts. The grammar is essentially functional, in that it is based on actual usage. Besides this functional grammar there is a section on "word order." At the end of each lesson is an exercise on vocabulary and grammar. Here the student is required to translate simple English sentences into German or to decline nouns with articles and attributes. The other general passages deal with the history of civilization. An English translation of each selection is given on the opposite page. These texts are selected from the standpoint of chronology, completeness, and interest. Professor

Barker believes that his general passages contain the required basic vocabulary or "those words which are actually of most frequent occurrence in the writings of the German people."

Part 2 is a collection of extracts of writings in German in the various scientific fields including chemistry, zoölogy, botany, physics, mathematics, and medicine. As in Part 1, the English translation of each passage is printed on the opposite page, and the basic vocabulary is collected at the foot of the page in the order of appearance in the text. In both Parts 1 and 2 the total number of basic German words listed is approximately 1372. It may be pointed out that the alphabetical glossary at the end of the book is much fuller than the listed "basic vocabulary."

On the whole, I believe, the book will serve its purpose. The method of selecting the basic vocabulary seems logical, and perhaps adequate. However, the sufficiency of the "reduced" grammar, I am inclined to think, is open to question. Though the points of grammar considered may be adequate as far as they go, still much may be lacking even for "reading knowledge." There is hardly anything on participial construction, and there is very little on sentence structure and word composition. Because of the conciseness of these forms, German scientists use them constantly in their writings. Familiarity with these forms is essential to a student who wishes to translate scientific German with facility and accuracy.

Finally the ready accessibility of the English versions of the texts may develop the line of least resistance in the student. Instead of stimulating learning, the English translation may entirely do away with the effort to learn, or induce the student to take too many things for granted. From a pedagogical point of view the "Appendices" containing German passages set in certain examinations given in English universities may result in greater learning power as exercises in retranslation. In my experience vocabulary building means constant use of the dictionary by the student.—E. N.

Wind-Pressure on Buildings. Experimental Researches. By J. O. V. Irminger and Chr. Nøkkentved. Translated from the Danish by Alexander C. Jarvis and C. Brødsgaard. First and Second Series. København, Denmarks Naturvidenskabelige Samfund, 1930, 1936. 2 vols., illus., plans, diagrams. Price, 20 Kr.

The first book contains records of experiments conducted on bodies subjected to air current in a wind tunnel designed for the purpose. The descriptions of the apparatus used and the description of the tunnel itself, together with the necessary accessories and connections, are given in detail and with photographs. The results of pressure measurements made at different points of the models are given in graphical form. The various shapes subjected to air current consist of plane surfaces and solids. Circular discs varying in diameter from 50 to 70 cm and rectangles and triangles of various dimensions were used. Among the solids used were spheres varying in diameter from 50 to 100 cm, cylinders of from 6 to 40 cm diameter, and prisms, pyramids, cones, and cubes of different dimensions.

In the second book are contained studies on models of partly open buildings and of buildings without any walls, and screens with and without perforations which were subjected not only to air current produced in the wind tunnel but also to natural wind. The authors made stream-field measurements in addition to pressure measurements. Photographic records of stream lines around the models are given. An Appendix giving the mathematical treatment of the results of the investigations upon stream fields surrounding buildings is included.

With the exception of this mathematical appendix, the books can be easily understood by average readers.—C. A. O.

THE PHILIPPINE JOURNAL OF SCIENCE

VOL. 67 NOVEMBER, 1938 No. 3

PHILIPPINE DIPTEROCARPACEÆ, III

By F. W. FOXWORTHY
Of Berkeley, California

NINE PLATES

Twenty years have passed since the last paper of this series[1] was published. During that time a number of collections, notably the fine series of collections by A. Loher, have been added to those in the herbarium of the Bureau of Science (now the Philippine National Herbarium). There has also been a great deal of study of the group in the Malayan region. It seems appropriate, at this time, to give a recapitulation of the work done and to indicate the present understanding of the Philippine species.

Dr. E. Quisumbing, curator of the Philippine National Herbarium, has kindly made most of the Philippine collections available for this work; and acknowledgment is made to him and to the Philippine Government for the loan of herbarium specimens. Gratitude is also expressed to the herbarium of the University of California, at Berkeley, for aid and provision of a place to do the work.

Published records of work done during the past twenty years are extensive. The list of publications dealing with the Dipterocarpaceæ appended to this paper contains only those of more general application. Other publications are mentioned in the notes about the different species.

A number of articles in publications of the Philippine Bureau of Forestry, the Philippine Bureau of Science, and elsewhere,

[1] Philip. Journ. Sci. § C 13 (1918) 163–200.

have dealt more or less completely with the uses and the distribution of various species. Some of these articles are mentioned in the notes for different species.

This large amount of work has added greatly to our understanding of the distribution of this family and of specific characteristics. It has changed our conception of some species and has made it desirable to reclassify and redescribe many of the forms.

The quantitative importance of the family has often been stressed. The timber has been extensively exploited. The largest part of the timber used in the Islands has been produced by members of this family. The average annual export of timber has, for twenty years, been more than 50,000,000 board feet, most of it dipterocarp. It seems probable that the family will continue to supply most of the timber of the Archipelago.

Merrill's publication called attention to the close relationship of the Philippine Dipterocarpaceæ to those of western Malaysia, and indicated their probable derivation from that region through former land connection with Borneo. Since the publication of his paper one species has been found which is a representative of the eastern Malaysian element. The species is *Vatica papuana* Dyer, which is also found in eastern Borneo, the Moluccas, and New Guinea. The fruits are water-borne, which accounts for the wide distribution of this species. The only other Philippine dipterocarp that shows close relationship to forms of eastern Malaysia is *Anisoptera thurifera* (Blco.) Bl., which seems to be closely related to *A. polyandra* Bl., of New Guinea. All of the other Philippine members of the family seem to be most closely related to forms found in western Malaysia. Fifteen species, which are not endemic, have their extra-Philippine distribution in western Malaysia.

Within the Philippines the distribution of the dipterocarps seems to be conditioned by the distribution of rainfall. Those parts of the Islands with no, or only a very short, dry season, have by far the greatest number of species. The parts that have a distinct dry season have extensive dipterocarp forests, with a relatively small number of species. Only a few species are known exclusively from the regions with a distinct dry season, and these species are represented by but few collections.

Fifty-one species are now recognized as occurring in the Philippines. Five species have been described as new, and additional material has made it possible to complete the description of eight other species. In no less than 19 of the species it has been impossible to complete the description, for lack of complete material. Seven of these species lack fruit and 12 lack flowering material. Additional collections may cause us to change our notions of some of the species, and it is probable that additional species will be found. A great deal of additional collecting is needed.

Key to the Philippine genera of the Dipterocarpaceæ.

a^1. Calyx urceolate, tnclosing fruit; 2 sepals growing out into long wings. Stamens usually more than 20, anthers long-awned. Style on a large, fleshy stylopodium.
- b^1. Fruit not grown together with calyx, stamens many, styles filamentous; stipules amplexicaul .... 1. *Dipterocarpus.*
- b^2. Fruit grown together with calyx. Stipules small, fugacious. Stamens 25 to 60; style short........ 2. *Anisoptera.*

a^2. Calyx imbricate in bud, in the ripe fruit usually 2 or 3 lobes larger than the others, developing into long wings. Stamens mostly 15, sometimes many, rarely 10. Appendage to connective usually long-pointed.
- b^1. Long wings not more than 2.
  - c^1. Two long wings, appendage to connective long-pointed. Usually a large stylopodium .... 3. *Hopea.*
  - c^2. Lobes of fruiting calyx short, not extending beyond fruit.
    - d^1. Calyx lobes not recurved, otherwise as in *Hopea.* 4. *Balanocarpus.*
    - d^2. Calyx lobes round and recurved, stamens 30 to 60 (§ 2. *Isoptera*). 6. *Shorea.*
- b^2. Long wings 3 or more.
  - c^1. Fruit with 3 long wings.
    - d^1. Anthers with 5 pointed projections........ 5. *Pentacme.*
    - d^2. Anthers with one projection from the connective, or without projections .... 6. *Shorea.*
  - c^2. Fruit with 5 long wings; calyx in bud almost valvate; no stylopodium .... 7. *Parashorea.*

a^3. Calyx valvate in bud; fruit usually with 2 long wings. Stamens 15. Anthers short, oval, smooth; appendage to connective blunt. 8. *Vatica.*

1. Genus DIPTEROCARPUS Gaertner, f.

Large trees with long, clear boles and rather thin, light-colored, resinous, scurfy bark.[2] Bark usually less than 2.5 cm

[2] Thick, dark-colored, and deeply fissured bark, such as is found in *D. obtusifolius* Miq. and in other species growing in similar situations, is not found in any of the Philippine species. The thick bark in *D. obtusifolius*, *D. intricatus*, and some other forms in Siam and Burma, seems to be suited to resistance to the frequent ground fires. The Philippine forms all belong to the wet tropical evergreen forest.

thick, gray or light brown, covered with scattered corky pustules, shedding in irregular scroll-work patches; middle bark brownish, more or less fibrous, distinctly brittle; inside of the bark of same pale or yellowish color as sapwood, darkening on exposure to air. The bark contains quantities of fluid resin, which flows out and thickens after a cut. All of the Philippine species seem to have the same type of bark. Stipules large, semiamplexicaul, when falling leaving conspicuous, obliquely-ascending scars completely encircling the twig. Twigs terminated by stipular scales, which are usually large and become very much enlarged and elongated before they are pushed off by the expanding new leaves. These stipular scales may, in some instances, grow to a length of 30 cm or more. They are usually light-colored, sometimes pink, inside, and they are found on the ground in great numbers just after the appearance of new leaves. It seems that their removal involves the formation of a corky layer, which is what renders the stipular scar so prominent and persistent. Leaves coriaceous when mature, seedling leaves membranaceous; usually entire but sometimes retuse or even dentate (as young leaves of *D. grandiflorus*); secondary nerves mostly straight, joined by parallel and reticulate tertiary nerves. In bud, the two halves of the leaf folded upon each other, folds between two secondary nerves, in most species, clearly seen in the mature leaf, in some cases tertiary nerves showing an angle along line of fold. Twigs with outer part of pith containing a large number of resin canals, which are arranged in a circle, or in two concentric circles, and number sometimes as many as 100; the freshly cut twig usually shows the location of these, even without the aid of a lens, by the circle of resin that oozes out. The wood of all species is practically identical in structure; in weight, hardness, and color the differences between various species seem to be no greater than those found within individuals of the same species growing in different places. All species of this genus are locally called *apitong*. A detailed description of the wood has been given by Reyes.[3] Flowers large, in few-flowered racemes which are sometimes branched. Receptacle concave, continued into a campanulate, tubular, or obconical tube, the segments of which are valvate or slightly imbricate in bud, unequal in size, two segments longer. The calyx tube in the flower does not give any indication of the section of the genus to which

[3] Philip. Journ. Sci. 22 (1923) 320–322.

the species belongs; moreover, members of the section *Sphærales* may show as distinctly ridged floral calyces as members of the section *Alati*. Petals at base often cohering, but not connate. Stamens usually many, sometimes only 15, anthers sometimes twisted; valves generally equal, connective prolonged into a long-pointed acumen. Ovary generally hairy, continued into a conical, fleshy stylopodium, terminating in a filiform style and a minute stigma. Tube of fruiting calyx not adnate to fruit, globose or ovoid, smooth or with five ribs or wings alternating with segments and formed by decurrent margins of segments, two of which develop into large membranous or coriaceous wings. Pericarp thin at base, thick and fibrous in upper portion. Mature seed often albuminous, in this case the cotyledons thin, folded, often lobed. When in the mature seed all albumen has been consumed, the cotyledons are intricately folded. The hypocotyl (radicle) is generally short.

Size and form of trees.—All Philippine species are of large size and similar form, and a single characterization will serve for the group. They are very large straight trees with relatively small crowns and a high form factor. From the standpoint of utilization they are the best-shaped trees of the group. Buttresses are small or absent. The total height is often more than 45 m, and trees as high as 55 m are not uncommon. Mature trees are often more than 30 m to the first branch. The average diameter is about 65 cm, and trees with a diameter of 180 cm have been found. The crown is roughly flat conical or irregular, open, and made up of a few large branches. Sapwood is usually present in only small amounts in large trees.

Fruits with more than the normal two long wings have occasionally been found. I have already recorded [4] abnormal fruits for *Dipterocarpus grandiflorus* from Negros and suggested that they might be due to hybridization. Young saplings occasionally have leaves different from those of the mature tree. In a few cases, as already mentioned for *D. grandiflorus*, the sapling leaves are sometimes distinctly dentate. There are also, with some species, normal sapling or seedling leaves very different in size, shape, and texture from those of the mature tree.

Flowering and fruiting.—Flowering time is more constant than in any of the other genera thus far observed. It seems that all species sufficiently observed flower every year. Flowering time may vary for different species and for different

[4] Philip. Journ. Sci. § C 6 (1911) 252, pl. 36.

individuals in the same species; but, within a given locality, certain trees seem to flower at nearly the same time year after year. Flowers are borne in very great profusion. They are light-colored and pleasantly scented, during the short time that they last, often making the whole forest fragrant. Most of the Philippine species have flowers 3 cm or more in diameter. The fruit is ripe in three to five months after the flowers appear and is borne in very great quantity, often almost completely covering the ground near big trees, and some fruits are distributed to a distance of quite a number of meters by the action of the wind. The forest floor is always very moist, and germination takes place within a very few days after the seed reaches the ground. If this were not the case, reproduction would be very difficult, because large numbers of seeds, sometimes the whole crop, are destroyed by insects. Sometimes, probably because of prevailing high humidity, seeds germinate before falling from the tree.

Germination and growth.—Burkill [5] studied in detail the germination of a number of the species occurring in the Malay Peninsula (including *Dipterocarpus grandiflorus* and *D. Kerrii*), and in giving the results of his work at Singapore says: [5]

> The flower of *Dipterocarpus* usually, it seems, faces earthwards; and after flowering is done, the growing fruit maintains the position. When the fruit is ripe it falls as a shuttle-cock to the floor of the forest and there without delay germinates. The embryo, at fruitfall, and if normal, has the placentar cotyledon enwrapped more or less completely by the other, the radicle extruding slightly, from the basal lobes that the cotyledons possess, or just covered by them . . . The apices of the cotyledons in the genus not uncommonly abut against a small lump of resin which acts as ballast when the fruits fall . . . After reaching the ground the radicle is extruded from the apex of the fruit without any well-defined cracks spreading down the fruit-wall; it is thrust out by the elongation of the petioles of the cotyledons, and growing, exhausts the cotyledons of the nutriment stored in them, without the development in them of any visible change. They do not part in any way nor develop chlorophyll. Their elaborate folding is a consequence of their size. Their surfaces, which are morphologically upper surfaces, are very even. *Dipterocarpus* produces after the cotyledons first a pair, and then alternating leaves, the first of the alternating leaves is not crowded on the pair.

All species studied have had the same type of germination; that is, hypogeous, the cotyledons remaining in the seed and not being raised from the ground.

[5] Journ. Roy. Asiat. Soc. Straits Branch.

The leaves formed during the first year's growth are smaller than those of the mature tree. Leaves formed in subsequent years are larger, and saplings of several years' growth may have leaves much larger than those of the mature tree, and usually of thinner texture. Young seedlings often develop a taproot when they are only a few centimeters high. Young plants require a good deal of protection until they are a meter high or higher. The mature tree is very exacting in its demand for light and must get its crown into full light. Tall seedlings and young saplings are able to push their heads up through vegetation at a most surprising rate, so that it is possible to stock fully an area with a much smaller number of seedlings than is necessary with most other forms, and to insure the clean, straight trunk with a high form factor, which means that the relative amount of clear timber per tree is very large. It also accounts for the marked freedom from clinging climbers.

Brown and Matthews [6] have given some growth records for *D. gracilis* and *D. grandiflorus*. Some species may grow more rapidly than these records indicate. There may be a long suppression period after which, however, growth is probably fairly rapid.

Pests.—Growing plants seem to have comparatively few enemies. Insect galls are occasionally found on twigs and leaves, but they are rarely developed enough to do much damage. The most serious attack is on the fruits, and is sometimes severe enough to destroy most of the crop. These attacks seem to be the most serious of limiting factors in the natural regeneration of the species of *Dipterocarpus*. Fungus attack seems to do relatively little damage to living trees, except in the case of hollow heart in overmature trees.

Products.—The wood is much the most important product, and its structure, already mentioned, has been studied in several of the species. Oleoresin, the oil locally called *balau*, is of little present commercial importance. A. P. West and W. H. Brown have given a detailed account of this product.[7]

Common names.—The name *apitong* is applied to *Dipterocarpus grandiflorus* and to certain other species. The wood of different species is not distinguished commercially, and as the

[6] Philippine dipterocarp forests. Philip. Journ. Sci. § A 9 (1914) 413–561.

[7] For. Bur. Bull. 22 2 (1921) 54–66, figs. 15–22.

name *apitong* is applied to all that is exported, it has become fairly generalized for various species of *Dipterocarpus*. *Panao* is the name applied to *D. gracilis* in many places, and also to other forms; *balau* is a variant of this name. *Anahaun, kamuyao, malapaho,* and *pagsahiñgan* are also commonly used names in various places. *Hagakhak* is the name most commonly applied to the forms with hairy leaves that grow in alluvial soil.

Distribution.—Apitong is one of the most abundant Philippine woods, apparently constituting, by volume, as much as 20 per cent of all the timber grown in the Islands. It probably occurs in all the good forests and is found under a wide range of soil conditions. A particular species may be exacting in its demands, but there are species adapted to most of the soil conditions of the Philippines. Some species occur in low flat forest, while certain others are ridge forms. The altitudinal range is from sea level up to about 1,800 meters, but usually below 1,000 meters.

The genus contains about 70 species, and reaches its best development in the Malayan region—Borneo with 31 species, Sumatra with 20, and the Malay Peninsula with 24, having the largest representation.

Of the 11 species now recognized as Philippine, 6 have extra-Philippine distribution, 6 extend to Borneo, 4 to Sumatra, 3 to the Malay Peninsula, and 2 each to lower Burma, lower Siam, and Java. Of the 5 species now classed as endemic, 4 are known only from scanty or incomplete material.

Divisions of the genus.—Fruiting material is essential for specific determination in this group Leaves of practically identical appearance may be found in species belonging to different sections of the genus. The flowers have not ordinarily been found a convenient or reliable basis for specific distinction.

The genus was divided into sections by Dyer on the basis of the form of the fruit and fruiting calyx. This distinction is an arrangement of convenience and may not necessarily indicate natural relationships; but it is the best so far proposed. There is often difference of opinion as to the section in which certain species should be placed. There is a considerable amount of variation, and, while most species fall readily into definite sections, the wide variation or the different degree of development of the fruit may cause difficulty in determining whether a particular form belongs to the *Sphaerales* or the *Tuberculati*, or whether another form belongs to the *Angulati* or to the *Alati*.

Key to the Philippine species of Dipterocarpus.

a^1. Tube of fruiting calyx smooth (§ 1. *Sphærales*).
- b^1. Leaves strongly pubescent or tomentose .... 1. *D. gracilis*.
- b^2. Leaves usually glabrous, or not tomentose.
  - c^1. Leaves small, long-caudate-acuminate .... 5. *D. caudatus*.
  - c^2. Leaves not long-caudate-acuminate.
    - d^1. Fruiting calyx tube turbinate .... 3. *D. Kerrii*.
    - d^2. Fruiting calyx tube globose, subglobose, or ellipsoid.
      - e^1. Leaves with 10 to 12 pairs of nerves, 10 to 20 cm long; fruit 2 cm in diameter .... 2. *D. Hasseltii*.
      - e^2. Leaves with 14 to 18 pairs of nerves, 9 to 11 cm long; fruit 1 cm in diameter .... 4. *D. subalpinus*.

a^2. Tube of fruiting calyx with 5 protuberances on its upper portion (§ 2. *Tuberculati*) .... 6. *D. Warburgii*.

a^3. Tube of fruiting calyx 5-angular, at least in the upper portion, with more or less conspicuous ridges (§ 3. *Angulati*). 7. *D. basilanicus*.

a^4. Tube of fruiting calyx with 5 wings from top to base or to middle only (§ 4. *Alati*).
- b^1. Leaves orbicular or suborbicular .... 10. *D. orbicularis*.
- b^2. Leaves not orbicular or suborbicular.
  - c^1. Twigs with distinct velvety annuli below stipule scars; fruit woody. 9. *D. speciosus*.
  - c^2. Twigs without such annuli; fruit not woody.
    - d^1. Leaves glabrous .... 8. *D. grandiflorus*.
    - d^2. Leaves strongly pubescent .... 11. *D. philippinensis*.

Section 1. SPHÆRALES

Tube of fruiting calyx smooth, globose, oblately spheroidal, conical, or obconical, never angular.

1. **DIPTEROCARPUS GRACILIS Blume. Agan-an (Bicol); anahaun (Bicol, Tag.); apitong (Tag.); balau (Tag., Sul., Chab.); bulai (Tag.); duha (Ibn.); duka (Klng., Cag.); ganan (Bicol); kalusuban (Ilk.); kamuyao (Cag., Ibn.); kurimau (Ibn); lalian (Tag.); lanutan (Neg.); lauaan (Nueva Ecija); lipot (Mbo.); lipus (Vis., Mbo.); malapaho (Tag.); mantolina (Zamb., Sul.); pagsahiñgan (Tag.); palanopang (Tag.) palohap (Sbl.); pamalalian (Cag., Ibn.); pamantulen (Ilk.); pamantuling (Pang.); pamarnisen (Ibn.); panao (Tag., Pang., Sbl., Ibn., Pamp.); patsahiñgan (Tag.); sitam (Ibn.).**

Dipterocarpus gracilis BLUME, Bijd. 5 (1825) 224; Fl. Jav. 2 (1828–1829) 20, *pl. 5;* VAN SLOOTEN, Bull. Jard. Bot. Buitenz. III 8 (1927) 276.

Mocanera verniciflua BLANCO, Fl. Filip. (1837) 451.

Dipterocarpus vernicifluus BLANCO, Fl. Filip. ed. 2 (1845) 314; ed. 3 2 (1878) 217, *pl. 183;* DYER, Journ. Bot. 12 (1874) 104; A. DC. Prodr. 16^2 (1868) 610; VIDAL, Sinopsis Atlas (1883) xiv, *pl. 14, fig. b;* Rev. Pl. Vasc. Filip. (1886) 59; BRANDIS, Journ. Linn. Soc. Bot. 31 (1895) 31; MERRILL, Philip. Journ. Sci. 1 (1906) Suppl. 97; Sp. Blancoanae (1918) 268; Enum. Phil. Fl. Pl. 3 (1923) 91; MERRILL & ROLFE, Philip. Journ. Sci. § C 3 (1908) 114; MERRITT, Philip. For. Bur. Bull. 8 (1908) 48; WHITFORD, Philip. Journ. Sci.

§ C 4 (1910) 703; Philip. For. Bur. Bull. 10[2] (1911) 70, *pls, 70, 71;* FOXWORTHY, Philip. Journ. Sci. § C 2 (1907) 391; § C 4 (1909) 514; § C 6 (1911) 248; § C 13 (1918) 177; REYES, Philip. Journ. Sci. 22 (1923) 321, *pl. 12.*

Dipterocarpus fulvus BL., Mus. Bot. 2 (1852) 37.

Anisoptera palembanica MIQ., Fl. Ind. Bat. (1860–1862) 191, 485.

Dipterocarpus lampongus SCHEFF., Nat. Tijdsch. Ned. Ind. 31 (1870) 346.

Dipterocarpus velutinus VIDAL, Rev. Pl. Vasc. Filip. (1886) 59.

Dipterocarpus bancanus BURCK., Ann. Jard. Bot. Buitenz. 6 (1887) 196.

Dipterocarpus Vanderhoevenii KOORD. et Val., Bull. Inst. Bot. Buitenz. 2 (1899) 3.

Shorea mollis BOERL., Cat. Hort. Bog. 2 (1901) 110.

Dipterocarpus gracilis has been very fully described by Van Slooten, and the following is adapted from his work.

All young parts tomentose with small tufts of short hairs intermixed with long ones, pubescence dark-colored, sometimes fugacious. Stipules up to 6 cm long and 6 to 8 mm wide. Leaves ovate to oblong-elliptic, 8 to 15 cm long, 4 to 10 cm wide, usually acuminate at apex, acumen sometimes 1 cm long, rounded at base, upper surface, at any rate when young, covered with long pilose hairs, lower surface tomentose with stellate hairs, brownish when dry; secondary nerves 9 to 16 pairs, curved near the margin and forming more or less conspicuous intramarginal veins, with a number of short intermediate nerves, soon without internerval folds; petioles 2 to 3.5 cm long. Inflorescences simple or branched, 3 to 9-flowered, 3 to 10 cm long; peduncles 1.5 to 4 cm long; bracts stellate, pubescent, oblong-lanceolate, 3 cm long. Flowers light-colored, fragrant, 0.5 to 1 cm apart; bracteoles linear, 15 mm long, 1 to 2 mm wide. Calyx tube subinfundibuliform, very slightly angular, tomentose outside, glabrous inside, about 1 cm long, short-pedicelled; larger calyx lobes linear, up to 1.5 cm long, 2 to 3 mm wide, the smaller ones rotund. Petals obliquely linear-spatulate, obtuse, about 4 cm long. Stamens about 30, 12 to 15 mm long; filaments, anthers, and appendages to connective each 4 to 5 mm long; anthers sagittate at base. Stylopodium ovate, attenuate at top, densely pilose; style 2 cm long, hairy below, glabrous above. Tube of fruiting-calyx subglobose or broadly ovate, rounded at base, sparsely pubescent with stellate hairs, or nearly glabrous, at most 2 cm long and wide; wings oblong-lanceolate, 11 to 15 cm long, 2 to 3.5 cm wide, obtuse or rounded, with slightly recurved margins at base, or flat, often subuninerved, sometimes 3-nerved, lateral nerves then running up to or beyond middle, sparsely pubescent with stellate hairs; smaller wings suborbicular or suboblong, 1 to 1.5 cm long and wide, recurved or concave. Nut oviform, up to 2.5 cm long, 1.5 to 1.75 cm in diameter, narrowed toward apex; densely minutely pubescent with the very base adnate to thin-walled tube of fruiting calyx, top not extending as far as ends of minor lobes.

The species usually occurs in well-drained soil, from sea level up to 800 meters. It seems to be commonest on the sides of ridges and is especially abundant in the regions where the dry season is pronounced.

Most workers on Philippine botany have used Blanco's name, *Dipterocarpus vernicifluus*, for this species. Merrill[8] in 1923 continued to use this name, but indicated that the species was possibly referable to *D. gracilis*. Van Slooten in 1927 showed that the Philippine form belongs to that species, which he gave a very careful description.

The type of Blume's *Dipterocarpus fulvus* was collected by Perottet near Manila in 1819. This is the earliest collection recorded of a dipterocarp species in the Philippines.

Dipterocarpus is widely distributed, from central Sumatra through Java and Borneo to the Philippines. It is one of the most abundant and widely distributed species in the Islands. The most common name for it is *panao*, and its wood is used commercially under the name of *apitong*.

About 125 collections in the herbarium show the following distribution:

LUZON, Cagayan, Isabela, Ilocos Sur, Nueva Vizcaya, Nueva Ecija, Pangasinan, Bulacan, Pampanga, Zambales, Bataan, Rizal, Laguna, Tayabas, Camarines, and Albay Provinces. POLILLO. MARINDUQUE. MINDORO. NEGROS, Negros Occidental Province. MINDANAO, Surigao, Davao, Cotabato, and Zamboanga Provinces. PALAWAN.

2. **DIPTEROCARPUS HASSELTII Blume. Apitong, balao (Pal.); alakak, oladan (Tagb.).**

Dipterocarpus Hasseltii BLUME, Fl. Jav. 2 (1828–1829) 22, *pl. 6*; KORTHALS, Verh. Nat. Ges. Bot. ("Kruidkunde") (1839–1842) 65; MIQUEL, Fl. Ind. Bat. 1^2 (1859) 497; Annales 3 (1867) 85; A. DC., Prodr. 16^2 (1868) 609; BURCK., Ann. Jard. Bot. Buitenz. 6 (1887) 196; BRANDIS, Journ. Linn. Soc. Bot. 31 (1895) 30; KOORDERS and VALETON, Bijd. v. Booms. Java (1900) 109; KOORDERS, Exk.

[8] Loc. cit.

Fl. 2 (1912) 620; F. BAKER, in Forbes's Mal. Pl. Journ. Bot. 62 (1924) 10; CRAIB, Fl. Siam. Enum. 1 (1925) 135; VAN SLOOTEN, Bull. Jard. Bot. Buitenz. III 8 (1927) 280.

Dipterocarpus quinquegona BL., Mus. Bot. 2 (1852) 36.

Dipterocarpus pentagona A. DC., Prodr. 16² (1868) 610.

Dipterocarpus balsamifera BL., Mus. Bot. 2 (1852) 37.

Dipterocarpus balsamifera KOORDERS and VALETON, Bijd. v. Booms. Java (1900) 111.

Dipterocarpus trinervis Auct. non Bl., FOXWORTHY, Philip. Journ. Sci. § C 6 (1911) 247; § C 13 (1918) 177; MERRILL, Enum. Philip. Fl. Pl. 3 (1923) 91.

Description adapted from Van Slooten: All vegetative parts entirely glabrous, underside of leaves often excepted. Stipules up to 12 cm long, 1 cm wide. Leaves of adult tree ovate or ovate-elliptic, 14 to 20 cm long, 8 to 12 cm wide, obtuse, upper surface at first clothed with long, adpressed, shining hairs, soon glabrous, lower surface on nerves very sparsely covered with a fine pubescence, whether or not intermixed with thin tufts of long, adpressed hairs, often entirely glabrous, repand, with 10 to 12 pairs of nerves, curved near margin, preserving for a long time internerval folds; leaves of sapling oblong-lanceolate, 25 to 32 cm long, 9 to 12 cm wide, acuminate, acumen blunt, 1 to 1.5 cm long, with about 20 pairs of nerves; petioles slender, glabrous, 3 to 5 cm long. Inflorescences simple or rarely branching, often very slender, 5- to 8-flowered, short ones 2- to 4-flowered, 8 to 15 cm long; peduncles 2.5 to 3.5 cm long; bracts of inflorescence up to 6 cm long, rather membranaceous; bracts of flowers a few mm long, base very wide. Flowers 1.5 to 2.5 cm apart, yellowish white, rose-colored inside, fragrant. Calyx tube campanulate-obconic, 11 to 13 mm long, glabrous outside except on margin, lower half of inner side glabrous, upper half densely covered by minute tufts of fine hairs, like both sides of calyx lobes; calyx lobes at base 5 to 6 mm wide, longer ones 1.5 to 2 cm, shorter ones 2 mm long. Petals 5.5 to 6.5 cm long, 1 to 1.5 cm wide. Stamens 30, 15 to 18 mm long; filaments, anthers, and prolonged connectives 5 to 6 mm long. Stylopodium oviform, narrowed into style, densely pubescent; style 15 mm long, upper third glabrous, for the rest pubescent like stylopodium. Tube of fruiting calyx subglobose or slightly pyriform, glabrous, marked by brownish points, 2 to 2.5 cm long, 2.5 cm wide, strongly constricted at top, forming a narrow neck 5 to 10 mm high. Accrescent calyx lobes linear-oblong to obovate-lanceolate, 12 to 20 cm long, 2.5 to 4 cm wide, obtuse or rounded, sprinkled with minute tufts of short hairs or glabrous, with 3 principal nerves usually running up to top and 2 lateral nerves ramified close to base; minor lobes rotund, 1.33 to 2 cm long, 1 to 1.33 cm wide. Nut ovate or conic when dry, diameter 2 cm, from the very base attenuate towards the acute top, densely covered with tawny shiny pubescence, slightly or not at all exceeding mouth of calyx tube.

TYPE: *Van Hasselt,* in H. L. B. *sub No. 902, 146-210* and *146-211,* in H. A. R. T. *sub. No. 72499,* collected in Java in 1823.

Dipterocarpus Hasseltii is found in lowland forest, usually below 500 m.

Van Slooten, after careful study of the type and extensive collections from the Netherlands Indies, prepared a careful description of the species. It is apparent, as he has indicated, that we who have worked on the group in the Philippines have misinterpreted the species. He has indicated the following collections from Palawan as belonging here: *Elmer 13172,* and *For. Bur. 29194 Cenabre* and *29107 Cenabre.* It is evident that *For Bur. 12272 Wallace, 27863 Cenabre, Gellidon & Paras,* and *30138 Cenabre & Ablasa,* all from Palawan, also belong here. Besides these, *For. Bur. 10195 Curran,* from Tayabas Province, and *13573 Meyer & Foxworthy* from Negros, are referred here with doubt, as they are sterile specimens. Thus the only Philippine distribution of this species that can be determined with certainty is Palawan. Some of this material was formerly, mistakenly, referred to *Dipterocarpus trinervis,* a species which seems not to occur in the Philippines. All of the Philippine material that has been referred to *D. trinervis* belongs to *D. Hasseltii;* the Philippine material formerly credited by me to *D. Hasseltii* must be placed in other species.

Dipterocarpus Hasseltii has a rather wide distribution and is recorded from Java, the Malay Peninsula, Sumatra, and Borneo.

3. **DIPTEROCARPUS KERRII** King. Apitong, panao, palsahiñgan.

Dipterocarpus Kerrii KING, Journ. Asiat. Soc. Bengal 62[2] (1893) 93; BRANDIS, Journ. Linn. Soc. Bot. 31 (1895) 28; RIDLEY, Fl. Mal. Penin. 1 (1922) 215; CRAIB, Fl. Siam. Enum. 1 (1925) 136; VAN SLOOTEN, Bull. Jard. Bot. Buitenz. III 8 (1927) 295; BURKILL, Journ. Str. Br. R. As. Soc. 81 (1920) 55; PARKER, Ind. For. Rec. 16[1] (1931) 15, *pl. 10;* FOXWORTHY, Mal. For. Rec. 10 (1932) 69.

Dipterocarpus obconicus FOXWORTHY, Leafl. Philip. Bot. 6 (1913) 1951; Philip. Journ. Sci. § C 13 (1918) 178; MERRILL, Enum. Philip. Fl. Pl. 3 (1923) 90; VAN SLOOTEN, Bull. Jard. Bot. Buitenz. III 8 (1927) 299.

Dipterocarpus perturbinatus FOXWORTHY, Philip. Journ. Sci. § C 13 (1918) 177.

Dipterocarpus cuneatus FOXWORTHY, Philip. Journ. Sci. § C 13 (1918) 178; MERRILL, Enum. Philip. Fl. Pl. 3 (1923) 89.

Description as given by King:

All parts, except the petals, glabrous; young branches thin, slightly flattened at the tips. Buds narrow, cylindric. Leaves coriaceous, ovate-elliptic, acute or very shortly and bluntly acuminate, the edges undulate, the base cuneate; main nerves 8 to 11 pairs, oblique, straight, bold, and shining on the lower surface; length 7.5–10 cm., breadth 5–6.3 cm., petiole 2–3 cm. Panicles short, spreading, few-flowered. Flowers 3.8 cm. long. Calyx-tube glaucous. Petals linear-oblong, obtuse, more or less pubescent or tomentose towards their middle externally. Fruit turbinate, smooth, 2.5–3.8 cm. in diam.; accrescent calyx-lobes linear-oblong blunt, reticulate, 3-nerved, 11–12.5 cm. long and 32–38 mm. broad; minor lobes very short, broad, rounded.

TYPE: specimens collected in Malacca: *Maingay 199; Griffith 727; Derry 1032.*

A large tree of lowland forest, from sea level up to 400 m altitude or more, often growing on the slopes of ridges.

Dipterocarpus Kerrii is distinguished from *D. Hasseltii* by the turbinate fruit and the smaller leaves, which are usually cuneate at the base and have less distinct internerval folds. There is variation in size and shape of fruits and leaves, and large-fruited forms may be almost indistinguishable from *D. Hasseltii*. *D. Kerrii* and *D. Hasseltii* have often been confused, and Brandis recorded the specimen collected by Derry (*1032*) under *D. Hasseltii,* although it was one of the numbers cited by King with the original description of this species.

Mr. Symington, examining the Philippine material, noted that the material classified under *D. cuneatus, D. obconicus,* and *D. perturbinatus* seemed to belong to this species; and, I believe that this view is correct.

The following Philippine collections seem to belong here: LUZON, Cagayan Province, *Bur. Sci. 78239 Edaño:* Nueva Ecija Province, *For. Bur. 22145 Alvarez;* Laguna Province *For. Bur. 10105 Curran, 19261 Curran:* Tayabas Province, *For. Bur. 3223 Hagger, 12500 Rosenbluth, 28341* (type of *D. perturbinatus* Foxworthy in the Philippine National Herbarium), *28361 Mabésa:* Camarines Province, *For. Bur. 21469* (type of *D. cuneatus* Foxworthy in the Philippine National Herbarium), *21703 Miránda:* Albay Province, *Cuming 881.* MINDORO, *Bur. Sci. 40873 Ramos.* SAMAR, *For. Bur. 25933 Cortez.* MINDANAO, Agusan Province, *Elmer 13498* (type of *D. obconicus* Foxworthy in the Philippine National Herbarium): Davao Province, *For. Bur. 27705 Angeles and Seloris.*

Some of the above material had previously been credited by me to *D. Hasseltii* and some to other species now reduced to synonymy.

The species, as at present understood, occurs from Burma and peninsular Siam, through the Malay Peninsula and Sumatra to the Philippines.

4. **DIPTEROCARPUS SUBALPINUS** Foxworthy.

Dipterocarpus subalpinus FOXWORTHY, Leafl. Philip. Bot. 6 (1913) 950; Philip. Journ. Sci. § C 13 (1918) 177.

Large tree. Leaves coriaceous, elliptic-oblong, acuminate, base subcuneate or rounded, glabrous except for scattered stellate hairs along midrib above and along secondary nerves beneath, 4 to 11 cm long, 2.7 to 7 cm broad; secondary nerves 14 to 16 pairs; petiole 15 to 22 mm long. Flowers unknown. Fruit about 9 to 13 mm in diameter and 9 to 13 mm tall; long calyx wings 8.5 to 12 cm long and 14 to 22 mm wide; short wings erect or only slightly recurved, 7 to 8 mm long, 6 to 9 mm wide.

MINDANAO, Agusan Province, Cabadbaran, Mount Urdaneta, *Elmer 13931* (type in the Philippine National Herbarium), August, 1912.

The collector's field notes state:

Leaves chartaceous, conduplicate on the upper much deeper green and lucid side, much paler beneath; infrutescence axillary or lateral, few inches long, the zigzag yellowish green subpendent stalks few-branched; fruits pendant, the nut portion subglaucous green, their calyx lobes reddish margined; the 2 ruber to purpureus ears only slightly curved, the exserted or apical portion of the seed yellowish.

Dipterocarpus subalpinus is found at from sea level up to an altitude of over 300 m.

Dipterocarpus subalpinus, D. Hasseltii and *D. gracilis* are very closely related. *D. gracilis* and *D. subalpinus* have the same kind of fruit; *D. Hasseltii* and *D. subalpinus* agree in having glabrous, or nearly glabrous, buds. The leaves of *D. subalpinus* are generally smaller than those of *D. gracilis,* and the number of secondary nerves is usually greater than in *D. Hasseltii.* The three short wings of the fruit of *D. subalpinus* are also shorter than is the case in *D. Hasseltii,* and are not expanded or reflexed as is usually the case in that species. Merrill[9] reduced this form to synonymy with *D. Hasseltii,* an arrangement which is not correct, for the reasons given above.

[9] Tom. cit., p. 90.

Dipterocarpus subalpinus is known only from the Philippines and is represented by the following collections:

LUZON, Cagayan Province, *For. Bur. 16947, 17211, 17780 Curran:* Ilocos Norte Province, *For Bur. 13922, 13925–13927, Merritt and Darling:* Nueva Viscaya Province, *For. Bur. 28507 Cenabre in part:* Laguna Province, *For. Bur. 15348 Tamesis:* Tayabas Province, *For. Bur. 31274 Arizabal:* Camarines Province, *For Bur. 21718 Peñas, Soriano and Cebellanosa.* LEYTE, *Bur. Sci. 12739 Rosenbluth.* BILIRAN, *Bur Sci. 18487 McGregor.* MINDANAO, Zamboanga Province, *For. Bur. 22007, 23837 Villamil, 22761 Nave.* A number of collections are not recorded here because of incomplete material.

5. DIPTEROCARPUS CAUDATUS Foxworthy. Apitong.

Dipterocarpus caudatus FOXWORTHY, Philip. Journ. Sci. § C **13** (1918) 177; § C **6** (1911) 250; MERRILL, Enum. Philip. Fl. Pl. **3** (1923) 89; VAN SLOOTEN, Bull. Jard. Bot. Buitenz. III **8** (1927) 302, 303.

Large tree. Leaves long caudate-acuminate, glabrous, elliptic, cuneate at base, 9 to 13 cm long, 2.5 to 5 cm wide, secondary nerves about 10 pairs; the long-caudate acumen about 1.5 cm long. Petiole 1.1 to 1.5 cm long. Stipules linear, ferruginous-pilose. Fruit globose.

LUZON, Camarines Province, Bo. Hibatac, *For. Bur. 21193 Alvarez* (type in the Philippine National Herbarium), March 28, 1914.

The material consists of leaves and very old and very young fruits picked up from the ground under the tree. It is too incomplete to permit of detailed description of the fruit. The long-caudate, small leaves remain the characteristic feature.

Said to occur on ridges at from 200 to 600 meters above sea level.

The three collections listed with the original description were from Camarines and Albay Provinces. No further material of this imperfectly known species has been collected, and its complete description will have to wait until better material is available.

Section 2. TUBERCULATI

Tube of fruiting calyx with 5 protuberances in the upper portion.

6. DIPTEROCARPUS WARBURGII Brandis. Hagakhak.

Dipterocarpus Warburgii BRANDIS, Journ. Linn. Soc. Bot. **31** (1895) 32; FOXWORTHY, Leafl. Philip. Bot. **6** (1913) 1952; Philip. Journ.

Sci. § C 13 (1918) 178; MERRILL, Enum. Philip. Fl. Pl. 3 (1923) 91; VAN SLOOTEN, Bull. Jard. Bot. Buitenz. III 8 (1927) 305.

Dipterocarpus pilosus Auct. non Roxb.; F.-VILL., Noviss. App. (1880) 20; VIDAL, Synopsis Atlas (1883) xv, *pl. 14, fig. c;* FOXWORTHY, Philip. Journ. Sci. § C 6 (1911) 244, *pl. 34;* § C 13 (1918) 176.

Dipterocarpus affinis BRANDIS, Journ. Linn. Soc. Bot. 31 (1895) 31; VIDAL, Synopsis Atlas (1883) *pl. 4, fig. d;* WHITFORD, Philip. For. Bur. Bull. 10[2] (1911) 70, *pls. 72, 73;* FOXWORTHY, Philip. Journ. Sci. § C 6 (1911) 246, *pl. 35;* § C 13 (1918) 176; MERRILL, Enum. Philip. Fl. Pl. 3 (1923) 88.

Dipterocarpus lasiopodus PERKINS, Frag. Fl. Philip. (1904) 22; MERRILL, Govt. Lab. Publ. 29 (1905) 30; Enum. Philip. Fl. Pl. 3 (1923) 90; REYES, Philip. Journ. Sci. 22 (1923) 322, *pl. 13.*

Dipterocarpus caudifera MERRILL, Philip. Journ. Sci. 29 (1926) 398; VAN SLOOTEN, Bull. Jard. Bot. Buitenz. III 8 (1927) 302.

Dipterocarpus macrorhina VAN SLOOTEN, Bull. Jard. Bot. Buitenz. III 8 (1927) 300.

Dipterocarpus Woodii MERRILL, Philip. Journ. Sci. 29 (1926) 398; VAN SLOOTEN, Bull. Jard. Bot. Buitenz. III 8 (1927) 303.

The most complete description is given by Van Slooten and is as follows:

Buds, young *branches, petioles, peduncles* and lowest parts of the axes of inflorescences densely covered with long, coarse, spreading or adpressed reddish brown but sordidescent tufted hairs. *Stipules* up to 24 cm. long. *Leaves* ovate, ovate-oblong or oblong-elliptic, 20–25 cm. long, 8–12 cm. wide, obtuse or acuminate, the acumen ½–1 cm. long, rounded or (sub) cordate at the base, repand, both sides glabrous, the lower surface clothed with long adpressed hairs along the midrib and 20–25 pairs of slightly prominent nerves, which originate rather close (± 1 cm.) to each other and are curved near the margin, without forming intramarginal veins, the internerval folds finally disappearing; *leaves* of sapling (± 2 m. in height) 40–50 cm. long, 14–16 cm. wide, nerves in 28–32 pairs, acumen 2–3 cm. long; *petioles* robust, 3–5 cm. long, glabrescent, in *sapling* 1½–2 cm. long. *Calyx-tube* narrowly campanulate, subcylindric, entirely glabrous as are the larger lobes, the latter being 2 cm. long, ± 3 mm. wide in bud. *Petals* yellowish green tomentose in bud when dry. *Infrutescences* simple, bearing 6–7 fruits, 10–15 cm. long; the axes robust, glabrous or the lower parts coarsely hairy as are the peduncles, which are 2–4 cm. long; the fruits placed 2–3 cm. from each other. Tube of the *fruiting-calyx* variously shaped; oviform, subglobose or obovate, the upper portion with or without small obtuse rounded protuberances (the hollows being filled up and the fruit becoming nearly spherical often a long time before the fruit ripens, in which case only a trace of the tubercles remains), with a narrow neck formed by the bases of the lobes, glabrous, 3–4 cm. long, 2½–3 cm. wide; accrescent calyx-lobes obovate-lanceolate or lanceolate, obtuse, constricted at the rounded base, with 3 principal nerves running up to the very top, glabrous, 14–15 cm. long, 3–5, cm. wide; minor lobes rotundate, folded, ½–1 cm. long. *Nut* oviform, ± 3 cm. long, tapering towards the top, at the base broadly rounded, covered with a fine tawny pubescence in the upper half, for the rest glabrous, with the very base adnate to the tube and with the apex equalling the ends of the minor lobes or overtopping these by ½–1 cm.

TYPE: *Warburg 14431*, from Davao Province, Mindanao.

I formerly thought that this form belonged to *Dipterocarpus pilosus* Roxb., a very imperfectly known species, which, as shown by the work of Parker,[10] seems not to be this species. This leaves *D. Warburgii* as the first adequately described form. *D. lasiopodus* Perkins is plainly the same species. *D. affinis* Brandis, described without fruit, seems to be the same, although the leaves are described as submembranous. I believe that the leaves so described were from an immature specimen, and that it comes within the range of variability of this species. Collections which I referred to *D. affinis* have fruit of a type representative of § *Tuberculati*. *D. caudifera, D. macrorhina*, and *D. Woodii* are reduced to synonomy on the basis of the comments by Van Slooten.[11]

The fruit, as indicated in the description, shows considerable variability in the amount of development of the tubercles, and it is sometimes difficult to determine the section of the genus to which it belongs. The pubescence, on twigs and petioles, is the heaviest found in any of the Philippine members of the family.

The tree grows to a large size and is gregarious. It is found from sea level (in one case it is recorded as being in black sand on the upper part of the beach) up to an altitude of about 300 m. It is usually on the flat land of stream valleys or on the lower slopes of ridges. It is perhaps most often found on alluvial soil, usually in tolerably well-drained situations. A few collections were said to have been made from limestone hills, and one was recorded as from swampy land. It often forms the bulk of the stand where it occurs.

A species of the nonseasonal part of the islands, recorded from:

LUZON, Cagayan, Isabela, Nueva Ecija, Rizal, Tayabas, and Camarines Provinces. MARINDUQUE. MINDORO. NEGROS, Occidental Negros Province. PANAY, Capiz and Iloilo Provinces. LEYTE. SAMAR. MINDANAO, Agusan, Surigao, Davao and Zamboanga Provinces. BASILAN.

Also widely distributed in Borneo.

[10] Indian Forest Records XVI 1 (1931).

[11] Tom. cit., p. 302, footnote.

Section 3. ANGULATI

Tube of fruiting calyx pentangular.

7. **DIPTEROCARPUS BASILANICUS** Foxworthy. Apitong.

Dipterocarpus basilanicus FOXWORTHY, Philip. Journ. Sci. § C **13** (1918) 179; MERRILL, Enum. Philip. Fl. Pl. **3** (1923) 88.

A tree 40 to 60 m tall and up to 130 cm in diameter. Leaves and twigs finer than in most Philippine species. Leaves chartaceous, elliptic, with acuminate apex and cuneate base; underside of leaves and young twigs pubescent. Terminal buds clothed with long, pilose, silky hairs. Secondary nerves 13 to 15 pairs. Leaves 6 to 11 cm long, 2 to 5.5 cm wide. Fruit 5-angled, 15 to 18 mm long and of about the same diameter. Angles of fruit more or less distinctly developed into wings, but thick and hard. Long wings of fruiting calyx 8 to 9 cm long, 1.5 to 2 cm wide, oblong-elliptic, with 3 distinct longitudinal nerves.

BASILAN, Mount Basilan, *For. Bur. 18895 Miranda* (type in the Philippine National Herbarium), August 28, 1912, at an elevation of 500 to 600 m. The wood is said to be harder than in most other Philippine species and to be used for general construction. Other collections seem to indicate that this is a lowland form. It is known with certainty only from Basilan. A sterile specimen, *For. Bur. 25962 Cortes,* from Samar, may belong here, but it cannot be definitely determined from the material available.

Dipterocarpus basilanicus differs from *D. fagineus* Vesque, of the Malay Peninsula and Borneo, in having slightly smaller fruits, which are more sharply angled, and in the more scantily developed venation of the fruit wings.

Tube of fruiting calyx with 5 straight wings.

Section 4. ALATI

Tube of fruiting calyx with 5 straight wings.

8. **DIPTEROCARPUS GRANDIFLORUS** Blanco. Apitong (Tag.); kanyin (Burm.); mai yang (Siam.); keruing (Mal.).

Dipterocarpus grandiflorus BLANCO, Fl. Filip. ed. 2 (1845) 314; ed. 3 2 (1878) 218, *pl. 263;* FOXWORTHY, Philip. Journ. Sci. § C **6** (1911) 251, *pl. 36;* § C **13** (1918) 179; Mal. For. Rec. **10** (1932) 87; MERRILL, Bibl. Enum. Born. Pl. (1921) 398; Enum. Philip. Fl. Pl. **3** (1923) 89; RIDLEY, Fl. Mal. Penin. **1** (1922) 216; REYES, Philip. Journ. Sci. 22 (1923) 321, *pl. 11;* VAN SLOOTEN, Bull. Jard. Bot. Buitenz. III **8** (1927) 333; CRAIB, Fl. Siam. Enum. **1** (1925) 134.
Mocanera grandiflora BLCO., Fl. Filip. (1837) 451.
Dipterocarpus Blancoi BLUME, Mus. Bot. **2** (1852) 35.

Anisoptera ? TURCZ., Bull. Soc. Nat. Moscou 31[1] (1858) 233.
Dipterocarpus Motleyanus HOOKER f., Trans. Linn. Soc. 23 (1860) 159.
Dipterocarpus Griffithii MIQUEL, Ann. 1 (1863–1864) 213.
Dipterocarpus pterygocalyx SCHEFF., Nat. Tijdschr. Ned. Ind. 31 (1870) 347.

Buds covered with a dense indumentum of very minute stellate, light-brown or grayish hairs; stipular bud scales greatly elongated before dropping. Branches and petioles usually glabrous and blackish when dry, or tawny pubescent and glabrescent. Leaves ovate or ovate-elliptic, elliptic when young, 15 to 38 cm long, 8 to 18 cm wide, rounded, subcordate or cordate at base, attenuate towards rounded obtuse or obtusely acuminate top, entire or obscurely repand-crenate, both sides glabrous, with 12 to 20 pairs of nerves, flat; petioles very long, 5 to 9 cm. Inflorescences very slender, glabrous, up to 26 cm long, often bifurcate, 2- to 5-flowered when simple; peduncle 4 to 8.5 cm long; flowers large, placed at distances of 3.5 to 6 cm from each other. Calyx 5-winged from base to apex. Petals up to 7.5 cm long. Stamens 30. Tube of the fruiting calyx oblong, 5 to 6 cm long, wings stout, usually 1.5 to 2, rarely 3 cm wide; accrescent calyx lobes oblong, obtuse, glabrous, 3-nerved, the 2 lateral principal nerves differing in length in different specimens, 14 to 25 cm long, 3.5 to 5.5 cm wide; smaller lobes suborbicular, 1.5 to 2 cm in diameter.

Though very variable in many respects (pubescence of buds and young branches, size of fruits and of leaves), this species is well characterized by the shape of its leaves, its long petioles, very slender, few-flowered inflorescences, and by the size and shape of its fruits, which are among the largest in the genus.

Usually a tree of low hills and ridges up to 600 m above sea level. Usually gregarious, often constituting a considerable part of the volume of the forest. The flowers, which are usually borne in dry weather, are very conspicuous and fragrant, and scent the whole forest when they expand. They are white or cream-colored, with a rosy tinge inside, on the lower part of the petals. Fruit is borne in very great quantity, and a very large part of it germinates.

Abnormalities of fruit and leaves are found where this form occurs with *D. speciosus*, as in Negros; it is believed that natural hybridization is taking place.

A good deal of oleoresin is found in the wood of this species, which is the principal source of the oil known as *balau*.

Dipterocarpus grandiflorus seems to be the most widely distributed species of the family, being found from the Andaman Islands and the Mergui Archipelago, through lower Burma, Siam, the Malay Peninsula, and the Netherlands Indies (except Java and the eastern part), to the Philippine Islands. This range is included between 20° north latitude and 7° south latitude, and between 105° and 125° east longitude.

As in Blanco's other species, no type specimen exists; but the species is very well known, and characteristic specimens may be found in most of the larger herbaria.

Recorded distribution in the Philippines (*fide* Merrill) is: LUZON, in all provinces between Cagayan and Sorsogon. MINDORO. PALAWAN. SIBUYAN. BILIRAN. PANAY. NEGROS. SAMAR. MINDANAO, Agusan and Misamis Provinces.

9. DIPTEROCARPUS SPECIOSUS Brandis. Anahauon (Bicol); apitong (Bicol, P. Bis., Sulu); balau (Ilk.); hagakhak (Ibn., Tag.); panalsalan (Bicol).

Dipterocarpus speciosus BRANDIS, Journ. Linn. Soc. Bot. **31** (1895) 38; FOXWORTHY, Philip. Journ. Sci. § C **6** (1911) 250, *pl. 37;* § C **13** (1918) 178; PERKINS, Fragm. Fl. Philip. (1904) 22; WHITFORD, Philip. Bur. For. Bull. **10**[2] (1911) 70; MERRILL, Enum. Philip. Fl. Pl. **3** (1923) 90.

Young branchlets covered with long, fasciculate, fuscous, stellate hairs. Leaves chartaceous, short-petiolate, oblong-elliptic, with scattered, very short stellate hairs on the midrib beneath, 15 to 27.5 cm long; petiole 18 mm long; secondary nerves 18 pairs; tertiary nerves parallel and reticulate. Flowers unknown. Fruit turbinate, with 5 thick rigid wings.

BASILAN, *Vidal 2160* (*type*).

Our material has petioles longer than those described for the species; but the petioles of *D. grandiflorus* and related forms seem to show considerable variation in length. Brandis says, "Differs from *D. grandiflorus* in the short petioles, the tomentum of long hairs on young shoots, and the thick, not membranous, edge of the fruit-wings."

The thick edge of the fruit wings is the most striking feature. There is a considerable range of variation from an exceedingly heavy and woody fruit where the wings are reduced to ridges, to a condition where the wings are almost as membranous as in *D. grandiflorus*. The species can be placed in either *Angulati* or *Alati*, according to the texture of the ridges or wings of the fruit. It is usually placed in the latter section.

Where these two species occur in the same locality there seem to be intergrades; and it is believed that natural hybridization takes place.

There are usually broad, tawny annuli below the stipule scars. This feature has heretofore been considered peculiar to *D. Kunstleri* King; C. F. Symington, who has examined the Philippine material, places it under that species, which has heretofore been known from the Malay Peninsula, Sumatra, and Bangka. The two may be identical, in which case *D. Kunstleri* would be the preferred name; but I do not make the reduction, because none of the Philippine collections are in flower, and the large flowers of *D. Kunstleri* are so distinct that flowering material is needed before reduction can safely be made.

A number of the collections have leaves bearing some resemblance to those of *D. Warburgii*, and further collections will be needed to determine the limits of the two species.

Distribution in the Philippines:

LUZON, Cagayan, Isabela, Tayabas, and Albay Provinces. POLILLO. NEGROS. SAMAR. BASILAN. Most of the collections are rather incomplete, and it may be necessary to change our notions of the distribution when more complete material is available.

10. DIPTEROCARPUS ORBICULARIS Foxworthy.

Dipterocarpus orbicularis FOXWORTHY, Philip. Journ. Sci. § C 13 (1918) 180; MERRILL, Enum. Phil. Fl. Pl. 3 (1923) 90; VAN SLOOTEN, Bull. Jard. Bot. Buitenz. III 8 (1927) 266, 324.

A large tree with brownish tomentum on twigs, petioles, and underside of leaves. Leaves mostly suborbicular, some obovate, 9 to 22 cm long, 6 to 11 cm wide, with crenulate margins; apex shortly and very bluntly acuminate; base rounded or cuneate; secondary nerves 9 to 12 pairs; tertiary nerves parallel and reticulate; petioles 2.5 to 3.5 cm long. Twigs, buds, petioles, and margins of leaves densely covered with long pilose hairs; upper side of leaf glabrous, except for a few scattered hairs along veins; lower surface very thickly covered with large stellate hairs, many of which are along the tertiary nerves; secondary nerves and midrib for the most part, clothed, with pilose hairs and uniting near margin with a fine intramarginal vein of almost the same size as the tertiary nerves and united with them. Van Slooten mentions that there is, "a very long, slender inflorescence and broadly winged calyx tubes. Fruit (immature) with membranous wings as in *D. grandiflorus*."

LUZON, Camarines Sur Province, Lagonoy, *For. Bur. 21719 Peñas, Soriano, and Abellanosa* (type in the Philippine National Herbarium), April 26, 1914. The species is known only from imperfect material from Camarines and from British North Borneo. It is most closely related to *D. conferta* V. Sl., of Borneo, and *D. rotundifolia* Foxw. and *D. concava* Foxw., of the Malay Peninsula. It differs from the first by its fewer-nerved leaves, laxer inflorescence, and definitely winged fruit; from *D. rotundifolia* by its pubescent leaves and winged fruit; and from *D. concava* by its flat leaves and pilose pubescence.

11. **DIPTEROCARPUS PHILIPPINENSIS** Foxworthy. Ayamban (Ilk.).

Dipterocarpus philippinensis FOXWORTHY, Philip. Journ. Sci. § C 6 (1911) 253, *pl. 38;* § C 13 (1918) 179; MERRILL, Enum. Philip. Fl. Pl. 3 (1923) 90.

A large tree, 30 m tall and 75 cm in diameter. Fruit winged, leaves similar to those of *D. gracilis.* Mature leaf (picked up under tree) 19 cm long, 11 to 12 cm wide, ovate-lanceolate, acute, entire, base truncate; secondary nerves 18 pairs; tertiary nerves parallel, reticulate, with stellate hairs; petiole 5 cm long. Young shoots and seedling leaves ferruginous hairy, exceedingly like the same parts in *D. gracilis.* Fruits much the size and shape of that of *D. marginatus,* but more constricted at the top and with ridges produced into membranous wings, as in *D. grandiflorus.* Fruit 3 to 3.5 cm long, 2 to 2.5 cm in diameter, the two long wings 15 to 17 cm long, 25 to 28 mm wide.

LUZON, Bataan Province, Limay, *For. Bur. 12395 Merritt & Curran* (type in the Philippine National Herbarium), August 27, 1908. The type consists of three mature fruits, two young seedlings, and one adult leaf, picked up under the parent tree. As always where the material is picked under the tree, there is question of the accuracy of the diagnosis, although in this case the collectors are known to be very careful.

The species was again collected in Abra Province, Luzon, in April, 1919, *For. Bur. 27444 Gonzales.* As before, the material consists of fruit and leaves picked up under the tree.

2. Genus ANISOPTERA Korthals

Always large trees, with good clear length of bole and distinct buttresses. Young shoots, inflorescences, and underside of leaves clothed with tufts of stellate hairs and minute round scales varying in color from yellow to cinnamon brown; scales may be few, in these cases the leaf appears to be almost or quite glabrous, unless examined with a lens. Stipules small, early deciduous. Flowers in much-branched, axillary and terminal, many-flowered panicles, racemes not unilateral; bracteoles early deciduous. Calyx lobes usually imbricate and unequal, 2 of them obtuse, the 3 others acute. Petals usually twisted in bud, membranaceous, many-nerved, outside minutely hairy on parts which are uncovered in bud. Stamens 25 to 50, in 2 to 3 whorls, glabrous in all parts, usually persistent in fruit; anthers unequal, one pair of cells much smaller than the other pair; connective prolonged into a long awn, as long as or longer than anther and filament together. Ovary half, or more than half, sunken in receptacle, with well-developed, fleshy, persistent stylopodium that is crowned by 3 short styles which cohere closely, without well-differentiated stigmas. Fruiting calyx tube adnate to and nearly enclosing fruit; the 2 large segments flat at base, with 3 prominent longitudinal nerves; the 3 small segments 1- to 3-nerved. Cotyledons very evidently unequal.

Bark.—Bark light or dark gray, sometimes with a brownish tinge, shallowly and irregularly longitudinally fissured, shedding in irregular thin pieces. Bark thick, sometimes 18 to 22 mm, made up of a number of alternating yellow and white layers, the former hard and fibrous, the latter soft. Inside of bark yellow, like the sapwood. Surface with numerous corky pustules. Trees in the open may be very light-colored, while those in dense forest may, on a wet day, appear to be almost black.

Wood.—Sapwood and heartwood distinct, the former very pale yellow or whitish, the latter yellow. The wood of all species is practically identical in structure and appearance, and is known in the market by the name of *palosapis*. The description of the wood, taken from Schneider [12] is as follows:

Wood soft and light to moderately hard and moderately heavy, sp. gr. 0.39 to 0.59; sapwood 5–10 cm. thick, staining to dirty grey or brown in drying; heartwood yellowish with rose-colored streaks and blotches or evenly rose-colored; when seasoned, the color is pale yellow with reddish or light yellowish brown markings; slightly disagreeable odor when fresh; grain somewhat crossed; texture coarse; does not check much, but is liable to warp if not carefully seasoned; easy to work, but sometimes cutting roughly on the saw. Not durable in contact with the ground. Subject to insect attack and rots quickly when placed in a wet situation. Makes good planks and has proved to be satisfactory in the manufacture of cupboards. A temporary construction timber. Pith rays numerous, very fine and moderately wide to wide, the latter very conspicuous; pores medium to large,

[12] Philip. For. Bur. Bull. 14 (1916) 162.

numerous, very evenly scattered; resin-canals rarely forming rings, resin content almost white; soft tissue conspicuous, forming minute dots and lines between the rays. The resin-canals often contain fluid resin which sometimes causes the freshly cut surface to be distinctly sticky.

Flowering and fruiting.—Flowers small, yellow or whitish, fragrant, borne in great quantity, lasting but for a short time. Apparently two or three months elapse from the first appearance of the flowers until the fruit is ripe; however, our observations as to the length of the flowering and fruiting times are scanty. Collections seem to indicate that flowers are usually borne in the latter part of the dry season.

Deciduous habit.—Whitford [13] states, "Trees in very dry situations may become entirely destitute of leaves for a few days."

Germination and growth.—Cotyledons very unequal, spreading horizontally on germination. Germination epigeous. First four leaves whorled; fifth leaf and all that follow alternate. First formed leaves smaller than those of mature tree. Saplings may have leaves larger and more acuminate than those of mature tree. Growth of seedlings seems to be slow.

The tree seems to have its best development where there is a distinct dry season; however, certain species do well in the nonseasonal part of the Philippines.

Pests.—Fruits very often destroyed by insects. Timber very subject to decay in wet places and to attacks of termites. Sapwood subject to attacks of shot-hole borers.

Products.—The wood is the principal product of this tree; its structure and uses have already been considered. The resin is of poor quality, relatively scanty in amount, and not used commercially. A certain amount of oleoresin is found in the sapwood, but is not used commercially.

Common names.—The wood of all of our species is known as *palosapis* or *mayapis*. The tree names are given with the descriptions of the different species.

Distribution.—Usually trees of lowland forest, and none of the Philippine species have been found at elevations of more than 750 meters. They are usually of scattered occurrence, ranking tenth in abundance of trees, and making up about 1.5 per cent of the volume of Philippine forests.

The genus seems to contain 12 to 15 species, distributed from Burma to New Guinea. It now seems that all of the Philippine species are endemic, although they are closely related to certain species of the Malayan region.

[13] Philip. Bur. For. Bull. 10 [2] (1911) 77.

Key to the Philippine species of Anisoptera.

a^1. Leaves green on both sides.
  b^1. Leaves 11.5 to 14.5 by 5.7 to 7 cm, with about 20 pairs of secondary nerves; flower clusters erect; flowers white; petals oblong or ovate; stamens 25 to 30 .... 1. *A. mindanensis.*
  b^2. Leaves usually smaller; flower clusters drooping; flowers yellow; petals lanceolate; stamens about 50.......... 2. *A. thurifera.*
a^2. Leaves of different color above and below.
  b^1. Leaves brown; stylopodium terete.......... 3. *A. brunnea.*
  b^2. Leaves golden yellow beneath; stylopodium sulcate.......... 4. *A. aurea.*

1. **ANISOPTERA MINDANENSIS Foxworthy. Palosapis (Zamb.).**

Anisoptera mindanensis FOXWORTHY, Philip. Journ. Sci. § C 13 (1918) 181; MERRILL, Enum. Philip. Fl. Pl. 3 (1923) 92.

A large tree. Leaves glabrous or nearly so, chartaceous, oblong-elliptic, 5.7 to 7 cm wide, 11.5 to 14.5 cm long; secondary nerves about 20 pairs, in lower half of leaf a number of short intermediate nerves; tertiary nerves very prominent, reticulate; secondary nerves anastomosing near slightly inrolled margin; petiole 18 to 20 mm long. Inflorescences paniculate, apparently terminal and erect, 17 to 18 cm long; peduncle and branches of inflorescence pubescent or tomentose, with scattered tufts of stellate hairs. Flowers spreading, about 1.5 cm in diameter, white, on stellate-pubescent pedicels 1 to 2 mm long. Sepals apparently all of same size, valvate, lanceolate, acute, covered outside with stellate tomentum, pubescent inside, 3 to 4 mm long and 1.5 to 2 mm wide at base. Petals broadly oblong or obovate, rounded at apex, glabrous, thin, up to 10 mm long and 6 mm wide, with 6 to 7 principal, branched, longitudinal nerves. Stamens about 25; filaments 0.3 to 0.4 mm long; anthers ellipsoid, one pair about 0.3 to 0.4 mm long, the other pair about 0.6 mm long; appendage to connective 1.5 to 2.5 mm long. Ovary sunken in receptacle; stylopodium large, almost cylindrical, deeply sulcate, pubescent, somewhat constricted just above base, 3.5 mm long, 1.5 mm in diameter at base, tapering at top and crowned by three slender styles, each about 0.4 mm long; stigmas minute. Fruit unknown.

MINDANAO, Zamboanga Province, Naganaga, *For. Bur. 21899 Villamil* (type in the Philippine National Herbarium), May 19, 1914. There were three other collections from the same section.

When the original description was published, I referred *For. Bur. 25937*, from Samar, to this species; but that collection consisted only of sterile material, and I now believe that it should have been referred to *A. thurifera.*

There have been, during the past twenty years, no further collections of this species of which the fruit is still unknown.

This species is distinct from other Philippine species by reason of its large, very distinctly veined leaves, its erect flowers, clusters, large white flowers, the oblong or obovate petals, the relatively small number of stamens, and the long, distinctly sulcate, stylopodium.

2. **ANISOPTERA THURIFERA (Blanco) Blume. Mayapis, palosapis, palohapi, dagang (S. E. Luzon).**

Anisoptera thurifera (Blanco) BLUME, Mus. Bot. Ludg.-Bat. 2 (1852) 42; VIDAL, Synopsis Atlas XV, *t. 14, fig. e;* BRANDIS, Journ. Linn. Soc. Bot. 31 (1895) 44; MERRILL & ROLFE, Philip. Journ. Sci. § C 3 (1908) 115; BRANDIS & GILG in Engler & Prantl, Nat. Pflanzenfam. 3^6 (1895) 258; MERRITT, Philip. Bur. For. Bull. 8 (1908) 48; WHITFORD, Philip. Journ. Sci. § C 4 (1910) 703; Philip. Bur. For. Bull. 10^2 (1911) 78, *pls. 82, 83;* FOXWORTHY, Philip. Journ. Sci. § C 6 (1911) 256; § C 13 (1918) 181; MERRILL, Sp. Blancoanae (1918) 269; Enum. Philip. Fl. Pl. 3 (1923) 92; REYES, Philip. Journ. Sci. 22 (1923) 323, *pl. 14;* VAN SLOOTEN, Bull. Jard. Bot. Buitenz. III 8 (1926) 4; SYMINGTON, S. S. Gard. Bull. 8 (1934) 18, *pl. 4, fig. c.*

Mocanera thurifera BLANCO, Fl. Filip. (1837) 446.

Mocanera mayapis BLANCO, Fl. Filip. (1837) 449.

Dipterocarpus thurifer BLANCO, Fl. Filip. ed. 2 (1845) 310; ed. 3 2 (1878) 212, *t. 264.*

Dipterocarpus mayapis BLANCO, Fl. Filip. ed. 2 (1845) 212, 310; DC. Prodr. 16^2 (1868) 610; DYER, Journ. Bot. 12 (1874) 108; BRANDIS, Journ. Linn. Soc. Bot. 31 (1895) 40.

Shorea mayapis BLUME, Mus. Bot. Ludg.-Bat. 2 (1852) 33.

Antherotriche lanceolata TURCZ., Bull. Soc. Nat. Mosc. 19^3 (1846) 505; WALP., Ann. 1 (1848) 113.

Anisoptera lanceolata WALP. *ex* DC. Prodr. 16^2 (1868) 616; VIDAL, Phan. Cuming Philip. (1885) 97; F.-VILL., Noviss. App. (1880) 20.

Anisoptera oblonga F.-VILL., Noviss. App. (1880) 20; VIDAL, Rev. Pl. Vasc. Philip. (1886) 60, *non* Dyer.

Anisoptera vidaliana BRANDIS, Journ. Linn. Soc. Bot. 31 (1895) 44; PERK., Frag. Fl. Philip. (1904) 23; MERRILL, Philip. Journ. Sci. 1 Suppl. (1906) 97.

Anisoptera tomentosa BRANDIS, Journ. Linn. Soc. Bot. 31 (1895) 45.

Anisoptera calophylla PERK., Frag. Fl. Philip. (1904) 22.

Large trees with clean straight boles and distinct buttresses. Bark thick, coarsely fissured, dark gray to almost black, pustulate; inner bark with alternate layers of hard and soft tissue, yellow. Leaves varying in texture from thinly chartaceous to coriaceous, green on both surfaces; elliptic, shortly acuminate, on long petioles; clothed below with fine round scales, which may be remote or closely crowded; secondary and tertiary nerves sometimes irregularly scurfy, large, branched stellate hairs often present along nerves, but their occurrence apparently very irregular; blade 8 to 13 cm long, 4 to 7 cm wide; petioles 3 to 4 cm long; secondary nerves 10 to 16 (or sometimes even 20) pairs, alternating with shorter intermediate nerves; tertiary nerves parallel, reticulate; sapling leaves narrower, long-acuminate. inflorescences axillary, terminal, drooping, up to 20 cm long; peduncle and branches tomentose, with scattered tufts of stellate hairs. Flowers yellow and fragrant, about 1.5 cm across when fully open; buds acuminate, about 7 to 8 mm long; pedicels about 2 mm long, tomentose, with tufts of stellate hairs. Sepals lanceolate, acute or obtuse, the 2 longer sepals about 2 mm long and obtuse at apex, the 3 smaller sepals about 1.5 mm long, acute at apex, tomentose outside with stellate hairs, pubescent inside, 0.5 to 0.6 mm wide at base. Petals spreading in anthesis, lanceolate, recurved at apex, twisted in bud, part exposed in bud pubescent, the rest glabrous, 8 to 9 mm long, 2 to 2.5 mm wide, with about 15 principal longitudinal nerves. Stamens about 50; filaments scarcely widened at base, 0.1 to 0.3 mm long; anthers ellipsoid, one pair twice as long as the other, 0.2 to 0.4 mm long, about 0.2 mm wide; appendage to connective filamentous, up to 1.5 mm long. Ovary partly sunken in receptacle, pubescent or tomentose, hemispherical, about 1 mm in diameter, 0.6 to 0.7 mm high, surmounted by the pubescent or tomentose stylopodium which is campanulate, about 1.5 mm high and 0.6 mm in diameter, narrowed to about 0.3 mm above ovary, narrowed above into the 3 pubescent styles which are 0.2 to 0.3 mm long, usually closely appressed; stigmas minute. Fruit globose, not much constricted at top, 4 to 15 mm in diameter; 2 long fruiting calyx wings 5 to 9 cm long, about 1 cm broad, with 3 prominent longitudinal nerves and numerous, more or less oblique, transverse nerves; the 3 short wings linear or linear-oblong, 2 to 3 cm long, 2 to 3 mm wide.

A tree of frequent, but scattered, occurrence in the lowland forest up to 600 to 750 m above sea level.

I formerly credited this species with a distribution into the Malay Peninsula and north to Burma, because *A. glabra* Kurz [= *A. scaphula* (Roxb.) Pierre] was believed to be a synonym. Symington [14] has shown this to be a mistake, and it now seems that *A. thurifera* is found only in the Philippines. Van Slooten [15] indicated that it is very close to *A. polyandra* Bl., of New Guinea, from which it differs in the rather larger

[14] Tom. cit., p. 4. [15] Tom. cit., p. 16.

leaves with more nerves, the greater number of stamens, and the form of the stylopodium.

The species has not been well understood; descriptions have been incomplete, and the older published illustrations were not entirely representative. Blanco's descriptions were not accompanied by herbarium material, so there is no type specimen. The first published illustration of the flower was in the 3d edition of the Flora Filipinas, published in 1878, plate 264, under the name *Dipterocarpus thurifer.* This plate does not show the characteristic forms of the ovary, stylopodium, and styles, and the number and forms of the stamens are not well shown. Vidal's illustration shows only the fruit. Brandis [16] shows a flower with the ovary cut open. This figure shows the stamens in three series; but the form of the ovary and stylopodium is not well represented and the styles (6) are more prominent than in the material that I have examined. Whitford's illustrations show the bark, leaves, and immature fruit. Recently (1934) Symington published excellent detailed drawings of the flowers. His drawings were made from the flowers of *For. Bur. 707,* a number which was not sent me for this work. My description was made from *Loher 5600,* collected in Rizal Province, Luzon, in May, 1904. There is a difference of opinion as to the number of styles, from 3 to 6 having been recorded. Symington says: "each style is readily divisible into two, a condition found in all the species of *Anisoptera* I have examined."

This is the commonest Philippine species of *Anisoptera* and is very widely distributed in the Archipelago. More than 150 collections in the Bureau of Science collection show the following distribution:

LUZON, Cagayan, Ilocos Norte, Ilocos Sur, Nueva Vizcaya, Abra, Nueva Ecija, Tarlac, Pangasinan, Bulacan, Zambales, Bataan, Rizal, Laguna, Camarines, and Albay Provinces. SIBUYAN. TICAO. MINDORO. PANAY, Capiz Province. NEGROS, Negros Occidental Province. MASBATE. BOHOL. CEBU. SAMAR. MINDANAO, Zamboanga Province.

This species is usually in flower in April, May, or June; but one collection of flowering material was made in October. Fruit has been found from June to April. It seems that flowers are usually borne during the dry season.

[16] Tom. cit., pl. 2, fig. 28.

In previous papers [17] I mentioned a form from Bataan Province that seemed to be intermediate between *A. thurifera* and *A. Curtisii* and had rather small leaves that were yellowish on the underside. It was represented by *For. Bur. 1377, 1381, 1390, 1407, 1792, 12921, 12923*, and *17515*. All of these were from the same locality, and most of them had immature fruit. Later collections, in flower, seem to indicate that these forms belong to *A. thurifera* and are within the natural range of variation of the species.

3. **ANISOPTERA BRUNNEA** Foxworthy. Afu.

Anisoptera brunnea FOXWORTHY, Philip. Journ. Sci. § C **6** (1911) 254, *pl. 40;* § C **13** (1918) 181; MERRILL, Enum. Philip. Fl. Pl. **3** (1923) 92.

Large trees. Leaves coriaceous, glabrous and dark green above, chocolate brown and pubescent or tomentose beneath, elliptic or oblanceolate, more or less blunt or rounded at apex and base, with margins slightly inrolled, 6 to 19 cm long, 3.5 to 9.7 cm wide, 12 to 17 pairs of secondary nerves, with intermediate shorter nerves joining the reticulate tertiary nerves, some of the nerves more or less uniting to form intramarginal veins; petioles 2 to 4.5 cm long, rather slender, thickened in upper fourth of their length. Inflorescences axillary or terminal, 7 to 15 cm long, suberect or drooping, rather sparsely flowered, peduncle and branches tomentose, with scattered stellate hairs. Flowers said to be yellow; mature bud acuminate, 7 to 8 mm long; expanded flower 1.5 cm in diameter; pedicels about 2.5 mm long, tomentose. Sepals, the 2 longer ones oblong, rounded at apex, 2.5 mm long, 1.5 mm wide at base, the 3 shorter sepals lanceolate-acuminate, 2 mm long and 1 mm wide at base, all tomentose on outside. Petals ovate, obtuse, 7 mm long, 2.5 to 3 mm wide, with 10 or more faint longitudinal nerves, pubescent or puberulous outside, glabrous within. Stamens about 40; filaments 0.2 to 0.3 mm long; anthers oblong, 0.4 to 0.6 mm long; appendage to connective filiform, 1 to 1.5 mm long. Ovary partly sunken in receptacle, constricted above, tomentose; stylopodium subcylindrical, tomentose, 1.5 mm high, 1 mm in diameter; styles pubescent, about 0.3 mm long; stigmas minute. Fruit globose, 1 to 1.5 cm in diameter, scurfy, dark brown. The two long wings somewhat pubescent, 5 to 8 cm long, 6 to 10 mm wide, with three or four principal nerves

[17] Philip. Journ. Sci. § C **6** (1911) 258; § C **13** (1918) 181.

and numerous secondary nerves, which are transverse or oblique and reticulate. The 3 short wings linear, 1- to 3-nerved, somewhat scurfy, like the fruit.

LUZON, Cagayan Province, Camalamugan, *For. Bur. 11292 Klemme* (type in the Philippine National Herbarium), April 26, 1908. The type was in fruit and the original description did not give an account of the flower, although one collection of flowering material was referred to it. The flowers were not described because the collection, *For. Bur. 13128,* had rather larger leaves than the type. Consideration of other collections has convinced me that there is a considerable range of variation in the leaves; therefore, the original description has been modified and the description of the flowers added. The flowers were described from *For. Bur. 12995,* collected in Cagayan Province in July, 1911.

This species differs from *A. thurifera* in the brown color of the underside of the leaves, the rather larger, globular fruit, the broader petals, the less dense flower clusters, and the rather stouter twigs.

It has been found principally in northern Luzon, in Cagayan and Ilocos Norte Provinces. A single collection from the Babuyanes Islands and one from Samar are also credited to this species.

4. ANISOPTERA AUREA Foxworthy sp. nov. Plates 1 and 2. Dugong, manapo, malahapi; dagang (Laguna, S. E. Luzon).

A. Curtisii FOXWORTHY, *non* Dyer, Philip. Journ. Sci. § C **6** (1911) 255; § C **13** (1918) 181; WHITFORD, Philip. For. Bur. Bull. **10**[2] (1911) 78, *pl. 41;* MERRILL, Enum. Philip. Fl. Pl. **3** (1923) 92; REYES, Philip. Journ. Sci. **22** (1923) 324, *pl. 15;* VAN SLOOTEN, Bull. Jard. Bot. Buitenz. III **8** (1926) 11; SYMINGTON, Gard. Bull. S. S. **8** (1934) 17.

A large tree, up to 40 m high and 1 m or more in diameter, crown conspicuous because of color of under side of leaves. Branchlets rather stout, densely clothed with a golden-yellow tomentum. Leaves oblong or elliptic, or sometimes obovate, narrowed to both ends, apex acute or shortly acuminate, base rounded, 7 to 15 cm long and 3 to 6 cm wide, glabrous and dark green above, with deeply depressed midrib, golden yellow beneath; secondary nerves 18 to 20 pairs, conspicuously looped toward margin, with occasional short intermediate veins, reticulations visible on both surfaces; petioles rugulose, scabrous, squamate, 2.5 to 3.5 cm long. Inflorescence terminal or axillary, 15 to 20 cm long, with numerous short branches, tomentose with numerous scattered tufts of stellate hairs, of same color as petioles and under side of leaves. Flowers greenish or whitish, fragrant, on 2 to 2.5 mm long tomentose pedicels. Sepals apparently valvate, of same length, lanceolate, tomentose outside and pubescent within, margins inrolled, about 3 mm long and 1.5 mm wide at base, bluntly acute at apex. Petals slightly twisted in bud, lanceolate, glabrous except where exposed in bud, 9 to 10 mm long, 2 to 2.3 mm wide at base, with 8 to 10 longitudinal nerves. Stamens about 40, attached to base of petals and along notched margin of gynœcium, persisting in fruit; filaments 0.2 to 0.3 mm long, slightly flattened at base; anthers of unequal size, one pair twice as long as the other, 0.2 to 0.6 mm long; appendage to connective filiform, 1 to 1.5 mm long. Ovary broad, rather flat, partly immersed in receptacle, tomentose, with edge indented where filaments occur, constricted above and surmounted by a rather keg-shaped tomentose stylopodium, which is sulcate and crowned by 4 to 5 spreading styles; stigmas minute; ovary about 1.2 mm in diameter, constricted portion about 0.5 mm in diameter; thickest part of stylopodium about 0.8 mm in diameter; styles 0.3 to 0.4 mm long, glabrous; total height of gynœcium about 2.5 mm. Fruit stalk 3 to 4 mm long, tomentose, with tufts of stellate hairs; calyx tube campanulate, adnate to $\frac{1}{2}$ to $\frac{2}{3}$ of the nut, about 6 to 8 mm in diameter, 8 to 10 mm high, tomentose when young; 2 large calyx lobes linear-spatulate, 8 to 12 cm long, 1 to 1.5 cm wide, pubescent when young, with scattered stellate hairs; 3 small lobes linear, acute, pubescent or tomentose, up to 3 cm long, 2 to 3 mm wide; nut tomentose, about $\frac{2}{3}$ enclosed in calyx cup, globular, about 1 cm in diameter, surmounted by part of stylopodium and styles.

LUZON, Tayabas Province, near Kabibihan, *For. Bur. 28359 Mabesa* (type of flowering specimen in the Philippine National Herbarium), June 6, 1918. The fruit was described from *For. Bur. 10700*, collected by H. M. Curran, in Camarines Province, Luzon, June, 1908.

Formerly, having only fruiting material, I considered this to be *A. Curtisii*, a Malayan species which it very much resembles; but Van Slooten and Symington have both expressed doubt as to the correctness of that identification. Additional material is now available and shows certain differences. I have now described it as a new species, the specific name having reference to the color of the underside of the leaves, the most conspicuous feature when the tree is seen in the field.

A. aurea is usually a tree of ridge forest, at from 100 to 600 m above sea level, and is known only from the part of the Archipelago having a nonseasonal climate.

The following collections are referred here:

LUZON, Laguna Province, *Bur. Sci. 8985*, in fruit (this specimen was not sent me), *For. Bur. 15353*, with fallen fruit and leaves: Tayabas Province, *For. Bur. 25654*, in flower, June, 1916; *31435*, in fruit, August, 1931; Camarines Province, *For. Bur. 10700*, in fruit, June, 1908; *12809*, *13358*, in fruit, July 1909; *18723*, *21128*, *21233*, *21725*, *30480*, flower and fruit, July, 1927; *30479*, fruit, July 1927. POLILLO, *For. Bur. 3218*, fruit, July, 1905; *26253*, *31429*, in fruit, July, 1931.

3. Genus HOPEA Roxburgh

Receptacle flat or slightly convex, bearing on its margin 5 imbricate calyx lobes. Stamens usually 15, regularly alternating in 3 whorls, the 5 outer and 5 inner standing opposite each other and alternating with the petals, the 5 of the middle row episepalous. Anther cells of equal length. Filaments broadened towards base, connective prolonged into a long awn. Styles of most species on a large fleshy stylopodium that, like the ovary, is smooth or only slightly hairy. In a small number of species there is no distinct stylopodium, and in these cases the style is usually long-filamentous, often with a circle of hairs at the base. The two outer lobes of fruiting calyx developed into long wings. Pericarp thin-walled. Seed-coat very delicate. Hypocotyl long, half as long, often as long as seed, point of attachment of cotyledons therefore in middle or at base of seed. Cotyledons thick, fleshy, deeply 2-lobed, mostly unequal, placentar cotyledon usually surrounded by the other. Cells of cotyledons usually filled with starch.

Large or medium-sized trees, some species growing gregariously, heartwood yellowish brown. Leaves usually coriaceous and smooth, stipules usually small and fugaceous. Flowers sessile or short-stalked, in 1-sided racemes, these joined in axillary or terminal panicles. In some species calyx and branches of inflorescence smooth, in others thickly hairy.

Bark thin or rather thick, smooth or longitudinally fissured. Dark-colored pyramids of bast fibers always distinct in inner part of bark. There is never any large development of sclerenchyma layers as in *Anisoptera* and some species of *Shorea*. The inside of the bark is usually yellow and darkens on exposure to the air. There is often a pale greenish or olive line at the junction of wood and bark.

The species of this genus are usually trees of medium or large size, although they do not reach the proportions of the large species of *Dipterocarpus* and *Shorea*, and their boles show a greater amount of taper.

Flowering and fruiting.—None of our species are known to have a regular fruiting period, although it is believed that all, or nearly all, fruit at tolerably frequent intervals. Fruiting appears to be local rather than general.

Distribution.—The members of this genus are much less abundant than some of the species of *Dipterocarpus* and *Shorea*, and have a more scattered occurrence. They may be gregarious to the extent of small groups at rather large intervals. None of the species are found very high in the mountains, although certain forms are common on ridges below 800 meters. Some species are characteristically found on low flat ground or along streams.

The genus comprises about 60 species, distributed throughout most of the range of the family, about as follows: Ceylon 3; India 5; Burma 4; Siam 5; Indo-China 5; Malay Peninsula 16; Sumatra 9; Java 2; Borneo 19; Celebes 1; Philippines 7. All the Philippine species are endemic.

Key to the Philippine species of Hopea.

a^1. Secondary nerves few and prominent.
  b^1. Leaves oblong, unilaterally unsymmetrical.
    c^1. Leaves 10 to 15 cm long, 2.2 to 7 cm wide; fruiting calyx lobes less than 8 cm long.
      d^1. Stipules long, semipersistent; calyx wings 6 to 7.5 cm long. 2. *H. philippinensis*.
      d^2. Stipules short; calyx wings 3.5 to 4.3 cm long.... 1. *H. basilanica*.
    c^2. Leaves more than 15 cm long; calyx wings 8 cm long or longer. 3. *H. mindanensis*.
  b^2. Leaves ovate or lanceolate.
    c^1. Leaves long-acuminate, without domatia................ 5. *H. acuminata*.
    c^2. Leaves not long-acuminate; domatia prominent........ 4. *H. plagata*.
a^2. Secondary nerves numerous, close, indistinct, almost parallel. § *Dryobalanoides*.
  b^1. Leaves elliptic, cuneate at base, 8 to 12 cm long; fruit wings 4 to 5.5 cm long .... 6. *H. malibato*.
  b^2. Leaves and fruit smaller.. 7. *H. Foxworthyi*.

1. **HOPEA BASILANICA** Foxworthy. Dalindingan, yacal.

Hopea basilanica FOXWORTHY, Philip. Journ. Sci. § C 6 (1911) 260, *pl. 42;* § C 13 (1918) 183; MERRILL, Enum. Philip. Fl. Pl. 3 (1923) 93.

Large trees, up to 64 m tall and 62 cm in diameter, with thick, black, furrowed bark, like that of *H. acuminata.* Stipules short, early deciduous. Leaves chartaceous, narrowly oblong or elliptic to oblanceolate, glabrous and shiny above except for the slightly pubescent midrib, 10 to 15 cm long, 2.2 to 4.8 cm wide, apex acuminate, tapering and unsymmetrical at base; secondary nerves 10 to 12 pairs, ascending and bent upward at margin of leaf, domatia in axils of at least lowest pairs of nerves; tertiary nerves parallel, reticulate; petiole dark-colored and wrinkled when dry, 6 to 12 mm long. Inflorescences terminal and axillary, mostly from the axils of fallen leaves, occasionally two inflorescences from one axil, few-flowered racemose panicles, not much branched, usually shorter, or not much longer than, leaves; peduncles and branches pubescent. Flowers (described from *For. Bur. 27248,* collected in Basilan, June, 1918, said to be yellow, pedicels short, less than 1 mm long. Sepals broadly ovate, about 1 mm wide and 1.5 mm long, tomentose outside, glabrous within. Petals ovate, tomentose on exposed portion, glabrous within, opaque, about 3.5 mm long and 1.5 mm wide. Stamens 15, attached to petals at base; filaments slender, about 0.4 mm long; anthers ellipsoid, about 0.1 mm long; appendage to connective as long as, or considerably longer than, anther. Ovary pubescent, surmounted by short cylindrical stylopodium; stylopodium about 0.5 mm in diameter; ovary and stylopodium about 1.5 mm long, 0.8 mm in diameter at base; style about 0.1 mm long; stigmas minute. Fruit 3 to 4 mm in diameter, 4 to 5 mm long; resin cavities in lower part of fruit; fruiting calyx with 2 long wings 3.5 to 4.3 cm long and 10 to 15 mm wide, with about 9 principal nerves; wings yellow when dry, nerves of darker color, nut and base of wings very dark brown; bases of the 2 large wings expanded so as to nearly conceal the 3 small ones.

BASILAN, *For. Bur. 15220 Klemme* (type in Philippine National Herbarium) August, 1910.

The wood is said to be of the quality of yacal.

The tree is said to be found in flat land, ridges, and slopes, from sea level up to about 70 m. It is known with certainty only from Basilan. One collection (*For. Bur. 27940*) of very imperfect material is credited to Sibutu.

2. HOPEA PHILIPPINENSIS Dyer. Gisok-gisok.

Hopea philippinensis DYER, Journ. Bot. 16 (1878) 100; VIDAL, Rev. Pl. Vasc. Filip. (1886) 62; BRANDIS, Journ. Linn. Soc. Bot. 31 (1895) 64; EVERETT & WHITFORD, Philip. Bur. For. Bull. 5 (1906) 16, 28, 53; WHITFORD, Philip. Bur. For. Bull. 10 [2] (1911) 75, *pl. 79;* FOXWORTHY, Philip. Journ. Sci. § C 4 (1909) 515; § C 6 (1911) 261; § C 13 (1918) 183; MERRILL, Enum. Philip. Fl. Pl. 3 (1923) 94; REYES, Philip. Journ. Sci. 22 (1923) 338, *pl. 30, fig. 2;* SYMINGTON, Gard. Bull. S. S. 8 (1934) 32; 8 (1935) 279.

A medium-sized tree with thin, dark-colored bark. Stipules linear-lanceolate, acute, 2 to 3.5 cm long, semipersistent. Leaves thinly coriaceous, narrowly oblong, caudate-acuminate, base very unequal-sided, obtuse, almost glabrous, midrib and the 17 to 22 pairs of secondary nerves prominent beneath, domatia conspicuous; leaf blade 10 to 15 cm long, 3 to 5 cm wide; petiole very short, 6.5 mm long, black, wrinkled. Inflorescences usually from axils of fallen leaves, not much branched, usually shorter than leaves. Flowers sessile or very short-stalked, a scar at the base seems to indicate that there have been bracts; flowers lightly colored and sweetly fragrant. Sepals pubescent or glabrous, ovate, apiculate, about 2.5 mm long, 2 mm wide. Petals oblong to lanceolate, exposed portion tomentose, 7 to 8 mm long and about 2 mm wide, with 7 or 8 principal longitudinal nerves. Stamens 15, in groups of 3 at base of petals; filaments about 0.2 mm wide at base and tapering into a filiform portion; anthers ellipsoid, about 0.3 mm long; appendage to connective slender, as long as or longer than, anther cells, sometimes 2 or 3 times as long, pubescent. Ovary almost hemispherical, about 1 mm in diameter and in height, narrowed into almost columnar stylopodium; stylopodium about 1.5 mm long and 0.3 mm in diameter, narrowed into the small, glabrous, 0.3 mm long style; stigma minute. Fruit with 2 long, spathulate calyx lobes, 6.5 to 7.5 cm long, 2 cm wide, very much narrowed toward base, red when fresh, sometimes becoming chocolate-colored on drying.

LUZON, Albay Province, *Cuming 879* (isotype in the Philippine National Herbarium). The flowers have been described from *Bur. Sci. 31296 Ramos & Edaño* (in the Philippine National Herbarium), collected in Panay, Capiz Province, Jamindan, April 15, 1918.

The wood is said to be of the *mangachapuy* grade and has been described by Reyes.[18]

The species is widely distributed in the nonseasonal part of the Archipelago. It is said to occur on slopes and to be abundant above 300 m elevation.

The recorded distribution is:

LUZON, Laguna, Tayabas, Camarines, and Albay Provinces. CATANDUANES. SAMAR. LEYTE. BILIRAN. NEGROS. PANAY. MINDANAO, Surigao, Agusan, Lanao, and Zamboanga Provinces.

3. HOPEA MINDANENSIS Foxworthy. Bagasusu, ganon, magasusu (Zamb.).

Hopea mindanensis FOXWORTHY, Philip. Journ. Sci. § C 6 (1911) 261, *pl. 43;* § C 13 (1918) 183; MERRILL, Enum. Philip. Fl. Pl. 3 (1923) 93; REYES, Philip. Journ. Sci. 22 (1923) 334, *pl. 29, fig. 2;* SYMINGTON, Gard. Bull. S. S. 8 (1934) 32.

A tree up to 34 m tall and 45 cm in diameter. Stipules linear-lanceolate, acute, semipersistent. Leaves narrowly oblong, very short-acuminate at apex, irregularly cordate and auriculate at base, midrib and 18 to 24 pairs of lateral nerves prominent beneath, 15 to 35 cm long, 6 to 11 cm wide; petiole very short, 5 to 15 mm long, pubescent. Inflorescences borne in clusters from axils of fallen leaves, branched, shorter than leaves. Flowers (described from *Bur. Sci. No. 37069,* collected in Zamboanga Province, Mindanao, November, 1919) light-colored, slightly fragrant, short-stalked, about 8 mm long and 4 mm wide before petals spread; pedicel less than 1 mm long. Sepals glabrous, broadly ovate to almost orbicular, convex, finely apiculate or blunt at apex, 3 mm long and 2.5 mm wide. Petals tomentose on portion exposed in bud, otherwise glabrous, 5 to 6 mm long, about 2 mm wide, with numerous faint longitudinal nerves. Stamens 15; filaments broad, about 0.3 mm wide above base, abruptly narrowed to filiform; anthers ellipsoid, about 0.3 mm long and 0.2 mm wide; appendage to connective slender, as long as or longer than anther. Ovary and stylopodium up to 2 mm long and 1 mm in diameter at base, glabrous, gradually narrowing into scarcely distinct style; stigma minute. Fruit large, distinct from accrescent calyx lobes; 2 large fruiting calyx lobes ovate, tumid at base, limb broadly spathulate, rounded at apex, gradually attenuate to base, principal longitudinal nerves 7.

[18] Tom. cit., p. 338.

MINDANAO, Zamboanga Province, Banga, *For. Bur. 9029 Whitford & Hutchinson,* December 2, 1907, in yacal forest, altitude about 30 m (type in the Philippine National Herbarium).

This species is very distinct from *H. philippinensis* by reason of the much larger leaves and fruit.

The wood is said to be of the yakal grade and has been described in detail by Reyes.[19]

The species has been found only in Zamboanga Province, Mindanao.

4. **HOPEA PLAGATA** (Blanco) Vidal. Gyam.

Hopea plagata (Blanco) VIDAL, Rev. Pl. Vasc. Filip. (1886) 62; BRANDIS, Journ. Linn. Soc. Bot. **31** (1895) 64; MERRILL, Govt. Lab. Publ. **27** (1905) 22; Sp. Blancoanae (1918) 269; Enum. Philip. Fl. Pl. **3** (1923) 94; FOXWORTHY, Philip. Journ. Sci. § C **2** (1907) 396; § C **4** (1909) 515; § C **6** (1911) 262; § C **13** (1918) 183; MERRITT, Philip. Bur. For. Bull. **8** (1908) 48; WHITFORD, Philip. Journ. Sci. § C **4** (1910) 715; Philip. Bur. For. Bull. **10**^{2} (1911) 73, *pls. 76, 77;* REYES, Philip. Journ. Sci. **22** (1923) 335, *pl. 31, fig. 2.*

Mocanera plagata BLANCO, Fl. Filip. (1837) 447.

Dipterocarpus plagatus BLANCO, Fl. Filip. ed. 2 (1845) 311; ed. 3^2 (1878) 212.

Anisoptera plagata BLUME, Mus. Bot. Ludg.-Bat. **2** (1852) 42; A. DC., Prodr. **16**^{2} (1868) 616.

Shorea reticulata F-VILL., Noviss. App. (1880) 21, *non* Dyer.

Hopea odorata VIDAL, Sinopsis Atlas (1883) 15, *t. 15, fig. a,* excl. fruit, *non* Roxb.

Hopea odorata FOXWORTHY, Philip. Journ. Sci. § C **13** (1918) 183, *non* Roxb.

Hopea sp. "Gyam" FOXWORTHY, Philip. Journ. Sci. § C **6** (1911) 263; *"paina"* FOXWORTHY, Philip. Journ. Sci. § C **6** (1911) 285.

Large trees up to 55 m high and 180 cm in diameter, with thick, fissured, black bark. Leaves lanceolate to ovate, chartaceous or coriaceous, glabrous, 5 to 12 cm long, 1.5 to 5 cm wide, apex acuminate, base cuneate; secondary nerves 8 to 12 pairs, with domatia in axils of some on underside; petiole 3 to 25 mm long; young leaves distinctly viscid. Inflorescences axillary, often from axils of fallen leaves, usually shorter than leaves and not much branched, 2 to 4 cm long. Flowers (described from *Loher no. 12914,* collected at Oriud, Rizal Province, Luzon) with short pedicels, which are usually less than 1 mm long. Sepals broadly ovate or orbicular, 2 mm high and wide, sometimes finely apiculate at apex, tomentose outside, glabrous within. Petals ovate-lanceolate, tomentose outside, glabrous within, spreading

[19] Tom. cit., p. 334.

in anthesis, about 3 mm long and 2 mm wide. Stamens 15 (Blanco says 30), borne in threes at base of petals; filaments broadened above base and then narrowed to filiform, 2.5 to 3 mm long; anthers almost orbicular, about 0.6 mm long and wide; appendage to connective tapering, as long as or longer than anther. Ovary without distinct stylopodium, conical, tapering gradually into stout style; stigma blunt or obscurely 3-parted; total length of pistil about 3 mm, maximum diameter about 1 mm. Fruit (described from *Loher no. 14901*, collected in Rizal Province, Luzon, July, 1913) with 2 long fruiting calyx lobes which are oblong or elliptic, 4 to 5 cm long, about 2 cm wide, narrowed at base to fit base of fruit, with 15 or more principal longitudinal nerves; the 3 short wings 0.5 to 2 cm long, broadly ovate or elliptic; nut about 1 cm long and about 7 mm in diameter, conical, tomentose, tapering to obscurely 3-parted stigma.

There is no type material extant for the plant described by Blanco; however, the species is an important one, as the wood, under the name of yakal, is widely used and is much esteemed because of its great strength and durability. Reyes [20] has given a detailed description of the wood. Blanco stated that there were 30 stamens, but Vidal's figure [21] indicates that there are 3 at the base of each petal. Vidal gives no number for the collection from which the drawing was made, but lists it as from San Miguel de Mayumo, Bulacan Province. He first credited this form to *H. plagata*,[22] and cites his *no. 84* from Bongabon, Nueva Ecija Province. Brandis [23] stated that this number was sterile. I had seen no flowering material when I wrote my earlier papers, and the fruit was not well known. Loher's excellent collections have made it possible to give a more complete description.

In my first paper of this series [24] I mentioned two forms, known only from sterile material, which it now seems belong here. One of these [25] was known as *gyam* and had been collected only once (*For. Bur. 13380*) on Tawitawi Island. It was considered distinct because of the small size of the leaves, but, collections now available seem to indicate that it is within the range of variation of the species. Another form (*Bur. Sci.*

[20] Tom. cit., p. 335.
[21] Sinopsis Atlas (1883) under *H. odorata* var.
[22] Rev. Pl. Vasc. Filip. (1886) 62.
[23] Loc. cit.
[24] Philip. Journ. Sci. § C 6 (1911) 231.
[25] Tom. cit., p. 263.

13141, collected in Tayabas Province) was considered distinct because of what was believed to be a curiously shaped immature fruit; I was unable to place it in a genus and listed it [26] among species of uncertain position. It is now evident that what was supposed to be an immature fruit was really an insect gall, and that the form belongs to *H. plagata.* There have since been other collections from Tayabas Province that show the same form of insect gall (*For. Bur. 20823* and *Bur. Sci. 25529*).

Of the nearly 60 collection sent me all are sterile except the following:

LUZON, Rizal Province, in flower, March, *Loher 12914;* in fruit, July, *Loher 14892, 14901:* Bataan Province, in fruit, July, *For. Bur. 25889, 26133:* Camarines Province, fallen fruit, November, *For. Bur. 22645, 22649:* Nueva Vizcaya Province, fruit, July, *For. Bur. 29530, 29531, 29532.*

It would seem that flowers are borne during the dry and fruit during the rainy season. It is said that the tree does not bear flowers every year, but only at irregular intervals.

The recorded distribution is as follows:

LUZON, Cagayan, Ilocos Norte, Nueva Vizcaya, Pangasinan, Nueva Ecija, Tarlac, Zambales, Bataan, Rizal, Bulacan, Tayabas, Camarines, and Sorsogon Provinces. MINDORO. TABLAS. BOHOL. MINDANAO, Cotabato and Zamboanga Provinces. BASILAN. TAWITAWI.

5. HOPEA ACUMINATA Merrill. Dalindingan, mangachapuy.

Hopea acuminata MERRILL, Govt. Lab. Publ. 29 (1905) 30; Philip. Journ. Sci. 1 Suppl. (1906) 98; Enum. Philip. Fl. Pl. 3 (1923) 93; WHITFORD, Philip. Journ. Sci. § C 4 (1910) 703; Philip. Bur. For. Bull. 10 [2] (1911) 75, *pl. 80;* FOXWORTHY, Philip. Journ. Sci. § C 2 (1907) 389; § C 4 (1909) 514, *pl. 27, fig. 68;* § C 6 (1911) 264; § C 13 (1918) 183; REYES, Philip. Journ. Sci. 22 (1923) 339, *pl. 30, fig. 1;* SYMINGTON, Gard. Bull. S. S. 8 (1934) 22.

Hopea maquilingensis FOXWORTHY, Philip. Journ. Sci. § C 13 (1918) 184.

Tall, slender trees up to 40 m high and 1 m in diameter. Branchlets nearly black when dry, glabrous, striate. Leaves broadly lanceolate, submembranous, glabrous, shiny above, narrowly acuminate at apex, rounded and inequilateral at base, 4 to 8 cm long, 2 to 3 cm wide; secondary nerves 8 to 10 pairs, rather prominent beneath; petioles 5 to 8 mm long, rugose, glabrous. Inflorescences grayish stellate-pubescent, axillary and terminal panicles, 5 to 6 cm long or less, spicate branches unilateral, 1.5 cm long or less. Flowers small, light-colored, fragrant.

[26] Tom. cit., p. 285.

Sepals imbricate, rusty pubescent outside, outer two slightly larger than inner. Petals slightly pubescent on the outside, falcate, 4 mm long, 1.8 mm wide, obtuse. Stamens 10; filaments thick; anthers 0.4 mm long; appendage to connective slender, usually longer than anther cells. Ovary glabrous or pubescent, 0.8 to 0.9 mm tall, 0.7 to 0.8 mm in diameter; style short, glabrous; stylopodium none; stigma minute. Fruit glabrous, 2 long wings oblong, about 2 cm long, 5 mm wide, apex rounded.

LUZON, Bataan Province, Mount Mariveles, *Merrill 3864* (type of fruit of *H. acuminata* Merr. in the Philippine National Herbarium), August, 1904; *For. Bur. 786 Borden* (type of flower of *H. acuminata* Merr. in the Philippine National Herbarium), May, 1904: Laguna Province, Mount Maquiling, *F. Canicosa, s. n.* (type of *H. maquilingensis* Foxw. in the Philippine National Herbarium), August, 1904. Six other specimens from the type locality were cited with the original description.

H. acuminata is distinct in form of leaf and in flower characters.

H. maquilingensis Foxw. was described from fruiting material of what seemed to be a distinct form of tree. The tree was of small size, with thinner, lighter-colored, and less deeply fissured bark. Merrell [27] considers it a synonym of *H. acuminata;* the features mentioned may be within the natural range of variation of the species.

A detailed description of the wood has been given by Reyes.[28]

This tree is common in hill forests, in both the seasonal and the nonseasonal parts of the Archipelago, at from 100 to 800 m altitude, but more abundant above 300 m.

Distribution.—BABUYANES. LUZON, Cagayan, Ilocos Norte, Nueva Vizcaya, La Union, Pangasinan, Tarlac, Nueva Ecija, Bataan, Bulacan, Laguna, Tayabas, Camarines, Albay, and Sorsogon Provinces. MINDORO. TICAO. MASBATE. SIBUYAN. SAMAR. LEYTE. NEGROS. PANAY. MINDANAO, Misamis, Cotabato, Davao, and Zamboanga Provinces.

6. HOPEA MALIBATO Foxworthy. Yacal, malibato, dalindingan.

Hopea malibato FOXWORTHY, Leafl. Philip. Bot. 6 (1913) 1953; Philip. Journ. Sci. § C 13 (1918) 184; MERRILL, Enum. Philip. Fl. Pl. 3 (1923) 93.

Small or medium-sized trees. Leaves firmly chartaceous, glabrous, elliptical or ovate-elliptical, long-caudate-acuminate at apex, cuneate or acute at base, 8 to 12 cm long, 3 to 4.5 cm wide;

[27] Tom. cit., p. 93. [28] Tom. cit., p. 339.

petiole 10 to 12 mm long. Infrutescences axillary, short. Flowers unknown. Fruiting calyx lobes, the 2 larger 4 to 5.5 cm long, 12 to 15 mm wide, chartaceous, reddish, glabrous, 8- to 9-nerved; the 3 shorter ones scarcely exceeding fruit. Nut very short-pedunculate, 8 to 9 mm long, less in diameter, with sticky resin.

MINDANAO, Agusan Province, Cabadbaran, Mount Urdaneta, *Elmer 13526* (type in the Philippine National Herbarium), August, 1912.

A collection of sterile material, *For. Bur. 13789,* from Zamboanga Province, Mindanao, may belong here. It was from a large tree.

7. **HOPEA FOXWORTHYI** Elmer. Dalindingan isaak (Laguna, Tayabas); pisac (Cagayan); mangachapuy (Laguna, Sibuyan); sugcao (Samar).

Hopea foxworthyi ELMER, Leafl. Philip. Bot. 6 (1912) 1469.

H. Pierrei FOXWORTHY, *non* Hance, *pro parte* Philip. Journ. Sci. § C 6 (1911) 265; § C 13 (1918) 184; WHITFORD, Philip. Bur. For. Bull. 10[2] (1911) 76; BROWN and MATTHEWS, Philip. Journ. Sci. § A 9 (1914) 439, 481; MERRILL, Enum. Philip. Fl. Pl. 3 (1923) 94; REYES, Philip. Journ. Sci. 22 (1923) 339, *pl. 31, fig. 1.*

H. glutinosa ELMER, Leafl. Philip. Bot. 6 (1912) 1470.

Medium-sized trees; branchlets glabrous, only petioles and ramifications of inflorescence slightly puberulous. Leaves glabrous, 4 to 6 cm long, 1.5 to 2 cm wide, folded in bud upon upper surface, paler green beneath, lanceolate or ovate-lanceolate, caudate-acuminate, rounded or subcuneate at base, gradually tapering into 1 to 1.5 cm long apical portion which terminates in an obtusely rounded or emarginate tip, small hairy glands (domatia) often found in axils of secondary nerves; petiole 5 to 8 mm long, at first puberulent, ultimately glabrous. Inflorescences axillary, usually shorter than leaves. Flowers said to be pale green (unopened), on glabrous pedicels about 1 mm long. The only available flowering specimens are too immature for detailed study. Fruit on pedicels 2 to 3 cm long. The two long fruiting calyx lobes oblanceolate, 2.5 to 3 cm long, about 7.5 mm wide; the 3 shorter lobes about 5 mm long, obtuse. Nut ovoid-conical, 1.5 cm long, 6 mm in diameter, often coated with a smooth resin coat.

BASILAN, *Elmer 12071* (type in the Philippine National Herbarium), March, 1910, on a ridge at about 600 m elevation; *Elmer 12071* (cotype of *H. glutinosa* Elmer in the Philippine National Herbarium), collected on the same island. I formerly considered most of the material placed here to belong to *H. Pier-*

rei Hance, a species which I now believe not to occur in the Philippines, although some of the Philippine material has leaves very like those described for that species. None of the Philippine flowering material, discussed below, shows a stylopodium, which is quite pronounced in *H. Pierrei.*

I am in agreement with Merrill in considering *H. glutinosa* and *H. Foxworthyi* the same species, the latter name having page priority.

The species seems to occur on ridges or high land at from 100 to 600 m above sea level in the nonseasonal part of the Archipelago.

The tree is of small or medium size, rather thin-barked; the wood is of the mangachapuy grade.

The following collections are placed here, though all, except where specified, are sterile:

LUZON, Cagayan Province, *For. Bur. 17206, 17256:* Laguna Province, *Phil. Pl.* (*Merrill*) *397,* in fruit, August, 1910; *Bur. Sci. 9882, For. Bur. 10150, 10157,* seedling; *1532, 17645,* fruit, February, 1910; *20710, 20714, 22499, 22500, 24665,* with immature flowers, November, 1916: Tayabas Province, *Whitford 792,* with immature flowers, September, 1904; *For. Bur. 23018, 30971,* fruit, June, 1929. SAMAR, *For. Bur. 20999.* SIBUYAN, *Elmer 12289* (type of *H. glutinosa*), in fruit, April, 1910; *For. Bur. 22603.* PANAY, Capiz, *For. Bur. 23932.*

Several collections remain of very uncertain status, and are here considered:

Bur. Sci. 28486 was collected in flower in Tayabas Province May, 1917, and was credited by Merrill to *H. malibato,* from which it differs by the thicker coriaceous leaves which are rounded at the base. It seems to me distinct; but its position will remain in doubt until flowering material of *H. malibato* and fruiting material of this form are available for study. The description of the flowering material from Tayabas is as follows: Inflorescences axillary and terminal, glabrous or sparsely pubescent, 3 to 15 cm long. Flowers said to be yellow; pedicels about 1.5 mm long, pubescent. Sepals ovate, about 2 mm long, 1.5 mm wide, blunt at apex, concave, pubescent outside, glabrous within. Petals oblong-lanceolate, slightly twisted in bud, blunt at apex, 5 to 6 mm long, 1 to 1.5 mm wide at base, rather opaque, portion exposed in bud silky, rest glabrous. Stamens 15; filaments slender, up to 0.9 mm long; anthers ellipsoid, about 0.1 to 0.2 mm long; appendage to connective much longer than anther.

Ovary ovoid-columnar, glabrous, without stylopodium, 0.6 mm in diameter, 0.8 mm long, tapering into the glabrous 1.5 mm long style; stigma minute.

The following collections have flowers very like the above, but have much smaller leaves: *For. Bur. 6726*, collected in Mindoro in April, 1907, flowers immature; *For. Bur. 21883, 21991, 23828, and 23834*, all collected in Zamboanga Province, Mindanao, May, 1914, said to be pinkish and with structures like that of *Bur. Sci. 28486*. Their leaves, however, are much smaller and of different shape. *For. Bur. 26249*, collected on Polillo in October, 1910, has flowers much like the above, but with rather larger petals and considerable pubescence on petioles, peduncles, and pedicels. It is, perhaps, most closely related to *H. foxworthyi*. *For. Bur. 24753*, collected in Tayabas in November, 1915, seeming to have a shorter ovary, but with too immature flowers for complete description, would seem to be closely related to *H. foxworthyi*. *Phil. Pl. (Merrill) 1623*, collected in Samar, April, 1914, has flowers much like *H. Forworthji* and is, perhaps, the same. *For. Bur. 21146*, collected in Camarines, April, 1914, has rather larger flowers than the other forms examined, the stamens being distinctly larger. It is probably a distinct form.

Besides these, there are a number of collections of sterile material, most of it apparently closely related to *H. foxworthyi*, but showing considerable variation in form and size of leaves.

All of these doubtful forms need further collecting before they can be definitely determined.

4. Genus BALANOCARPUS Beddome

This genus has been regarded as distinct by reason of its calyx lobes, which are pointed and do not exceed the fruit. Symington [29] has called attention to the lack of natural generic characters, which will probably lead to the disruption of the genus in the near future. As at present constituted, this genus contains about 15 species, the position of some of which is very doubtful. Species are credited to Ceylon, India (Madras Presidency), the Malay Peninsula, Borneo, and the following from the Philippines.

Key to the Philippine species of Balanocarpus.

a^1. Calyx wings only about one-half as long as fruit; leaves narrowly oblong .... 1. *B. cagayanensis*.

a^2. Calyx wings nearly as long as fruit; leaves lanceolate. 2. *B. brachypterus*.

[29] Gard. Bull. S. S. 8 (1934) 27.

1. **BALANOCARPUS CAGAYANENSIS** Foxworthy. Plate 3. Narek.

Balanocarpus cagayanensis FOXWORTHY, Philip. Journ. Sci. § C 13 (1918) 194, *pl. 2;* MERRILL, Enum. Philip. Fl. Pl. 3 (1923) 101; REYES, Philip. Journ. Sci. 22 (1923) 335, *pl. 29, fig. 1;* SYMINGTON, Gard. Bull. S. S. 8 (1934) 27, 32.

Large tree. Leaves oblong, acuminate, faintly cuneate, slightly rounded, or slightly inequilateral at base, 7 to 13 cm long, 2 to 4 cm wide, margin slightly inrolled; secondary nerves 10 to 12 pairs, with occasional intermediate short ones; tertiary nerves approximate, mostly parallel; domatia in axils of secondary nerves, glabrous above, almost glabrous beneath, with occasional scattered hairs. Flower clusters not distinctly unilateral, black or dark gray. Petals yellowish brown in dried material, about twice as long as sepals, pale sericeous on outside, glabrous within. Stamens with filaments expanded at base, attached to base of petals and, more or less, to each other, forming at least an indication of a monadelphous condition; anthers almost round, equal; connective prolonged into a tapering awn, distinctly longer than anther. Gynœcium hour-glass-shaped. Ovary subspherical, stylopodium as long as ovary, almost columnar, abruptly narrowed into style, which is rather less than half as long as ovary; stigma shallowly notched. Fruit 1 to 1.3 cm long, about 1 cm in diameter, roughly conical, apiculate. Calyx wings of about equal length, less than two-thirds the height of fruit.

LUZON, Cagayan Province, Claveria, *For. Bur. 19987 Bernardo* (type in the Philippine National Herbarium), August, 1913.

This species has been found only in northern Luzon, all but one of the collections being from Cagayan Province. One collection is from Apayao Subprovince. The wood is said to be very good for house posts, in sandy places to be as good as molave (*Vitex* spp.), and may last 50 years or more. One collector reports that this species does not bear flowers yearly, but once every 4 or 6 years.

Symington [30] has called attention to the close relationship of the flowers of this species to those of *Hopea philippinensis* Dyer and of *H. mindanensis* Foxw., as well as to certain extra-Philippine species of *Hopea* and *Balanocarpus*.

2. **BALANOCARPUS BRACHYPTERUS** Foxworthy. Babase (Sub.).

Balanocarpus brachypterus FOXWORTHY, Philip. Journ. Sci. § C 13 (1918) 195; MERRILL, Enum. Philip. Fl. Pl. 3 (1923) 101; SYMINGTON, Gard. Bull. S. S. 8 (1934) 27, 28.

[30] Tom. cit., pp. 27, 32.

A medium-sized tree. Leaves chartaceous, elliptic or oblong to ovate-lanceolate, apex blunt-acuminate, base rounded or subcuneate, margin crenulate, glabrous except along principal nerves, where there is a sparse pubescence, mainly of grayish pilose hairs, with hairy domatia in the axils of nerves on underside, 5.8 to 7.3 cm long, 2.7 to 3.8 cm wide; secondary nerves 10 to 12 pairs; tertiary nerves rather indistinct, mainly reticulate; petioles 3 to 5 mm long. Inflorescences axillary, 4 to 5 mm long, lax, few-flowered; peduncle and branches slender, glabrous or pubescent. Flowers "small, violet, not odorous, and not showy," about 3 mm long, on stout, pubescent pedicels 1 to 1.5 mm long. Sepals broadly ovate, acute at apex, about 1.5 to 2 mm long and wide, tomentose outside, smooth within. Petals oblong, about 3 mm long and 1 mm wide, tomentose outside, glabrous within. Stamens 15, small; filaments filiform, slightly expanded at base, several times longer than anther; anther oblong, about 0.1 mm long; appendage to connective aristate, considerably longer than anther. Ovary and stylopodium tomentose, about 1.3 mm long and 0.6 mm in diameter, abruptly tapering into 0.3 mm long style; stigma minute. Fruit ovoid, about 1 cm long and 9 mm in diameter. Calyx lobes triangular-ovate, imbricate, rather closely surrounding and a little shorter than fruit. Margins of calyx lobes frequently brownish and scarious, sometimes very slightly reflexed. Fruit conical, faintly pubescent, with thin pericarp, the short style projecting through a small circular depression at apex. Style glabrous, about 0.5 mm long.

MINDANAO, Zamboanga Province, Naganaga, *For. Bur. 21895 Villamil* (type in the Philippine National Herbarium), May 18, 1914. The flowers were described from *For. Bur. 31304 Zamuco,* collected in Zamboanga Province, April, 1930.

This species has been found only in one district. The wood seems to be of the quality of dalindingan.

Symington[31] has called attention to the close relationship of this species to *B. Curtisii* King, and, possibly, to another species of the Malay Peninsula.

5. Genus PENTACME A. de Candolle

The generic characteristics, as given by Brandis, are:

Sepals strongly imbricate. Petals broad, spreading. Stamens 15. Anthers oblong, on short broad filaments. Anther-cells equal, each prolonged

[31] Tom. cit., pp. 27, 28.

into a short appendix; the connective also prolonged, so that each anther has 5 apical appendages. Ovary glabrous or pubescent, prolonged into a conical stylopodium; style filiform, glabrous. Stigma obtuse, indistinctly 3-partite. The 3 outer segments of fruiting-calyx much larger than the others, narrowed into a stalk, but expanding into a broad base, which is adpressed to the lower portion of the fruit, but does not enclose it.

Wood of the Philippine forms soft, light-colored, light in weight, coarse-grained, not durable.

Four species are known, 2 from the eastern Indian Peninsula and 2 from the Philippines.

It seems surprising that the genus should be represented in the Philippines and that its wood should be so different from that produced by the genus elsewhere. *Pentacme siamensis* (Miq.) Kurz is the representative species of the genus from the Indian Peninsula (It may be considered doubtful if *P. tomentosa* Craib is really distinct). It occurs at from 25° north latitude in Burma southward through Burma, Siam, and Indo-China, to a little north of 6° north latitude in the Malay Peninsula. It occurs where there is a distinct and prolonged dry season and where there are frequent fires. The wood of this species is very dense, very heavy, and very durable, a tremendous contrast with the wood of the Philippine forms.

Key to the Philippine species of Pentacme.

*a*¹. Leaves ovate or oblong, less than 15 cm long .... 1. *P. contorta*.
*a*². Leaves lanceolate, more than 15 cm long .... 2. *P. mindanensis*.

1. **PENTACME CONTORTA** (Vidal) Merrill and Rolfe. Anas, apnit, balac, balagbag, bayucan, bugugnan, bunga, danlig, guiscan, lauan, malaanonan, malacayan, malasinoro, malatiaong, mayapis, sandana.

Pentacme contorta (Vidal) MERRILL & ROLFE, Philip. Journ. Sci. § C 3 (1908) 115; MERRITT, Philip. Bur. For. Bull. 8 (1908) 48; WHITFORD, Philip. Journ. Sci. § C 4 (1910) 703; Philip. Bur. For. Bull. 10² (1911) 61, *pls. 56, 57;* FOXWORTHY, Philip. Journ. Sci. § C 4 (1909) 511, 516; § C 6 (1911) 266; § C 13 (1918) 186; MERRILL, Enum. Philip. Fl. Pl. 3 (1923) 95; REYES, Philip. Journ. Sci. 22 (1923) 332, *pl. 25.*

Shorea contorta VIDAL, Sinopsis Atlas (1883) 15, *fig. e,* Rev. Pl. Vasc. Filip. (1886) 88; BRANDIS, Journ. Linn. Soc. Bot. 31 (1895) 88; MERRILL, Philip. Journ. Sci. 1 Suppl. (1906) 98.

Pentacme paucinervis BRANDIS, Journ. Linn. Soc. Bot. 31 (1895) 73.

Large trees, reaching a height of 40 to 50 m and a diameter of 150 cm. Stipules minute, early caducous. Leaves glabrous, ovate, acuminate at apex, rounded or subcordate at base, margin undulate or entire; secondary nerves 6 pairs; tertiary nerves parallel, not conspicuous, joined by reticulate veins; blade 10 to

14.5 cm, petiole 2.5 cm long. Inflorescences terminal and axillary panicles, the ramifications of which, as well as outside of sepals and petals, are gray with dense stellate tomentum. Flowers white, somewhat fragrant, nearly 1.25 cm long, on short obconical pedicels. Sepals ovate, 4 mm long, 2 to 3 mm wide, puberulous within. Petals elliptic, lanceolate, or ovate, narrowed at top and base, spreading after surpassing sepals, 9 to 10 mm long, 5 mm wide, with about 15 longitudinal nerves. Stamens 9 to 10 mm long, filaments stout, 2.5 to 3 mm long, 0.6 mm wide at base, narrowed about 1.7 mm above base to stalk about 1 mm long; anthers linear, 4.5 to 5 mm long, 0.6 mm wide at base, narrowing above to pointed apex which, like appendage to connective, is only about 0.5 mm long. Ovary depressed, spherical, faintly lobed, glabrous or pubescent, 1.2 mm high, about 2 mm in diameter, narrowing into long, cylindric, faintly ridged style, which is 5.5 mm long, 0.4 mm in diameter at base and 0.2 mm at top; stigma slightly concave, pubescent. Fruit tomentose, acuminate; wings of fruiting calyx twisted, very unequal, the two largest 7 to 13 cm long, with 10 to 12 prominent nerves, the third 6.5 cm long, the others much smaller. The number of nerves is variable as is also the size of fruit. All parts of wings densely stellate pubescent when young.

TYPES: *Shorea contorta* Vidal was described from *Vidal 987* collected in Rizal Province; and *Vidal 2159*, collected in Tayabas Province. *Pentacme paucinervis* Brandis was described from *Vidal 79*, collected in Nueva Ecija and Tarlac Provinces, *Vidal 1166*, collected in Ilocos Norte Province, and *Vidal 2167*, collected in Rizal Province.

This is one of the species producing the wood known as white lauan and very extensively used. The structure of the wood has been treated in detail by Reyes.

The tree is abundant in lowland forest from sea level up to about 700 m.

Distribution.—Known only from the Philippine Islands, where it is, apparently, the commonest and most widely distributed species of the family. It is found from the Babuyanes Islands to Basilan, and Whitford (1911), Foxworthy (1911), and Merrill (1923) have suggested that it is probably found in every province. It is represented in the Philippine herbarium by collections from:

BABUYANES. LUZON, Cagayan, Isabela, Ilocos Norte, Ilocos Sur, Abra, Mountain, Nueva Vizcaya, Nueva Ecija, Tarlac, Pangasinan, Bulacan, Zambales, Bataan, Rizal, Laguna, Tayabas, Camarines, Albay, and Sorsogon Provinces. POLILLO. MARINDUQUE. MASBATE. MINDORO. CEBU. SAMAR. LEYTE. NEGROS, Negros Occidental Provinces. SIBUYAN. MINDANAO, Agusan, Davao, Cotabato, Lanao, and Zamboanga Provinces. SAMAL. POLAUI. BASILAN.

Common names.—The 138 collections examined give many common names, among which *malaanonan* is the commonest in Rizal and Bulacan Provinces. The name *lauan* is also used in Rizal Province. It seems that *malaanonan* is a common name for species of *lauan* the wood of which is light-colored and coarse-grained. There are 17 collections from Rizal, several without common name, and 7 with the name *malaanonan*. The two collections from Bulacan have the name *malaanonan*.

2. **PENTACME MINDANENSIS** Foxworthy.

Pentacme mindanensis FOXWORTHY, Philip. Journ. Sci. § C 13 (1918) 185; MERRILL, Enum. Philip. Fl. Pl. 3 (1923) 95; REYES, Philip. Journ. Sci. 22 (1923) 332, *pl. 24*.

Large trees. Leaves oblong-lanceolate, glabrous, bluntly acuminate at apex, rounded at base, 19 to 29 cm long, 8 to 10 cm wide; secondary nerves 8 to 12 pairs; petioles 2.5 to 4 cm long. Inflorescences terminal, paniculate; branches of inflorescence stellate-pubescent. Flowers white, spreading in anthesis, about 1.5 cm in diameter; pedicels slightly obconical, grayish pubescent, 1 to 2 mm long. Sepals imbricate, broadly elliptic, concave, 6 mm long, 5 to 6 mm wide, grayish pubescent outside, with a fringe of coarser pubescence along edge, puberulous inside, with very faint longitudinal veinlike markings. Petals grayish pubescent outside, yellow or brownish within when dry, spreading after surpassing sepals, obovate-elliptic, sometimes slightly retuse at top, narrowed to base, 12 to 13 mm long, 4.5 to 6 mm wide, with about 15 longitudinal nerves. Stamens 15, 8 mm long; filament thick, 3.5 mm long and 0.6 mm wide; anther cells narrowly oblong, mucronate at apex, 4.5 mm long, each anther narrowed to apex; appendages short, 0.5 to 1 mm long. Ovary depressed-hemispheric, densely pubescent, 1.8 mm high, 2 mm in diameter, tapering abruptly into long, cylindric, pubescent, faintly ridged style, which is 6.6 mm long and 0.3 mm in diameter, slightly concave at apex to hold the rather flat stigma. Fruit pubescent, 3 cm long, 13 to 14 mm in diameter; long wings 7 to 8 cm long, 15 to 17 mm wide; short wings 2.5

to 3 cm long, 6 to 7 mm wide; longitudinal nerves 12 to 14, transverse veins numerous, distinct, oblique.

MINDANAO, Zamboanga Province, *For. Bur. 21893 Villamil* (type in the Philippine National Herbarium), May 25, 1914.

The species is very like *P. contorta*, differing principally in the larger size of nearly all parts.

It is known only from Mindanao and Basilan.

6. Genus SHOREA Roxburgh

The generic characters, as given by Brandis, are:

Large resinous trees; stipules in a few species large and persistent, in most small and early deciduous. Leaves coriaceous; secondary nerves prominent; tertiary nerves mostly parallel. Flowers as a rule in unilateral spikes or racemes, these distichous, and regularly alternating on the branches of large axillary and terminal panicles. Each flower subtended by two mostly deciduous, in a few species persistent and conspicuous bracts. Sepals strongly imbricate, always hairy outside, and often inside also, on the margin of a broad obconical receptacle. Petals oblong, rarely ovate-oblong, hairy on the outside. Stamens generally 15, in some species more. Anther-cells generally equal; connective prolonged into a pointed appendage, generally longer than anther, sometimes short or wanting. Segments of fruiting-calyx with their broad bases tightly enclosing the fruit, the three outer ones generally longer than the others and much longer than the fruit. In one section the segments of fruiting-calyx shorter or not much longer than the fruit.

This genus is the largest of the order and comprises about 120 species, distributed throughout the principal range of the family. About two-thirds of the species are from the Malayan region.

Several of the most important Philippine timbers are produced by species of this genus.

Divisions of the genus.—Brandis has called attention to the variability of different floral organs within the genus and has indicated the difficulty of making clearly marked divisions. This difficulty still exists, and it is further necessary to make another section of the genus, because of the reduction of *Isoptera* from generic rank.

Key to the Philippine species of Shorea.

a^1. Appendage to connective ciliate.
  b^1. Fruit with 3 long wings. § 1. *Eushorea.*
    c^1. Leaves green on both sides .... 1. *S. guiso.*
    c^2. Leaves lighter-colored on underside.
      d^1. Leaves cuneate or subcuneate at base.
        e^1. Secondary nerves 8 to 9 pairs .... 6. *S. ciliata.*
        e^2. Secondary nerves about 14 pairs .... 5. *S. malibato.*

d^2. Leaves rounded at base.
e^1. Style scarcely distinct.. 4. *S. astylosa.*
e^2. Style distinct.
f^1. Leaves ovate-oblong, 16 cm long, 7 cm wide.......... 2. *S. gisok.*
f^2. Leaves oblong to oblong-lanceolate, 8.5 to 12 cm long, 3 to 6 cm wide .... 3. *S. falciferoides.*
b^2. Fruit wings not exceeding fruit (§ 2. *Isoptera*)........... 7. *S. seminis.*
a^2. Appendage to connective not ciliate.
b^1. Stamens 15 to 17 or 23 to 30; no stylopodium. Flowers large. Wood yellow. Anthers oblong; appendage long, filiform, naked. Style longer than ovary. § 3. *Anthoshorea.*
c^1. Stipules distinct, semipersistent; leaves stellate-pubescent. 8. *S. philippinensis.*
c^2. Stipules small and fugacious; leaves glabrous.
d^1. Leaves usually distinctly lighter-colored beneath, retuse at apex. 9. *S. polita.*
d^2. Leaves of same color on both surfaces, acute at apex. 10. *S. kalunti.*
b^2. Stamens 15, anthers short (except in *S. negrosensis*); appendage sometimes scabrous at end, not ciliate; with or without distinct stylopodium. § 4. *Pinanga.*
c^1. Leaves glabrous throughout.
d^1. Fruit wings stellate-pubescent.................................. 11. *S. plagata.*
d^2. Fruit wings glabrous.. 12. *S. polysperma.*
c^2. Leaves stellate-pubescent beneath.
d^1. Stipules broadly ovoid, acute or obtuse................ 13. *S. squamata.*
d^2. Stipules lanceolate-acuminate.
e^1. Anthers small, orbicular; stamens about 15.......... 14. *S. almon.*
e^2. Stamens more numerous; anthers large, oblong. 15. *S. negrosensis.*

Section 1. EUSHOREA

Fruiting calyx with 3 long wings; stamens 20 to 60; appendage of connective ciliate. Stylopodium usually large, hairy ovary; style short; stigma minute. Flowers in unilateral spikes or racemes, these distichous, alternating.

All Philippine species of this section produce wood which is hard and heavy, and, with the exception of *S. guiso*, of the yacal grade, of a yellowish or brownish color. Collections of fertile material have been few, with the consequence that descriptions are not complete. Some species, moreover, may have to be reduced after further collections, and it is possible that additional species are represented by some of the sterile material.

Nearly all of the forms included here have leaves that are lighter-colored on the underside when mature; the young leaves and leaves of saplings are usually of the same color on both surfaces.

Various species are abundant locally. *S. guiso* is the most common and widely distributed. It is also the only species of the group represented by sufficiently complete material to make possible detailed descriptions of both flowers and fruits. *S. gisok* is found in southeastern Luzon and the Visayas and is most commonly known by the name *gisok*. *S. astylosa* is found most commonly in Zamboanga Province, Mindanao, where it is known as *yacal*. *S. ciliata* is recorded from Tayabas with the name *yacal*, and from Biliran. *S. falciferoides* is known principally from Zambales and Pangasinan Provinces, with the name *yamban*. *S. malibato* was described from Agusan Province, Mindanao, where it has the names *malibato* and *dungon-dungon*. Sterile material, which seems, to belong to this species, has been collected as far north as Tayabas and the Camarines Provinces. The species has also been recorded from British North Borneo.

1. **SHOREA GUISO (Blanco) Blume.**

Shorea guiso (Blanco) BLUME, Mus. Bot. Ludg.-Bat. (1852) 34; VIDAL, Sinopsis Atlas (1883) 15, *t. 15, fig. c;* BRANDIS, Journ. Linn. Soc. Bot. 31 (1895) 89; PERKINS, Frag. Fl. Philip. (1904) 23; MERRILL, Philip. Journ. Sci. 1 Suppl. (1906) 98; Sp. Blancoanae (1918) 270; Enum. Philip. Fl. Pl. 3 (1923) 97; FOXWORTHY, Philip. Journ. Sci. § C 2 (1907) 384; § C 4 (1909) 509, *pl. 27, fig. 70;* § C 6 (1911) 272; § C 13 (1918) 191; Mal. For. Rec. 10 (1932) 175; EVERETT & WHITFORD, Philip. Bur. For. Bull. 5 (1906) 16; MERRITT & WHITFORD, Philip. Bur. For. Bull. 6 (1906) 36; MERRITT, Philip. Bur. For. Bull. 8 (1908) 48; WHITFORD, Philip. Journ. Sci. § C 4 (1910) 703; Philip. Bur. For. Bull. 10^2 (1911) 71, *pls. 74, 75;* REYES, Philip. Journ. Sci. 22 (1923) 337, *pl. 28;* VAN SLOOTEN *ex* Merr. in Univ. Calif. Publ. Bot. 15 (1929) 203; DESCH, Mal. For. Rec. 12 (1936) 20, *pl. 3, fig. 3;* SYMINGTON, Gard. Bull. S. S. 8 (1935) 266, *pl. 16.*

Mocanera guiso BLANCO, Fl. Filip. (1837) 449.

Dipterocarpus guiso BLANCO, Fl. Filip., ed. 2 (1845) 313.

Euphoria malaanonan BLANCO, Fl. Filip. (1837) 286.

Anisoptera guiso A. DC., Prodr. 16^2 (1868) 616.

Shorea robusta F.-VILL., Noviss. App. 21 (1880) *non* Gaertn.

Shorea vulgaris LANESSAN, Pl. Utiles Col. Fr. (1886) 301; PIERRE, Fl. For. Cochinch. 15 (1890) *t. 232.*

Shorea Vidaliana BRANDIS, Journ. Linn. Soc. Bot. 31 (1895) 83.

Shorea longipetala FOXWORTHY, Mal. For. Rec. 10 (1932) 174, *pl. 13.*

Large trees, 40 to 55 m tall and up to 180 cm in diameter. Branchlets dark-colored, pubescent. Leaves lanceolate or ovate-lanceolate to oblong, acute or acuminate at apex, rounded or subcuneate at base, glabrous or nearly so, 5 to 19 cm long and 1.8 to 8 cm wide; secondary nerves 12 to 16 (or even 26) pairs;

petioles usually 1 to 3 cm long, dark pubescent. Panicles axillary, terminal, 4 to 8 cm long, with numerous short, few-flowered branches. Flowers short-stalked or almost sessile; buds elongate with slightly twisted corolla. Sepals deltoid, ovate, blunt, tomentose outside, 1 mm high, 1.3 mm broad. Petals 9 to 10 times as long as sepals, linear-oblong, obtuse, slightly expanded at base, with slightly irregular margins, pale sericeous outside, smooth and darker-colored inside, longitudinal nerves about 15, about 1 cm long and 1.5 mm wide at base. Stamens 20 to 41 (*vide* Symington), apparently in groups of 3, filaments dilated at base; anther cells shortly oblong, about 0.2 mm long; connective produced into an apical process which is slightly reflexed and has 1 to 8 cilia, cilia usually longer than anther cells. Ovary hemispherical, narrowing above into stylopodium, both long, tomentose, about 1 mm in diameter and, with stylopodium, about 1.3 mm high; style short; stigma minute. Fruit with 3 long wings expanded at base to enclose nut, then oblanceolate, obtuse at apex, grayish pubescent or tomentose, densely so at base, 3 to 4 cm long, 8 to 10 mm wide, with 7 to 10 longitudinal nerves; 2 short wings expanded at base to enclose nut, then linear-oblong, 2 to 2.5 cm long, 2 to 4 mm wide, with about 5 longitudinal nerves, pubescence as in the long wings; nut almost spherical, gray tomentose, about 1 cm in diameter, prolonged into a beak about 5 mm long. The fruit is rather variable. The description was made from *For. Bur. 22076*. Usually the wings are rather short and distinctly grayish pubescent, thus contrasting with those of *S. polysperma*, which are much longer, more slender, and not so pubescent. Nut of *S. polysperma* also distinctly smaller.

There is no type specimen extant; but illustrative material distributed by Merrill, in Species Blancoanae, is *no. 407*, from Limay, Bataan Province, Luzon.

Whitford's description of the tree states:

It has a straight, regular bole, strongly buttressed, that is from three-fifths to two-thirds the height of the tree. The crown is irregularly globular in shape, somewhat open, especially in the dry season. Guijo is found in all the dipterocarp types. While it is tolerant of shade it does better in slightly open places.

The bark of guijo is 5 to 6 mm. in thickness. Long exposed bark is light brown in color with corky pustules and sheds in scroll-shaped or nearly rectangular patches. Freshly exposed bark is cinnamon brown in color. The inner bark is light reddish brown in color and stringy in texture.

The wood has been described in detail and figured by Reyes [32] and Desch.[33]

The form which I have called "pubescent guijo" [34] may be, as Whitford suggested (*fide For. Bur. 11798*), only a young form of this species. Numbers representing this form are *For. Bur. 5899, 6373, 6506, 6933, 10076, 10393, 11798, 12679, 17520, 17699, 17782,* and *Bur. Sci. 10845.*

For. Bur. 22712, collected in Tayabas Province, Luzon, was determined by me as *S. scrobiculata* Burck.[35]

Merrill [36] credits this collection to *S. guiso,* and Symington [37] agrees with him. The leaves of the specimen are very similar to those of that species; but the fruit, with its slender long wings and differently shaped nut, seems to place it elsewhere. The wood is reputed to be a yacal. This form will remain in doubt until flowering material from it can be examined.

S. guiso is one of the most widely distributed Philippine species, being recorded from Indo-China, Siam, the Malay Peninsula, and Borneo. In the Philippines it is very widely distributed, from northern Luzon to southern Mindanao and Basilan. It is usually of rather scattered occurrence in lowland forest and seems to be about the fifth most abundant timber tree of the Archipelago.

2. **SHOREA GISOK** Foxworthy sp. nov. Plate 4.

Shorea balangeran Auct. *non* Dyer; DYER *ex* Vidal, Phan. Cuming Philip. (1885) 97; VIDAL, Rev. Pl. Vasc. Filip. (1886) 61; BRANDIS, Journ. Linn. Soc. Bot. **31** (1895) 86; FOXWORTHY, Philip. Journ. Sci. § C **4** (1909) 508, 516, *pl. 27, fig. 67;* § C **6** (1911) 269; § C **13** (1918) 187; WHITFORD, Philip. Bur. For. Bull. 10 [2] (1911) 73, *pl. 78;* MERRILL, Enum. Philip. Fl. Pl. **3** (1923) 96; REYES, Philip. Journ. Sci. **22** (1923) 336, *pl. 27.*

Ramuli, petioli, racemique lepidoto-velutini, fulvi. Folia e basi rotundata, ovato-lanceolata vel elliptica, acuminata, supra glabra, subtus tenuissime lepidoto-velutina, flavicantia, 10 ad 14 cm longa, 4 ad 6.5 cm lata, nervis secondariis 10 ad 12, tertiariis parum distinctis, parallelis et reticulatis; petioli 2 ad 2.5 cm longi. Racemi folio æquales vel breviores. Sepala deltoi-

[32] Philip. Journ. Sci. 22 (1923) 337, pl. 28.

[33] Mal. For. Rec. **12** (1936) 21–26, pl. 3, fig. 3.

[34] Philip. Journ. Sci. § C **6** (1911) 274.

[35] Philip. Journ. Sci. § C **13** (1918) 192.

[36] Enum. Philip. Fl. Pl. **3** (1923) 97.

[37] Gard. Bull. S. S. **8** (1935) 267.

dea, acuta, intus et extus tomentosa, 2.5 mm longa, 2 mm lata. Petala lineari-oblonga, intus glaber, extus pubescentia, 18 mm longa, 1.5 ad 3 mm lata. Stamina circiter 30, 1 mm longa, filamenta linearia, seta connectivi loculis bis longiore. Ovario conico, tomentoso, 2.5 mm alto, 1.5 mm diametro; stylo glabro, 0.3 mm longo; stigma minuta. Fructus ignotus.

Large trees, with brownish or yellowish pubescent twigs, petioles, and flower clusters. Crown with a light to brownish appearance because of color of underside of leaves. Leaves ovate-lanceolate or elliptic, acuminate at apex, rounded at base, glabrous and dark green above, much lighter-colored beneath because of a fine lepidote covering, 10 to 14 cm long, 4 to 6.5 cm wide; secondary nerves 10 to 12 pairs; tertiary nerves not very distinct because of pubescence, but with a parallel and reticulate arrangement; petioles 2 to 2.5 cm long. Inflorescences terminal and axillary, about as long as leaves or shorter; peduncles pubescent or tomentose. Flowers almost sessile, pedicel only about 0.1 mm long. Sepals deltoid, acute, 2.5 mm long, about 2 mm wide. Petals spreading, linear-oblong, blunt at top, about 18 mm long, 1.5 to 3 mm wide, pubescent outside. Stamens numerous, in groups, about 1 mm long; filament slender, linear, 0.6 mm long; anthers ovate, acute, about 0.4 mm long; appendage to connective slender, pointed, about as long as anther cells, with a number (6 or 7) of long hyaline cilia, which may not be seen with a low magnification. Ovary conical, tomentose, about 2.5 mm high and 1.5 mm in diameter, tapering into short, glabrous, 0.3 mm long style; stylopodium not distinct, or only a slight swelling at upper part of the ovary; stigma minute. Fruit unknown.

LUZON, Tayabas Province, *For. Bur. 25657 Cailipan* (type in the Philippine National Herbarium), June 2, 1916.

This form was first credited to the Islands by Dyer, on *Cuming 884*, from Albay Province. He referred it to *Shorea balangeran* (Korth.) Dyer, a species of Borneo and some other Islands of the Netherlands Indies; his identification was accepted as correct by subsequent workers, although, in 1918, I mentioned that this form differs from Korthals's species in the number of stamens, which are ciliate, and in the shorter style. Some years later, Dr. D. F. van Slooten, at Buitenzorg, told me that he was sure that the reference of the Philippine material to Korthals's species was wrong. Symington [38] says:

[38] Gard. Bull. S. S. 8 (1935) 272, 273.

S. collina, which clearly belongs to the section *Eushorea*, is remarkable in the number of stamens, the shape of the filaments, and the large, short-winged nut. The flower structure is very similar to that of a species erroneously considered by Philippine botanists to be *S. balangeran* (Korth.) Dyer ex Vidal. These species (*S. collina* and *S. balangeran* Auct. non Dyer) are, however, readily distinguishable on vegetative and fruiting characters . . . From the Philippines I have seen three sheets (*For. Bur. 27099, 27381, and 31057*) that are remarkably similar to *S. Foxworthyi* in vegetative characters. Floral dissection, however, shows that the species is quite distinct, although clearly a member of the same group.

and in a footnote: "27099 and 27381 are cited in Merr. Enum. Phil. Pl. 3 (1923) 96 as *Shorea Balangeran* (Korth.) Dyer ex Vidal, but it is very evident that they are not that species." Unfortunately the three numbers cited were not included in the material sent me for study.

It seems evident that this form is distinct from *S. balangeran;* I have described it as new, using for the specific name the vernacular name of the tree in the place where early collections were made.

At the time of my first paper of this series (1911) there had been but one collection of flowering material, *For. Bur. 7096 Kobbe*. That collection was not sent me for this study, but it seems to be the material from which Whitford's plate 78 was prepared. It seems to represent very faithfully the form of the leaves and flower clusters.

Merrill[39] says of *S. balangeran*, "Although this is represented by more than 60 individual collections, all are sterile except the following": He lists eight numbers, only three of which were available for this study, and only one, *For. Bur. 25657*, seems to belong here.

The tree is a large one and produces wood of the grade of yacal. It is known only from the nonseasonal part of the Islands, where it is common in certain districts.

Its distribution, as determined by sterile material, seems to be:

LUZON, Tayabas, Camarines, and Albay Provinces. SAMAR. LEYTE. SIBUYAN. MINDANAO, Agusan, Surigao, and Davao Provinces.

3. **SHOREA FALCIFEROIDES Foxworthy. Yamban, matibia (Zamb.); pamayawasen (Pang.)**

Shorea falciferoides FOXWORTHY, Philip. Journ. Sci. § C 13 (1918) 189.

[39] Tom. cit., p. 96.

A large tree with oblong to oblong-lanceolate, coriaceous leaves which are glabrous, or nearly so, dark green above, distinctly lighter and finely pubescent beneath, 8.5 to 12 cm long, 3 to 6 cm wide, rather abruptly blunt-acuminate at apex, rounded at base; secondary nerves 12 to 14 pairs, occasionally with domatia in axils of some of lower nerves, tertiary nerves not conspicuous; petiole 15 to 20 mm long, grayish pubescent, as are also the twigs and branches of the inflorescence. Stipules small, fugacious. Fruit conical, gray pubescent, tapering into the hairy persistent style, 7 to 8 mm in diameter and 7 to 10 mm tall. The three long accrescent calyx lobes 4 to 5 cm long, 10 to 12 mm wide, grayish pubescent, oblanceolate, with 8 to 10 principal longitudinal nerves and numerous, irregular cross-veins, the short wings 2.5 to 3 cm long, 2 to 3 mm wide, oblanceolate, with about the same number of longitudinal nerves as the larger wings. Flowers unknown.

LUZON, Zambales Province, Masinloc, *For. Bur. 25664 Mayor* (type in the Philippine National Herbarium), June 8, 1916.

Merrill does not mention this species in his Enumeration but includes the type number, *For. Bur. 27170*, and the common name under *S. balangeran* (= *S. gisok*).

The species seems to be most closely related to *S. gisok*, from which it differs in size and shape of leaves. It is known from fruiting, and *S. gisok* from flowering material. Further collecting will be necessary before the two species can be fully described.

The common name in Zambales Province is *yamban*, often with some qualifying term. What is apparently the same species is known in Pangasinan as *pamayawasen*.

For. Bur. 27170, from Zambales Province, with young fruit, is also referred here. The following collections of sterile material may belong here: *For. Bur. 6507, 6931, 11045, 13203, 13204, 13205, 19469*, all from Zambales Province; and *For. Bur. 8278, 8279, 9635, 9637, 13478, 13487, 14390, 21262*, all from Pangasinan Province. Besides these there are three collections of incomplete material from Camarines, *For. Bur. 10643, 21714*, and *21716*, doubtfully referred here.

4. SHOREA ASTYLOSA Foxworthy. Plate 5. Yacal.

Shorea astylosa FOXWORTHY, Philip. Journ. Sci. § C 13 (1918) 188; MERRILL, Enum. Philip. Fl. Pl. 3 (1923) 96.

A very large tree, 25 to 30 m tall, 1 m or more in diameter. Wood very hard, dark brownish yellow, resinous. Leaves ovate, entire, margins slightly inrolled, acuminate at apex, rounded at base, glabrous on upper surface, only slightly pubescent beneath, coriaceous, shiny, 6.5 to 9 cm long, 3.5 to 4.5 cm wide; petioles dark, slender, 1 to 2 cm long; secondary nerves 8 to 12 pairs, tertiary nerves fine, parallel, reticulate, almost as distinct above as below. Inflorescence axillary, paniculate, less than 5 cm long; branches of inflorescence, calyx, and outside of corolla grayish pubescent. Flowers pale to rusty yellow, with a sweet odor. Sepals broadly ovate, concave, imbricate, pubescent outside, smooth within, 1.5 mm long and wide. Petals oblong-lanceolate, rusty yellow, more or less twisted in bud, concave, rounded at apex, 8 mm long, 2 mm wide, distinctly pubescent on the part exposed in bud, faintly puberulous within. Stamens 20 to 30, less than 1 mm long, appendix to connective ciliate, about 0.3 mm long. Ovary pyramidal or conical, grayish pubescent, 1.5 mm tall, about 1 mm in diameter at base, bluntly rounded at apex; style scarcely distinct. Fruit unknown.

MINDANAO, Zamboanga Province, along Dumanguilis River, *For. Bur. 13271 Foxworthy & Demesa* (type in the Philippine National Herbarium), May 8, 1912.

This species differs from *S. gisok* by the shorter and relatively broader leaves, with a smaller number of secondary nerves, smaller flowers; and almost complete absence of a style. It differs from *S. ciliata* in the broader leaves, which are rounded at the base; and in the petals, ovary, and style.

Several collections have been made in the district where the type was collected; the species seems to be fairly common there. It has also been collected in Tayabas and Camarines Provinces, Luzon. Sterile material, which may belong to this species, has been collected in Samar and in Negros.

5. **SHOREA MALIBATO** Foxworthy. Plate 6. Malibato; yacal (Tayabas, Zamboanga); guisok, guisok amarillo (Camarines); guisok madlao (Leyte).

Shorea malibato FOXWORTHY, Leafl. Philip. Bot. 6 (1913) 1955; Philip. Journ. Sci. § C 13 (1918) 189; MERRILL, Enum. Philip. Fl. Pl. 3 (1923) 97; VAN SLOOTEN, Univ. Calif. Publ. Bot. 15 (1929) 203.

A large tree with exceedingly hard wood. Branchlets and twigs grayish pubescent. Leaves lanceolate or ovate-lanceolate, glabrous, dark green above, much lighter-colored beneath, acute or acuminate at apex, rounded or subcuneate at base, 6 to 14 cm long, 2.5 to 5.5 cm wide; secondary nerves about 14 pairs, tertiary nerves parallel, reticulate, not prominent; petiole 12 to 15 mm long, pubescent. Fruit small, almost spherical, with 3 broadly spathulate membranous wings and 2 narrowly spathulate shorter wings. Wings yellow when dry. Fruit covered with a sparse grayish pubescence and enclosed by the expanded bases of calyx lobes.

MINDANAO, Agusan Province, Cabadbaran, Mount Urdaneta, *Elmer 13525* (type in the Philippine National Herbarium), August, 1912.

Fruit and leaves were collected from different trees. Subsequent collections from different localities that have been referred here make it appear that the leaves described are from a rather young tree. Most of the collections have leaves that are whitish, or very light-colored, beneath. Other Philippine material referred here, *For. Bur. 22786,* from Zamboanga Province, Mindanao, and cited by me, was in fruit. The remaining collections, all sterile, are *For. Bur. 1, 4531, 11515,* Tayabas Province; *10647, 10730, 21221,* Camarines Province; *12732,* Leyte Province; *13296,* Zamboanga Province.

This species has been found only in the nonseasonal part of the Archipelago. It is very closely related to *S. ciliata* but differs in fruit and leaf characters. It is distinct from *S. falciferoides* by the more narrowly lanceolate leaves, of thinner texture, subcuneate at base, and drying darker. The fruits are larger and have glabrous, instead of pale-pubescent, wings as in that species.

Van Slooten[40] has recorded this species from British North Borneo, on Elmer's collections, *nos. 21653* and *21713,* from near Tawao, Elphinstone Province. Both of these collections are in flower; the following description is from *Elmer 21713:* Flower buds almost spherical. Sepals almost orbicular, tomentose, about 1.5 mm in diameter. Petals ovate or ovate-lanceolate, tomentose outside, glabrous within, about 4 mm long and 2 mm wide, with numerous longitudinal nerves. Stamens more than 30, filaments long and slender, some of them slightly broadened above base, up to 3 mm long; anthers about 1 mm long, pointed at top, covered with a number of short ciliæ; appendage to connective rather shorter than anther, covered with scattered ciliæ. Ovary almost hemispherical, tomentose, about 1.5 mm high, nearly 2 mm in diameter, abruptly narrowed into glabrous, stoutish, 0.5 mm long style; stigma rather smooth.

Additional collecting is needed to clear up the status of this form.

[40] Tom. cit., p. 203.

6. **SHOREA CILIATA** King.

Shorea ciliata KING, Journ. R. As. Soc. Beng. 62[2] (1893) 118; BRUHL & KING, Ann. Bot. Gard. Calc. 5[2] (1896) 154, *pl. 187a;* BRANDIS, Journ. Linn. Soc. Bot. 31 (1895) 82; RIDLEY, Flor. Mal. Penin. 1 (1922) 229; FOXWORTHY, Philip. Journ. Sci. § C 13 (1918) 188; Mal. For. Rec. 10 (1932) 171.

A medium-sized tree; young branches slender, dark, deciduously hoary puberulous. Leaves coriaceous, lanceolate or oblong-lanceolate, acuminate, base cuneate; both surfaces glabrous, minutely reticulate, lower usually whitish when dry; main nerves 5 to 9 pairs, ascending, curved, shiny on lower surface; length 7.5 to 9 cm, breadth 2 to 4 cm; petiole 19 to 23 mm long. Seedling leaves green on both surfaces. Panicles 5 to 6.5 cm long, axillary and terminal, little branched, few-flowered, hoary. Flowers yellow, very short-stalked, about 12 mm long, secund; buds elongate with twisted corolla. Sepals ovate-deltoid, obtuse, 2.5 to 3 mm long and wide, pale tomentose outside, glabrous inside. Petals narrowly oblong, obtuse, slightly expanded at base, margin slightly reflexed in upper part, 8 mm long, 2 mm wide at base, adpressed sericeous outside, glabrescent inside. Stamens 15 to 30, in fascicles of 3, unequal, the shorter with undilated filaments, the longer with filaments dilated in lower half; connective produced into an apical process crowned by 3 to 5 spreading cilia, which are longer than oblong anthers. Ovary with stylopodium ovoid-conic, sericeous, 2 mm tall, 1 mm in diameter, tapering into short glabrous style. Fruit ovoid, apiculate, pale tomentose, 12 mm long; accrescent sepals membranous, reticulate; 3 outer 5 cm long, 7 to 8 mm broad, 7-nerved, narrowly oblong, narrowed to above concave base; 2 inner 2.5 cm long, linear-lanceolate, few-nerved.

PENANG, *Curtis 1578* (type).

The two collections previously recorded are the only ones thus far known from the Philippines. Neither of these collections were sent me for this study, and I have had to include them without further study. The species description has been adapted from King.

Merrill [41] and Symington [42] think my identification a mistaken one and that the material I have placed here should be under *S. astylosa* Foxw.

[41] Enum. Philip. Fl. Pl. 3 (1923) 96.

[42] Journ. Mal. Br. R. As. Soc. 14 (1936) 348.

The two collections, in flower, are *Bur. Sci. 18575*, from Biliran Island, and *For. Bur. 22788*, from Tayabas Province, Luzon. They seem to me to belong to the Malayan species.

Section 2. ISOPTERA

Fruit supported by spreading coriaceous sepals, which are scarcely longer than fruit; 3 outer sepals orbicular, larger than inner. Sepals imbricate, unequal. Petals linear, much longer than sepals. Stamens 30 to 60: anther cells equal; appendix to connective ciliate. Ovary and stylopodium densely tomentose; style short, glabrous. Cotyledons plano-convex, enclosing hypocotyl, cells filled with fat.

This section was formerly regarded as a separate genus, but van Slooten called attention to the fact that the principal species really belongs to the genus *Shorea*, which makes it necessary to establish a new section of that genus. The floral structure shows that the section is closely related to *Eushorea*.

7. **SHOREA SEMINIS (de Vriese) Van Slooten.**

Shorea seminis (de Vriese) VAN SLOOTEN *ex* Merrill in Univ. Calif. Publ. Bot. **15** (1928) 204.

Hopea seminis DE VRIESE, Minjak Tengkawang (1861) 32.

Hopea ovalifolia FOXWORTHY *non* Boerl., Philip. Journ. Sci. § C **6** (1911) 263; § C **13** (1918) 183.

Isoptera borneensis SCHEFF. *ex* Burck in Ann. Jard. Bot. Buitenz. **6** (1887) 222, *t. 8;* BRANDIS, Journ. Linn. Soc. Bot. **31** (1895) 106; HEYNE, Nutt. Plant. Ned. Ind. **3** (1917) 310; FOXWORTHY, Philip. Journ. Sci. § C **13** (1918) 194, *pl 1;* Mal. For. Rec. **10** (1932) 238; MERRILL, Enum. Philip. Fl. Pl. **3** (1923) 101; REYES, Philip. Journ. Sci. **22** (1923) 336, *pl. 26.*

A large tree. Leaves oblong or oblong-lanceolate, subacute, slightly narrowed to rounded or subcordate base; upper surface glabrous except puberulous midrib; lower surface light-colored, glabrous; main nerves 14 or 15 pairs, oblique, prominent beneath; length 17 to 26 cm, breadth 6 to 8 cm; petiole 2 cm long, pubescent. Stipules caducous. Panicles axillary and terminal, about 15 cm long, stellate-pubescent. Bracts caducous. Flowers short-pedunculate. Calyx lobes minutely tomentose, rounded, 1 to 2 mm long. Petals minutely pale tomentose, 15 mm long, 2 mm wide. Stamens 30 to 60, in 3 series, filaments dilated at base: anthers equal, ovate; connective elongate, ciliate. Ovary sericeous tomentose as is stylopodium, style short, glabrous. Fruit supported by spreading coriaceous sepals; 3 outer sepals orbicular, larger than inner. Cotyledons plane-convex, enclosing hypocotyl, cells filled with fat.

No. 902, 146434 in Herb. Lugd.-Bat. (type).

Sterile material that I formerly referred to *H. ovalifolia* Boerl. belongs here, as Merrill[43] indicated.

A large tree in lowland forest, usually in stream valleys. The wood is of the yacal grade and is used for heavy construction. The fat from the fruit seems not to be used in the Philippines. Of common occurrence in Borneo.

For. Bur. 9133, 9374, 22683, 23829, and *23839,* all from Zamboanga Province, Mindanao, have been referred here. It seems that the following sterile collections may also be referred here, *Bur. Sci. 15002,* from Albay Province [formerly cited by me under (*S. balangeran*)], *For. Bur. 20267,* from Zamboanga Province, *For. Bur. 21199* and *21738,* from Camarines, and *For. Bur. 25954,* from Samar.

Section 3. ANTHOSHOREA

Fruiting calyx with 3 long wings. Flowers large, stamens generally 15 to 17, in a few species 23 to 30; anthers oblong, connective terminating in a long, filiform, naked appendage, sometimes scabrous at end. Ovary mostly glabrous; style longer than ovary; stigma generally 3-dentate: no stylopodium.

The Philippine species of this section produce wood of the *mangasinoro* grade. This wood is pale yellow or whitish and used for temporary construction. The detailed wood structure of *S. mindanensis* Foxw. (*S. polita* Vid.) has been described by Reyes.[44]

8. SHOREA PHILIPPINENSIS Brandis. Saray (Cag.); danlig, malaanonang (Laguna); mangasinoro (Tayab.); malagangao (Cam.); banganon (Agusan); gagil-bato (Lanao).

Shorea philippinensis BRANDIS, Journ. Linn. Soc. Bot. 31 (1895) 88; FOXWORTHY, Philip. Journ. Sci. § C 6 (1911) 272; § C 13 (1918) 190; MERRILL, Enum. Philip. Fl. Pl. 3 (1923) 98; DESCH, Mal. For. Rec. 12 (1936) 27.

Shorea pallida FOXWORTHY, Philip. Journ. Sci. § C 13 (1918) 190.

Large trees, up to 30 m high and 120 cm in diameter. Twigs dark, stellate-pubescent, with short internodes. Stipular bracts enclosing bud triangular-ovate, rather large, semipersistent, with several longitudinal nerves; stipules leaving a distinct scar

[43] Tom. cit., p. 101.

[44] Philip. Journ. Sci. 22 (1923) 330.

on falling. Leaves 3.5 to 9 cm long, 3 to 5 cm wide, elliptic, coriaceous, pallid above and beneath when dry, very young leaves darker, bluntly acuminate at apex, rounded or subcordate at base, under side covered with stellate hairs; secondary nerves 10 to 15 pairs, tertiary nerves usually distinct, parallel; petioles 8 to 10 mm long, pubescent, with stellate hairs. Inflorescences longer than leaves, stellate-pubescent. Flower 1 cm long or longer, white or pale yellow. Stamens 15; appendage to connective filiform, longer than anther. Ovary with base of style puberulous; style filiform, glabrous, longer than ovary; stigma minute. Fruit green when fresh, reddish brown when dry, ovoid, about 1 cm long and about the same diameter, enclosed by bases of calyx lobes; 3 long wings oblong-spathulate, 7 cm long, 16 mm wide, with 10 to 12 longitudinal nerves and numerous reticulate crossveins; 2 short wings 4 to 6 cm long, 5 to 6 mm wide, with 5 to 6 longitudinal nerves.

LUZON, Bulacan Province, Angat, *Vidal 983* (fragment of type of *S. philippinensis* Brandis in the Philippine National Herbarium). Cagayan Province, Casambalangan, *For. Bur. 12996 Bernardo* (type of *S. pallida* Foxw. in the Philippine National Herbarium), July 17, 1911.

The type material was not available to me and so I have not described the flowers more completely. Collections were very few and the species was, for long, very imperfectly understood. *S. pallida* was described from fruiting material and was reduced, by Merrill, to this species.

The species differs from the two other Philippine species of this section in its conspicuous stipules and bracts and its stellate pubescent leaves.

It seems to occur in both the seasonal and nonseasonal parts of the Archipelago but is apparently not abundant.

Collections referred here are:

LUZON, Cagayan Province, *For. Bur. 7084, 17158* (type of *S. pallida*): Laguna Province, *For Bur. 17652, 22290, 23471:* Tayabas Province, *For. Bur. 6068:* Camarines Province, *For. Bur. 27007.* LEYTE, *For. Bur. 12885.* MINDANAO, Agusan Province, *Elmer 14175:*[45] Davao Province, *For. Bur. 31281:* Lanao Province, *For. Bur. 25021.* BASILAN, *Bur. Sci. 15418, 16102, For. Bur. 18887.*

[45] Cited by me in Leafl. Philip. Bot. 6 (1913) 1956, as *S.* sp. aff. *S. Vidaliana* Brandis.

9. **SHOREA POLITA** Vidal. **Lauan, malaanonan.**

Shorea polita VIDAL, Sinopsis Atlas (1883) 15, *t. 15, fig. d;* Rev. Pl. Vasc. Filip. (1886) 61; BRANDIS, Journ. Linn. Soc. Bot. 31 (1895) 88; FOXWORTHY, Philip. Journ. Sci. § C 13 (1918) 190; MERRILL, Enum. Philip. Fl. Pl. 3 (1923) 98; DESCH, Mal. For. Rec. 12 (1936) 39.

Mocanera malaanonan BLCO., Fl. Filip. (1837) 858.

Dipterocarpus malaanonan BLCO., Fl. Filip. ed. 2 (1845) 312.

Shorea malaanonan (Blco.) BL., Mus. Bot. Lugd.-Bat. 2 (1852) 34; A. DC., Prodr. 16^2 (1868) 631; BRANDIS, Journ. Linn. Soc. Bot. 31 (1895) 103; F.-VILL., Nov. App. (1880) 21; MERRILL & ROLFE, Philip. Journ. Sci. § C 3 (1908) 115; WHITFORD, Philip. For. Bur. Bull. 10^2 (1911) 64; FOXWORTHY, Philip. Journ. Sci. § C 6 (1911) 270; § C 13 (1918) 189; MERRILL, Sp. Blancoanae (1918) 271.

Shorea mindanensis FOXWORTHY, Philip. Journ. Sci. § C 13 (1918) 192; MERRILL, Enum. Philip. Fl. Pl. 3 (1923) 97; REYES, Philip. Journ. Sci. 22 (1923) 330, *pl. 21.*

Large tree. Leaves glabrous, distinctly lighter-colored on under side, ovate-lanceolate to elliptic or elliptic-lanceolate, acute at apex, rounded at base, 5 to 15 cm long, 2 to 7.5 cm wide; secondary nerves 12 to 15 pairs, tertiary inconspicuous, parallel, joined by dense reticulate venation; petiole 2 to 3 cm long. Flowers in unilateral spikes in large terminal panicles, the branches of which are slender. Sepals deltoid, pubescent, with straight hairs. Petals broadly oblong, blunt at apex, finely pubescent outside. Stamens about 15; filaments broadened at base, shorter than anther; anthers linear-oblong; appendage to connective elongate, about twice length of anther. Ovary conical, glabrous, narrowed into long cylindrical style; stigma 3-dentate. Fruiting calyx of a brilliant gray, the part which envelops the nut very round, with three long, usually unequal (5 to 8 cm) wings and 2 short (3 cm) and narrow, reddish-yellow, which are much reticulated and with about 10 nerves.

LUZON, Nueva Ecija Province, Bongabong, *Vidal 989* (type of *S. polita* Vidal). BASILAN, near Isabela, *For. Bur. 13769 Foxworthy, Demesa, & Villamil* (type of *S. mindanaensis* Foxw. in the Philippine National Herbarium), April 27, 1912.

The species has had various vicissitudes in terminology. Blanco, in 1837, gave a very indefinite description of what seems to be this species and gave it the name *Mocanera malaanonan.* He changed the name to *Dipterocarpus malaanonan* in his second edition (1845), but did not alter the description. Blume (1852) realized that it belonged to the genus *Shorea* and gave it the name *Shorea malaanonan.* His descriptive note did little but mention the shape of the leaves and the light color of their under sides. DeCandolle (1868) took up Blume's name. He did not elaborate the description, but emphasized the whitish underside of the leaves and the three long wings of the fruiting calyx. The third edition of Flora Filipinas (1880) added nothing to the description, but gave it also in Latin. In the Novissima Appendix [46] however, is given "*Shorea Malaanonan* Bl.—*Mocanera malaanonan* Blanco—*Dipterocarpus malaanonan* Blanco—*S. stellata* Dyer. *Fructus* alae 2 maximae, 1 minor et 2 minimes. Stamina infra 20." This apparently adds nothing except to emphasize the *Shorea* type of fruit. It also shows the first confusion with *Parashorea* (*Shorea stellata* Dyer = *Parashorea stellata* Kurz). Vidal, in 1883, described *S. polita* from fruiting material, his *no. 989* being the type. Brandis (1895) added the description of the flowers,[47] but placed *S. malaanonan* with the insufficiently known forms. Merrill and Rolfe (1908) were the first to consider the two identical and reduced *S. polita* to synonomy. I followed them in this (1911), indicating that *S. polita* was merely a narrower-leaved form. Later (1918) I considered the two distinct, and both good species. Whitford [48] described *malaanonang-lauan* and stated that it was produced by *S. malaanonan*. He indicated that the common name, *malaanonang*, is used also for *Parashorea plicata* and *Pentacme contorta*. Merrill (1918) in his Species Blancoanae placed *S. malaanonan* in *Parashorea*, with the name *P. malaanonan*, keeping *S. polita* distinct, an arrangement which he retained in his Enumeration (1923). His argument was:

> I am now convinced that this interpretation (that of Merrill & Rolfe (l. c.) was erroneous; that *Shorea polita* is a valid species entirely distinct from *Mocanera malaanonan* Blanco, and that Blanco's species is identical with the common and widely distributed Philippine *Parashorea plicata* Brandis. Among all the Philippine Dipterocarpaceae *Parashorea plicata* Brandis is the only one that agrees with Blanco's description in the character of the leaves, whitish beneath, which are further described as wide, pointed, and a "geme" (i. e., 15 to 18 cm. long, while the pericarp of the fruit is described as fragile. The description conforms to *Parashorea plicata*, and I have not the slightest hesitation in adjusting the synonymy. The native name cited by Blanco, malaanonan, is valueless in interpreting the species, as it is a made-up one, literally "false anonang", *anonang* = *Cordia Myxa* Linn., and, as used to-day, is very loosely applied, although I have specimens of *Parashorea plicata* Brandis from Laguna Province, Luzon, bearing this name.

[46] Page 21. [47] Tom. cit., p. 103. [48] Loc. cit.

I have already stated [49] under *S. malaanonan,*

> Other species that have been considered as belonging here are *Parashorea plicata* and *Shorea polita.* The principal reason for considering the first is that it has the underside of the leaves whitish and is sometimes known by the common name of *malaanonan.* Both of these conditions are met by the other two species. Blanco's description refers to three long calyx-lobes in the fruit, which would certainly indicate *Shorea* rather than *Parashorea.* The description also mentions three stigmas, which is not the case in *Parashorea plicata.*

These facts seem to me to indicate that *Parashorea* was not meant. Merrill has called attention to the unsatisfactory nature of the common name, *malaanonan.* However, collections have shown the use of this name more commonly for *S. polita* and for *Pentacme contorta* than for *Parashorea.* The record, in the material sent me for study, is as follows: 101 Collections of *Parashorea plicata* show the use of this common name but once (from Laguna Province); the species not having been found in the locality where Blanco did his work; 138 collections of *Pentacme contorta* show the use of this name 13 times, 2 of them from Bulacan, no other common name being recorded on the collections from that province; 28 collections of *S. polita,* at no great distance from the part of Bulacan Province where Blanco worked for so many years, all of them from Rizal Province, show the use of this name 4 times. It seems, therefore, that such evidence as is furnished by the common name favors this species. I am now (as in 1911) inclined to believe that *S. malaanonan* and *S. polita* constitute one rather variable species, the latter name having originally been applied to the narrower-leaved forms. *S. polita* is adequately described and is represented by a type specimen. It is, therefore, the preferred name.

Mr. Symington, when he examined the Philippine material, indicated that he considered *Shorea mindanensis* Foxw. a synonym of *S. polita,* and I believe that he is right. The transfer was made by Desch.[50] The scanty collections of *S. mindanensis* do not show the whitish underside of the leaves, but otherwise they seem to fit this species.

S. polita is a species of the lowland forests, apparently of rather scattered occurrence, in both the seasonal and nonseasonal parts of the Islands. The wood is coarse-grained yellow lauan of the sort often known by the name *mangasinoro.*

[49] Philip. Journ. Sci. § C 13 (1918) 190.
[50] Tom. cit., p. 39.

The recorded distribution is as follows:

LUZON, Cagayan, Ilocos Sur, Pangasinan, Nueva Ecija, Zambales, Rizal, Laguna, and Tayabas Provinces. MINDORO. MINDANAO, Davao and Cotabato Provinces. BASILAN.

One collection, *For. Bur. 10333*, which I formerly identified [51] as *Pentacme* sp., has been placed by Symington in this species. I cannot agree with this, as the specimen seems to be distinct by reason of its distinct stipules, its pronounced tomentum, and its shape. The material is sterile, and a definite identification seems impossible.

10. SHOREA KALUNTI Merrill. Kalunti, mangasinoro.

Shorea kalunti MERR., Philip. Journ. Sci. 26 (1925) 475; DESCH, Mal. For. Rec. 12 (1936) 35, 39.

A tree about 50 m high, glabrous except the densely cinereous-pubescent inflorescences. Branches and branchlets terete, glabrous, with numerous small lenticels, usually dark brown when dry. Leaves 7 to 10 cm long, 3.5 to 5 cm wide, coriaceous, smooth, shiny, ovate to oblong-ovate or elliptic-ovate, pale olivaceous or sometimes greenish when dry, about the same color on both surfaces, narrowed upward to the obtusely acuminate apex, base subobtuse to rounded; lateral nerves about 7 on each side of midrib, slender, distinct, reticulations lax, not prominent; petioles 6 to 10 mm long, glabrous. Inflorescences axillary, densely and softly cinereous-pubescent with short hairs, flowers falcately arranged on ultimate branchlets. Flowers about 7 mm long, their pedicels stout, about 1 mm long. Sepals elliptic-ovate, obtuse, 2 mm long, densely pubescent. Petals oblong, 6 mm long, about 2 mm wide, obtuse, densely pubescent externally, twisted in anthesis. Stamens 15, minute anthers globose to ellipsoid, 0.2 mm long, apical appendage 0.3 mm long, slender, glabrous. Ovary glabrous below, minutely pubescent above; style pubescent, less than 1 mm long; stylopodium none. Young fruits oblong-ovoid, about 1 cm long, pubescent, accrescent sepals in fruit 5, oblanceolate to spathulate, rounded, about 8 mm wide, more or less pubescent, much narrowed below, the 3 longer ones up to 5 cm long, the 2 shorter ones nearly as long.

MINDANAO, Davao Province, Banauan, *For. Bur. 27701 Angeles & Hilario* (type in the Philippine National Herbarium), April 30, 1919. Fruit described from *For. Bur. 13294* and

[51] Philip. Journ. Sci. § C 6 (1911) 268.

13902 Foxworthy & Demesa, collected in Zamboanga Province, Mindanao, May and June, 1912. These two fruiting specimens and various sterile specimens doubtfully referred by me to *S. mindanensis* Foxw. have also been placed here.

This large tree of lowland forest is known only from southern Mindanao. It has been recorded from Davao, Lanao, and Zamboanga Provinces.

Section 4. PINANGA

Fruiting calyx with 3 long wings; stamens 15; anthers short; appendage of connective not ciliate, sometimes scabrous at the end.

Two of the species, *S. plagata* and *S. negrosensis,* may be incorrectly placed in this section. The former is known only from fruiting material, the latter has many more stamens, with rather long anthers. Their position is obscure, but they are placed here because stem structure seems to indicate closer relationship to this than to the other sections recognized as occurring in the Philippines.

11. SHOREA PLAGATA Foxworthy.

Shorea plagata FOXWORTHY, Philip. Journ. Sci. § C 13 (1918) 192.

Large trees, up to 40 m tall and 90 cm in diameter. Bark black, thick, furrowed or scaly. Stipules small, fugaceous. Leaves coriaceous, glabrous, ovate-lanceolate or elliptic, acuminate at apex, rounded at base; blade 6 to 12 cm long, 3 to 5.5 cm wide; secondary nerves 9 to 12; petioles 12 to 15 mm long, black. Flowers unknown. Fruit ovoid, sericeous, 12 to 15 mm long, 11 mm in diameter; 3 long wings spathulate, 7 cm long, 12 to 16 mm wide, with 7 to 10 longitudinal nerves and reticulate crossveins; 2 short wings 3 to 4 cm long, 2 to 3 mm wide, with about 6 longitudinal nerves. Wings with pubescence of scattered stellate hairs.

MINDANAO, Zamboanga Province, Fort Banga, *For. Bur. 13758 Foxworthy, Demesa & Villamil* (type in the Philippine National Herbarium), June 17, 1912.

The wood is a fine grade of red lauan, but harder and heavier than is usually the case with that wood. It has some resemblance to *guijo* and is sometimes locally known by that name.

The section of the genus to which this species belongs cannot be determined with certainty until flowering material is available.

Sterile material of this species was [52] referred to *Shorea* sp. Merrill [53] referred this species to *S. astylosa,* which it cannot possibly be.

The species is known only from Mindanao. It has been collected in Bukidnon, Lanao, and Zamboanga Provinces. Two collections from Lanao, *For. Bur. 30605* and *30631,* have immature flowers and may belong here. Flowering material from the type locality is needed.

12. **SHOREA POLYSPERMA** (Blanco) Merrill.

Shorea polysperma (Blanco) MERR., Philip. Govt. Lab. Publ. 20 (1905) 22; 29 (1905) 29; Philip. Journ. Sci. 1 Suppl. (1906) 98; Sp. Blanconae (1918) 269; Enum. Philip. Fl. Pl. 3 (1923) 99; FOXWORTHY, Philip. Journ. Sci. § C 2 (1907) 356, 357, 394; § C 4 (1909) 423, 510, 518, *pl. 27, fig. 72;* § C 6 (1911) 277; § C 13 (1918) 191; EVERETT & WHITFORD, Philip. Bur. For. Bull. 5 (1906) 26; MERRITT, Philip. Bur. For. Bull. 8 (1908) 16, 48; WHITFORD, Philip. Journ. Sci. § C 4 (1910) 703; Philip. Bur. For. Bull. 10^2 (1911) 62, *pls. 66, 67;* REYES, Philip. Journ. Sci. 22 (1923) 328, *pls. 19, 20.*

Mocanera polysperma BLANCO, Fl. Filip. (1837) 448.

Dipterocarpus polysperma BLANCO, Fl. Filip., ed. 2 (1846) 312.

Hopea tangili BLUME, Mus. Bot. Lugd.-Bat. 2 (1852) 35.

Shorea talura F.-VILL., Novis. App. (1880) 21, *non* Roxb.

Shorea warburgii GILG in Engl. Bot. Jahrb. 18 Beibl. 45 (1894) 38; BRANDIS, Journ. Linn. Soc. Bot. 31 (1895) 98; FOXWORTHY, Philip. Journ. Sci. § C 6 (1911) 278; § C 13 (1918) 191.

Shorea Teysmanniana FOXWORTHY, Philip. Journ. Sci. § C 6 (1911) 279; § C 13 (1918) 192, *non* Dyer; WHITFORD, Philip. Bur. For. Bull. 10^2 (1911) 68; MERRILL, Enum. Philip. Fl. Pl. 3 (1923) 99; REYES, Philip. Journ. Sci. 22 (1923) 326, *pl. 17.*

A very large tree of hill forests, at from 100 to 800 m above the sea, reaching a height of 50 m and a diameter of more than 2 m. Branchlets dark brown, glabrous. Leaves ovate-lanceolate, acuminate, 8 to 11 cm long, 3 to 5 cm wide, shiny, coriaceous, base rounded, rarely somewhat acute, apex usually rather long-acuminate; nerves 10 to 12 pairs, subprominent, ascending; petioles 2 cm long, glabrous or at first pubescent. Panicles 20 cm long or less, branches ascending, lower branches often 15 cm long, densely pubescent with gray hairs. Flowers small, yellowish. Sepals imbricate, broadly ovate, obtuse or subacute, 3 mm long, 2.5 mm wide, densely pubescent, three outer ones enclosing the two inner. Petals 8 mm long, 3.5 mm wide,

[52] Philip. Journ. Sci. § C 6 (1911) 279.
[53] Enum. Philip. Fl. Pl. 3 (1923) 96.

obtuse. Stamens 15, in two series, filaments broad, 1 mm long; anthers broadly ovate, 0.6 mm long, appendix to connective slender, as long as anther. Ovary pubescent, stylopodium very obscure or wanting; style slender, 1.5 mm long. In fruit all sepals accrescent, three outer sepals 4.5 cm long, 8 to 10 mm wide, obtuse; two inner sepals about 2 cm long or less, 3 mm wide.

For. Bur. nos. 606, 734, 784, 819, 1410, and Whitford no. 132, all from Bataan Province, Luzon, were cited with the original description: Cagayan Province, Peñablanca, *Warburgh 12399* (type of *S. Warburgii* Gilg) in the Kew Herbarium (type in the Philippine National Herbarium).

Merrill suggested that Blanco's use of the specific name *polysperma* was due to his having mutilated or very imperfect fruits. I think it more likely that Blanco's material had more than one ovule developed in each fruit. This abnormal development occasionally occurs in many members of this family.

Tiaong, a common hill form in Laguna and Tayabas, was referred by me to *S. Teysmanniana* Dyer, a species known only from sterile material collected in Bangka. Symington recently [54] described that species more fully, and his description does not fit the Philippine form known as tiaong, which is still known only from sterile material. The wood seems to be slightly lighter and softer than that of tanguile and the stipules seem to be larger, but these differences may not be constant; it seems best to consider the form known as tiaong as belonging to this species.

The wood is a good grade of red lauan, known on the market as tanguile. It is used for bancas, interior construction, and furniture.

S. polysperma is widely distributed in the Archipelago and has been recorded from the following regions:

BABUYANES. LUZON, Cagayan, Isabela, Ilocos Norte, Pangasinan, Nueva Ecija, Bulacan, Zambales, Bataan, Rizal, Laguna, Tayabas, Camarines, Albay, and Sorsogon Provinces. POLILLO. MARINDUQUE. MINDORO. NEGROS, Negros Occidental Province. CEBU. LEYTE. BILIRAN. PANAY, Capiz Province. SAMAR. SIBUYAN. MINDANAO, Agusan, Bukidnon, Lanao, Davao, and Zamboanga Provinces. BASILAN.

13. SHOREA SQUAMATA (Turcz.) Dyer. Mayapis, pura, kalian, alam, tabac.

Shorea squamata (Turcz.) DYER *ex* Vidal, Phan. Cuming Filip. (1885) 97; Rev. Pl. Vasc. Filip. (1886) 62; BRANDIS, Journ. Linn. Soc.

[54] Gard. Bull. S.S. 7 (1933) 134, pl. 38.

Bot. 31 (1895) 92; MERRILL, Philip. Journ. Sci. § C 2 (1907) 285; FOXWORTHY, Philip. Journ. Sci. § C 2 (1907) 386; § C 4 (1909) 519; § C 6 (1911) 275; § C 13 (1918) 191; Leafl. Philip. Bot. 6 (1913) 1957; MERRITT, Philip. Bur. For. Bull. 8 (1908) 16, 43; WHITFORD, Philip. Journ. Sci. § C 4 (1910) 715; Philip. Bur. For. Bull. 10[2] (1911) 66, *pl. 63.*

Hopea squamata TURCZ., Bull. Soc. Mosc. 31[1] (1858) 239; A. DC., Prodr. 16[2] (1868) 635.

Shorea floribunda F.-VILL., Novis. App. (1880) 21, *non* Kurz.

Shorea palosapis MERR., Sp. Blancoanae (1918) 271; Enum. Philip. Fl. Pl. 3 (1923) 98; REYES, Philip. Journ. Sci. 22 (1923) 325, *pl. 16.*

Shorea rugosa FOXWORTHY, Philip. Journ. Sci. § C 13 (1918) 191, *non* Heim.

A large tree up to 50 m high and 150 cm in diameter. Twigs dark, stellate-pubescent. Stipules broadly ovoid, acute or obtuse, large, semipersistent, leaving distinct scars on falling. Leaves coriaceous, ovate-oblong or elliptic, shortly acuminate at apex, rounded or cordate at base, upper side glabrous except for tomentose midrib, underside rough with tufts of stellate hairs; secondary nerves 14 to 18, curved, tertiary nerves parallel; blade 10 to 20 cm long, 6 to 10 cm wide; petiole 2 cm long, stellate-pubescent, with scattered hairs. Inflorescences axillary and terminal, longer than leaves, tomentose, with scattered tufts of stellate hairs; branches short, few-flowered, distichous, unilateral. Flowers almost sessile, bibracteolate, with oblong bracts, yellowish with slightly aromatic odor, about 9 mm long. Sepals deltoid, gray tomentose outside, 3 to 3.5 mm long, about 2 mm wide at base. Petals oblong or oblong-lanceolate, about 9 mm long and 3 mm wide, reflexed in anthesis, with numerous longitudinal nerves; tomentose outside, glabrous within. Stamens 15; "filaments of the 5 inner episepalous stamens with a thick rounded base, upon which the 5 outer episepalous filaments are inserted;" filaments about 0.3 mm wide at base, broad part 0.3 to 0.4 mm high, abruptly narrowed to the 0.2 mm long filiform portion below anther; anthers almost orbicular, about 0.3 mm in diameter, appendage to connective filiform, up to 1 mm long. Ovary and stylopodium almost conical, tomentose, about 1 mm in diameter at base and 1.5 mm tall, tapering into glabrous 1.5 mm long style; stigma minute. Fruit with nut ovoid, gray tomentose, about 2.5 cm long and 2 cm in diameter, 3 long wings 10 to 12 cm long (sometimes 15 to 17 cm), 1.5 to 2 cm wide, with about 10 longitudinal nerves; 2 short wings 4 to 6 cm (Brandis says 4 to 5 inches) long, 4 to 6 mm wide, with about 4 longitudinal nerves.

LUZON, Albay Province, *Cuming 883* [cotype of *Shorea squamata* (Turcz.) Dyer in the Philippine National Herbarium], *892*. The species was described from *Cuming's 883* and *892*.

The stipules are larger than in any other Philippine species of *Shorea;* they are persistent for a time, extending nearly around the stem. In some cases the stipules drop early, and although they leave distinct scars, it is more difficult to recognize the species. There is considerable variation in the amount of hairiness.

Whitford's description adds the following:

The tree is strongly buttressed and has a regular bole with a length up to 25 or 30 m. The crown is spreading, flatly conical in shape, and dense. It is found more or less abundantly from the northern part of Luzon to the southern part of Mindanao. It does best on rich, deep, but fairly well-drained soils in the lowlands and seldom reaches an altitude of over 300 meters . . . It is confined to regions where the dry season is not pronounced.

The bark is from 8 to 16 mm. in thickness: it is brown to dark brown or cinnamon brown in color, gray when exposed to strong light and black when wet. It is rather prominently ridged, especially above. The inner bark is stringy in texture and brown to slightly pink in color, especially a distinct vertical band beneath the furrows . . . This tree resembles closely almon-lauan, but can be distinguished from it by its darker colored bark and much coarser, larger leaves and more prominent hairs. The wood, also, is redder in color.

The plate in Whitford's paper gives a good representation of the leaves and stipules.

Merrill's change of the name to *S. palosapis* seems undesirable. If he is correct in his interpretation of Blanco's exceedingly scanty description ("Some botanists might consider his name a *nomen nudum* or at least a *nomen subnudum*")[55] it is evident that Blanco made a mistake and confused the common names *palosapis* and *mayapis,* both of which are usually applied to *Anisoptera thurifera* (Blco.) Bl. The name *palosapis* has not been found to be used for this species; the name *mayapis* is the most used name for it in certain sections, particularly in eastern Laguna Province and adjacent localities. It seems better, in view of the inadequate description, the mistake in the use of the common name, and the lack of type material, to discard the name *S. palosapis* and to retain the well-authenticated name *S. squamata*.

[55] Loc. cit.

Merrill[56] has reduced to synonomy the name *S. rugosa* which I used[57] for a collection, *For. Bur. 13293*, from Mindanao. The material has young fruit and is not typical of this species, differing in the shape of stipules and in the size and form of fruit; however, it may be within the range of possible variation of the species.

S. squamata has been credited to Borneo, on the one collection by Beccari in Sarawak.

The Philippine distribution, as shown by herbarium specimens, is:

LUZON, Cagayan, Isabela, Nueva Ecija, Bulacan, Rizal, Laguna, Tayabas, Camarines, Albay, and Sorsogon Provinces. POLILLO. MARINDUQUE. BOHOL. SAMAR. LEYTE. BILIRAN. MINDANAO, Agusan, Bukidnon, Misamis, Davao, Lanao, Surigao, and Zamboanga Provinces. BASILAN.

More than 100 collections indicate that *mayapis* is the commonest name.

14. SHOREA ALMON Foxworthy sp. nov. Plate 7. Almon.

Shorea furfuracea Auct. *non* Miquel; ROLFE, Journ. Bot. 23 (1885) 210; VIDAL, Rev. Pl. Vasc. Filip. (1886) 62; BRANDIS, Journ. Linn. Soc. Bot. 31 (1895) 98; FOXWORTHY, Philip. Journ. Sci. § C 4 (1909) 517; WHITFORD, Philip. Journ. Sci. § C 4 (1910) 712; Philip. Bur. For. Bull. 10[2] (1911) 63, *pls. 58, 59.*

Shorea eximia Auct. *non* Scheffer; FOXWORTHY, Philip. Journ. Sci. § C 6 (1911) 276; § C 13 (1918) 191; MERRILL, Enum. Philip. Fl. Pl. 3 (1923) 96; REYES, Philip. Journ. Sci. 22 (1923) 331, *pl. 28.*

S. squamata (Turcz.) Dyer similis, sed folia, stipulae, et ovario minores.

Large trees, gregarious. Bark ridged, 1.5 to 2 cm thick. Branchlets, stipules, petioles, underside of leaves, and branches of inflorescence with tufts of stellate hairs, which are sometimes very long. Leaves elliptic to ovate, shortly acuminate at apex, rounded at base, 9 to 12 cm long, 4 to 6 cm wide, underside with clusters of stellate hairs along nerves; secondary nerves 14 to 22 pairs, tertiary nerves parallel, prominent; petiole 1 to 2 cm long, stellate, tomentose. Inflorescences axillary and terminal, much branched, up to 25 cm long; peduncles scabrous, with tufts of stellate hairs. Flowers subtended by broadly ovate bracts, which are tomentose, 5 to 6 mm long and 3 to 4 mm

[56] Enum. Philip. Fl. Pl. 3 (1923) 98.
[57] Philip. Journ. Sci. § C 13 (1918) 191.

wide; pedicels 1 to 2 mm long, tomentose with stellate hairs; flowers spreading, about 7 mm high and 8 mm wide, said to be yellow and fragrant. Sepals broadly lanceolate, slightly recurved at apex, coarsely tomentose outside and smooth within, 3 mm long and 2 mm wide at base. Petals oblong, about 8 mm long and 3.5 to 4 mm wide, the portion exposed in bud tomentose, the rest glabrous, with about 10 longitudinal nerves. Stamens 15, in two series, the two series alike except for length of filaments; filaments of longer series 1 to 2 mm long, about 0.3 mm wide near base, tapering to a slender filiform portion below orbicular anthers, anthers about 0.3 mm in diameter, appendage to connective long-filiform, up to about 1.2 mm long. Ovary without stylopodium, finely tomentose, 1 to 1.5 mm high and about same diameter at base, tapering into filamentous, glabrous, 3 mm long style; stigma minute. Fruit almost spherical, tomentose, about 1 cm in diameter; fruiting calyx with 3 wings 9 to 12.5 cm long, 15 mm wide, narrowed below; base dilated, tightly enclosing fruit, 7 to 9 longitudinal nerves, transverse nerves prominent; the 2 short wings narrower, up to about 5 cm long. Young fruit and calyx wings pubescent or tomentose, with numerous scattered stellate hairs, some of which persist on mature fruit.

NEGROS, Occidental Negros Province, Cadiz, *For. Bur. 11647 Whitford* (type of *S. Almon* Foxw. in the Philippine National Herbarium), April 10, 1909.

This form was first credited by Rolfe (1885) to *S. furfuracea* Miq., on *Cuming 880*, from Albay Province, Luzon. This same reference was used by Vidal (1886). Brandis (1895) considered *S. eximia* (Miq.) Scheff. a synonym and referred to it two of Vidal's collections from Albay Province. He also gave a partial description of the flowers, presumably from the Philippine material: "Flowers only on the Philippine specimens, which have shorter elliptic leaves and are perhaps specifically different." Merrill[58] referred to *S. furfuracea* a sterile specimen of *S. guiso* from Bataan Province. In 1911 I reduced *S. furfuracea* Miq. to synonomy with *S. eximia* (Miq.) Scheff., which I believed to be the Philippine form. Ridley[59] stated that the Philippine material referred here was quite distinct from *S. furfuracea*. Merrill (1923) stated that our form apparently

[58] Philip. Journ. Sci. 1 Suppl. (1906) 98.
[59] Fl. Mal. Penin. 1 (1922) 233.

needed a new name. Van Slooten [60] called attention to the fact that *S. eximia* is distinct from *S. furfuracea*, and material identified by him as the latter species was quite distinct from the Philippine form here described as new.

S. almon is a large tree of wide distribution in lowland forest in the nonseasonal part of the islands. It is closely related to *S. squamata*, from which it differs in the smaller size of its leaves, its flower structure, and in its lighter-colored wood.

The recorded distribution of *Shorea almon* is:

LUZON, Tayabas, Camarines, Albay, and Sorsogon Provinces. NEGROS, Negros Occidental Province. SAMAR. LEYTE. MINDANAO, Surigao, Agusan, Bukidnon, Misamis, Lanao, and Zamboanga Provinces. BASILAN.

15. **SHOREA NEGROSENSIS** Foxworthy.

Shorea negrosensis FOXWORTHY, Philip. Journ. Sci. § C 6 (1911) 274, *pl. 44;* § C 13 (1918) 192; MERRILL, Enum. Philip. Fl. Pl. 3 (1923) 97; REYES, Philip. Journ. Sci. 22 (1923) 327, *pl. 18.*

Large trees, up to 50 m tall and 2 m in diameter. Bark thick, black, fissured. Twigs tomentose. Stipules small, triangular, nerved, hairy, fugacious. Leaves elliptic, oblong or ovate, smooth and dark green above, except for depressed, tomentose midrib, pilose or stellate hairy along nerves beneath, sharply acuminate at apex, rounded at base, 9 to 15 cm long, 4 to 6 cm wide; secondary nerves 12 to 16; tertiary nerves parallel, reticulate, distinct, with regularly placed tufts of stellate hairs; underside of leaf much like that of *S. almon*, but less hairy; petioles 1.5 to 2 cm long, tomentose; when dried, leaves often with a coppery color beneath. Inflorescences axillary and terminal, up to 15 cm long; branches short, unilateral, few-flowered; peduncle and branches tomentose, with stellate hairs. Flowers sessile, spreading in anthesis, about 1.5 cm across, "cream-colored, with sickish odor." Sepals with grayish tomentum of straight hairs outside, glabrous within, deltoid, about 2.5 mm long and wide, with numerous longitudinal nerves. Petals tomentose outside, glabrous within, broadly oblong or ovate, 6 to 7 mm long, 3 to 4 mm wide, ragged at top, with 10 to 12 very distinct longitudinal nerves. Stamens numerous, sometimes as many as 50, fascicled; filaments flattened at base, tapering to filiform below anthers, 3 to 4 mm long, 0.4 to 0.6 mm

[60] Univ. Calif. Publ. Bot. 15 (1929) 203.

wide at base; anthers oblong, rounded or acute at apex, about 1 mm long; connective a dark line between anther cells; appendage to connective fine, reflexed, tapering to a very fine point, distinctly shorter than anther. Ovary conical, tomentose, about 1.5 mm high, a little less in diameter, tapering into smooth, 1.5 mm long style; stigma slightly broader than style, obscurely lobed; no stylopodium. Fruit unkown.

NEGROS, Occidental Negros Province, along Himugaan River. *For. Bur. 7281 Everett* (type in the Philippine National Herbarium), May 22, 1907.

This form is of uncertain relationship. It does not fit the section *Pinanga,* as defined by Brandis, but it has been placed there as a matter of convenience, as its stem structure is very similar to that of some members of that section.

A tree of lowland forest, gregarious and occurring in great quantities in some localities.

The wood is a good grade of red lauan and has sometimes been marketed under the trade name of "Philippine mahogany."

Recorded distribution:

LUZON, Cagayan, Isabela, Nueva Ecija, Bulacan, Laguna, Tayabas, Camarines, Albay, and Sorsogon Provinces. POLILLO. BILIRAN. CEBU. SAMAR. LEYTE. NEGROS. MINDANAO, Surigao and Agusan Provinces.

7. Genus PARASHOREA Kurz

Large trees up to 50 or 60 m high and 2 m in diameter. Stipules leaving annular scars. Leaves light-colored beneath. Inflorescences axillary and terminal. Sepals imbricate in bud but soon opening at top and overlapping only at base, so as to appear valvate. Petals imbricate. Stamens 15; anthers linear, on short filaments, connective more or less prolonged; anther cells more or less unequal, two posterior cells shortly beaked. Ovary hairy. Fruit tomentose. Five long wings, narrowed below, not enclosing fruit. Cotyledons fleshy, equal or subequal, deeply bilobed.

Seedling development.—Certain species have seedlings which during their early development show only aciculate leaflike organs, which may be stipules. *P. plicata* usually has seedlings with leaves of normal type, but there is an indication of aciculate organs at some of the early nodes.

Wood.—The wood is coarse in texture and of the lauan type. Reyes [61] has given a detailed account of the wood structure.

[61] Philip. Journ. Sci. 22 (1923) 330.

Resin.—The resin is usually scanty in amount and apparently of no value.

Trees characteristic of the nonseasonal parts of the islands, where they are abundant. Reproduction copious. Flowering and fruiting occur at wet times, and the seed is disseminated by the wind. Storm winds have been observed to carry fruits to a distance of more than one kilometer.

Five species are known, 1 in Burma, Siam, and Indo-China, 2 in the Malay Peninsula, 3 in Sumatra, and 2 in the Philippines.

Key to Philippine species of Parashorea.

a^1. Leaves rather smooth and whitish beneath; fruit less than 2 cm in diameter .... 1. *P. plicata.*
a^2. Leaves brownish pubescent or tomentose beneath; fruit more than 2 cm in diameter .... 2. *P. warburgii.*

1. **PARASHOREA PLICATA Brandis. Apnit (Polillo, Tayabas, Catanduanes, Camarines, Albay, Sorsogon); bagtican (Occidental Negros, Davao); bayucan (Nueva Ecija, Laguna); binaliuan (Bulacan); danlig (Tayabas, Masbate, Occidental Negros); lauan (Nueva Ecija, Laguna, Rizal, Tayabas, Camarines, Sorsogon, Masbate, Capiz, Occidental Negros, Leyte, Samar, Surigao, Agusan, Davao, Zamboanga); malaanonang (Laguna); mayapis (Polillo); tacuban (Camarines).**

Parashorea plicata BRANDIS, Journ. Linn. Soc. Bot. 31 (1895) 104; MERR. & ROLFE, Philip. Journ. Sci. § C 3 (1908) 114; FOXWORTHY, Philip. Journ. Sci. § C 6 (1911) 280; § C 13 (1918) 194; WHITFORD, Philip. Bur. For. Bull. 10[2] (1911) 64, *pls. 60, 61.*

Parashorea malaanonan MERRILL, Sp. Blancoanae (1918) 271; Enum. Philip. Fl. Pl. 3 (1923) 100, *excl. syn.;* VAN SLOOTEN, Bull. Jard. Bot. Buitenz. III 8 (1927) 373; Univ. Calif. Publ. Bot. 15 (1929) 202; REYES, Philip. Journ. Sci. 22 (1923) 330, *pls. 6–8, 22.*

Branchlets dark when dry, glabrous or with scattered stellate hairs. Stipules deciduous, semiamplexicaul, leaving annular scars. Leaves elliptic to ovate, 6 to 15 cm long, 5 to 8 cm wide, glabrous, shiny dark green above, whitish beneath; secondary nerves 7 to 10 pairs, with a distinct fold between them, similar to that in *Dipterocarpus;* petioles 1.5 to 2 cm long, grayish pubescent. In terminal bud young leaves completely enclosed within stipules. Inflorescences branched, 12 to 15 cm long, branches few-flowered, gray tomentose. Flowers large, up to 2.5 cm in diameter, white or yellowish, rather fragrant, on thick tomentose pedicels half length of sepals. Sepals equal, lanceolate, acute, 7 to 8 mm long, 3 mm wide at base, grayish tomentose outside, pubescent inside. Petals ovate, 1.5 to 2 cm long, about 1 cm wide, pubescent or tomentose on part exposed in bud, pubescent or glabrous inside, many-nerved. Stamens 15, in two whorls; filaments ovate or ovate oblong, abruptly attenuate, 1 to 2 mm long, up to 1 mm wide at base; anthers linear, glabrous, cells nearly equal, two posterior cells bluntly apiculate, 2 to 2.5 mm long; appendage of connective 4 to 5 mm long, thick, spindle-shaped, with a long point. Ovary half immersed in broad obconical receptacle, narrowed into a 2 mm long hairy stylopodium; style longer than stylopodium, upper half glabrous; stigma minute, flat. Fruit with 5 long wings, 8 to 15 cm long, wings narrowed below, not enclosing fruit. Nut nearly globose. tomentose, 1.5 to 2.75 cm high, about the same diameter, crowned by persistent stylopodium.

Vidal 76, 990, 2033 (type).

Merrill[62] has, I think, a mistaken view of the identity of Blanco's *Mocanera malaanonan* and *Dipterocarpus malaanonan*, which seem to belong to *Shorea malaanonan* Bl.=*S. polita* Vid.[63] The name "malaanonan" is commonly used for several of the species producing lauan, but it is rarely used for *Parashorea*.

This species is also known from Borneo.

Distribution in the Philippines:

LUZON, Nueva Ecija, Bulacan, Rizal, Laguna, Tayabas, Camarines, Albay, and Sorsogon Provinces. POLILLO. CATANDUANES. MASBATE. PANAY, Capiz Province. NEGROS, Occidental Negros Province. LEYTE. SAMAR. BILIRAN. MINDANAO, Surigao, Agusan, Bukidnon, Davao, and Zamboanga Provinces.

The name "bagtican" has come into common use because it was the name used locally in Occidental Negros Province, where the species was first exploited commercially on a large scale.

2. PARASHOREA WARBURGII Brandis. Apnit, danlig, lauan pula (Tayabas); lauaan, bagtican (Agusan).

Parashorea Warburgii BRANDIS, Journ. Linn. Soc. Bot. **31** (1895) 105; FOXWORTHY, Leafl. Philip. Bot. **6** (1913) 1954; Philip. Journ. Sci. § C **13** (1918) 184; MERRILL, Enum. Philip. Fl. Pl. **3** (1923) 100.

Brandis says:

Only fruit known, which, however, undoubtedly belongs to this genus. Fruit on a thick obconical pedicel ¼ in. long, globose, ¾ in. diam., tomentose, with the remains of a slender tomentose stylopodium ⅓ in. long. The three larger wings of fruiting-calyx up to 5 in. long. and ¾ in. broad; the two smaller segments narrower and ⅔–¾ the length of the larger segments. Longitudinal nerves of the larger segments 8–10. Pericarp thin, crustaceous. Cotyledons equal, bifid to base, the 4 lobes prismatic with 2 flat and 1 rounded face. Radicle half the length of embryo. Cells of cotyledons closely packed with minute starch-grains.

[62] Sp. Blancoanae (1918) 271. [63] Op. cit., p. 271.

I, formerly,[64] considered this form a synonym of *P. plicata.* Examination of the material at the British Museum and material collected by Elmer in Agusan convinced me that it was a distinct species. The young twigs and the under side of the leaves are densely brown pubescent or tomentose and soft to the touch. This covering causes the leaves to appear brownish below, instead of whitish, as in *P. plicata.* Van Slooten and Merrill have expressed doubt as to the distinctness of the two species.

MINDANAO, plain forest of Dagatpan, *Warburg, s. n.* (*type*).

Distribution:

LUZON, Tayabas Province, *For. Bur. 6047 Kobbe; For. Bur. 10221 Curran; For. Bur. 29347 Labaco and Masias.* All of these are sterile. MINDANAO, Agusan Province, Cabadbaran, *Elmer 14066, For Bur. 27471 Demesa.* The latter is included on Merrill's authority.[65] BRITISH NORTH BORNEO, *Foxworthy 568.*

8. Genus VATICA Linnæus

Small to large trees, usually of more scattered occurrence than is the case with members of other genera of this family. The bark is usually light-colored, thin, and not deeply longitudinally fissured. It is often very shallowly wrinkled when dry. The inner bark is usually yellow or brownish. .

The most complete account of the botanical characteristics of the genus has been given by Van Slooten[66] and the following, with only very slight change, is taken from his account. Stipules nearly always small, never semiamplexicaul, early deciduous; scars of stipules never annular. Leaves as a rule coriaceous, entire, flat; lateral nerves limited in number, always distinct, though sometimes hardly prominent, curved near margin but not forming an intramarginal nerve, often alternating with more or less distinct intermediate nerves; venation reticulate. Inflorescences terminal and axillary, forming one single large, many-flowered panicle or arranged along branches. Flowers often white, very fragrant. Calyx tube very short; lobes imbricate, afterwards pseudo-valvate, equal in length or distinctly unequal and then the larger lobes obtuse, the 3 shorter ones acute. Petals imbricate, at their tops more or less distinctly contorted in bud, overlapping either to right or to left, many-nerved, minutely pubescent on half of outer surface which is

[64] Philip. Journ. Sci. § C 6 (1911) 280.
[65] Enum. Philip. Fl. Pl. 3 (1923) 101.
[66] Bull. Jard. Bot. Buitenz. III 9 (1927) 67.

external in bud. Stamens 15, of which 10 are episepalous, placed in 5 radical pairs, all stamens very short, glabrous, subcoherent at base; filaments triangular, very rarely gradually passing into a filiform upper portion, inwardly increasing in length; anther cells short, usually very unequal, margins always glabrous; connectives produced into a thick, conical, never filiform, obtuse or subacute point shorter than anther cells. Ovary inserted with a broad base, free or partly immersed in calyx tube, generally semiglobose or rounded-conical, densely and minutely stellate-tomentose, without stylopodium, thick-walled, 3-celled; style short, usually furrowed and ribbed, entirely glabrous or pubescent at base, crowned by a small cup containing 3-lobed stigma; lobes obtuse or acute, then converging, stigma capitate or acutely conical. Fruiting calyx developed in different ways: (*a*) segments unequal, all growing out but only two expanding into long wings (subgenus *Synaptea*) nut adnate to the calyx tube either with its very base only or for nearly half its length; (*b*) segments equal, all enlarged though often but little, adnate to very base of fruit either with bases only or entirely, in the first case loosely enclosing fruit or spreading or reflexed, in the second case forming one level more or less flat or 5 woody tubercles (subgenus *Isauxis*, incl. subgenus *Retinodendron;* (*c*) segments equally though slightly enlarged or falling off, but calyx tube much enlarged, thickened into a cup nearly entirely surrounding nut or a considerable part of it (subgenus *Pachynocarpus*).

A genus of some 60 species, found throughout most of the range of the family. The center of distribution seems to be in the Malayan region. Borneo is credited with 19 species, the Malay Peniusula with 17 and Sumatra with 9.

Most species are recorded as occurring at low elevations, but *V. Whitfordii* is said to occur at altitudes up to 800 m and *V. mindanensis* at altitudes up to 1100 m. Certain forms are found on low coastal hills, or even down to the edge of the beach.

Products.—Wood not abundant, but well regarded. A good description of the wood is given by Reyes.[67]

Wood oil, a considerable amount, sticky, resembling balao, is found in certain species in the freshly cut wood. No commercial use is made of this product.

Resin is present in all species, but usually in small amounts and not used commercially in the Philippines.

[67] Philip. Journ. Sci. 22 (1923) 319.

Growth studies have not been made of the Philippine species, and growth is believed to be rather slow.

Key to the Philippine species of Vatica.

a[1]. Fruiting calyx with 2 long wings that are much longer than the 3 others. § 1. *Synaptea.*
  b[1]. Leaves obtusely rounded at both ends .... 3. *V. obtusifolia.*
  b[2]. Leaves acute or acuminate at apex.
    c[1]. Stigma distinctly lobed, not glandular.
      d[1]. Calyx segments unequal in flower .... 1. *V. mangachapoi.*
      d[2]. Calyx segments equal in flower .... 2. *V. Whitfordii.*
    c[2]. Stigma capitate and glandular or obscurely lobed.
      d[1]. Branchlets ferruginous furfuraceous .... 4. *V. pachyphylla.*
      d[2]. Branchlets glabrous or nearly so.
        e[1]. Secondary nerves about 7 .... 5. *V. Blancoana.*
        e[2]. Secondary nerves 11 to 14 pairs .... 6. *V. mindanensis.*
a[2]. Fruiting calyx without long wings; calyx segments equal, usually shorter than fruit, bases only or entirely adnate to very base of fruit. § 2. *Isauxis.*
  b[1]. Leaves 24 to 46 cm long; fruit 4 to 6 cm long .... 7. *V. papuana.*
  b[2]. Leaves 5 to 13.5 cm long; fruit less than 1 cm long .... 8. *V. elliptica.*

1. **VATICA MANGACHAPOI** Blanco. **Narig, karig.**

Vatica mangachapoi BLANCO, Fl. Filip. (1837) 401; FOXWORTHY, Philip. Journ. Sci. § C **6** (1911) 282; § C **13** (1918) 196; MERRILL, Sp. Blancoanae (1918) 272; Enum. Philip. Fl. Pl. **3** (1923) 101; REYES, Philip. Journ. Sci. **22** (1923) 320, *pl. 10;* VAN SLOOTEN, Bull. Jard. Bot. Buitenz. III **9** (1927) 94.

Trees usually of medium size, though specimens up to 35 m high and 70 cm in diameter have been recorded. Bark light gray, rather smooth. Wood hard, heavy, brown, fine-grained. All parts glabrous except inflorescence and young shoots, which are covered with a stellate tomentum. Stipules small, caducous. Leaves pale on both sides, drying pale, coriaceous, lanceolate to elliptic, 7.5 to 12.5 cm long, 3 to 8 cm wide; petiole about 1 cm long (small leaves on flowering branches may be as little as 3 cm long and 15 mm wide, with petiole 6 to 7 mm long); secondary nerves 8 to 10 pairs, slightly prominent, tertiary nerves reticulate. Inflorescences terminal and axillary, pseudoterminal flowers frequent between main axis and a branch of panicle. Flowers white or cream-colored, very fragrant, 1 to 1.2 cm long, on pedicels nearly as long as calyx. Sepals in flower more or less unequal, two longer than others, on both sides with gray stellate pubescence. Petals white or cream-colored, linear-oblong, obtuse, hairy outside, 10 to 12 mm long, 1 to 3 mm wide. Stamens 15, 5 interior stamens on filaments longer than anthers.

10 outer stamens on very short filaments; prolongation of connective short, conical. Ovary more or less immersed in receptacle, tomentose with stellate hairs; style glabrous, 5-ribbed; stigma of 5 conical lobes. Fruit about 4 mm in diameter, free from calyx. Fruiting calyx with two long wings, 3.5 to 5 cm long, 12 to 18 mm wide, with about 5 principal longitudinal nerves; 3 shorter wings 10 to 18 mm long, 3 to 4 mm wide, with 3 or 4 principal longitudinal veins. Wings membranous or chartaceous.

There is no type material extant and Blanco's description leaves much to be desired. Merrill[68] indicates that he thinks the correctness of the reference of this form to Blanco's species doubtful, but this is the form to which the material has usually been referred; Merrill[69] has distributed illustrative material of it.

This tree is of scattered occurrence, in lowland or ridge forest, from sea level up to an altitude of 500 m. It has been known to occur down to the forest edge of the beach. It is very widely distributed in the Archipelago, from the Babuyanes Islands to Basilan, in seasonal and nonseasonal regions. It is also known from Sarawak and British North Borneo.

2. VATICA WHITFORDII Foxworthy sp. nov. § Synaptea. Plate 8.

Arbor mediocris. Folia elliptica, glaberrima, superne nitida, inferne opaca, acuta, petiolis tomentosis, nervi secundarii utrinque 8, nervis tertiariis reticulatis. Paniculae axillares et terminales pilis stellatis obtectae. Calycis segmenta triangularia ovata, extus pilis stellatis tecta. Petala lineari-oblonga, acuta, extus pubescente. Stamina 15, antherae brevae et latae. Ovarium a pilis stellatis tectum, stylo glabro, stigmate capitate. Fructus ovatus, sepalis 2 oblongis 3 cm longis, 3 lanceolatis 1 ad 2 cm longis.

Trees of medium size, up to 20 m tall and 40 cm in diameter. Young twigs ferruginous-tomentose. Leaves glabrous, 5 to 10 cm long, 2 to 5.5 cm wide, elliptic, blunt or subacute at apex, rounded or subcuneate at base, shiny above, dull beneath, secondary nerves about 8 pairs, tertiary nerves reticulate; petioles 8 to 12 mm long, ferruginous-tomentose or scurfy. Inflorescences terminal and axillary, 4 to 10 cm long, peduncle and pedicels ferruginous-tomentose, with stellate hairs. Flowers white,

[68] Sp. Blancoanae (1918) 272.
[69] Op. cit., no. 866.

on pedicels 1.5 to 2 mm long. Sepals triangular-ovate, tomentose outside, 2.5 to 3 mm long, 1.5 mm wide at base. Petals oblong-linear, acute at apex, 9 to 10 mm long, 1.5 to 2 mm wide, spreading in anthesis, overlapping in bud, with 10 to 12 longitudinal veins, pubescent outside, glabrous within. Stamens short, broad, about 0.5 mm long and wide, with short, acute projection of the connective. Ovary flattened hemispherical, 1.5 to 2 mm in diameter, 0.7 to 1 mm high, slightly sunken in receptacle, sometimes obscurely 5-ridged. Style columnar, about 0.7 mm long, slightly thickened at the top to hold the capitate or obscurely lobed stigma, stigma about 0.3 mm in diameter, 0.2 mm high. Fruit (described from *For. Bur. 1593*) with nut ovate, 0.6 mm in diameter, 0.8 mm high, sparsely covered with stellate hairs; 2 long wings oblong, 3 cm long, 7 to 8 mm wide, glabrous, with 5 principal longitudinal veins; 3 short wings broadly lanceolate, acute, 1 to 2 cm long, 6 to 8 mm wide, with 5 principal longitudinal veins.

LUZON, Bataan Province, Mount Mariveles, *Whitford 306* (type in the Philippine National Herbarium), May 21, 1904. Other specimens placed here are, *For. Bur. 804 Borden, Whitford 1224,* and *For. Bur. 27144 Udasco,* all in flower; *For. Bur. 1593 Borden and Merrill 3896,* in fruit. All of these were taken from the same locality. The only collection from another locality is *For. Bur. 21811 Maneja,* with immature fruit, collected in Pangasinan Province in 1914. No vernacular name has been recorded for the species.

All of the specimens listed here were formerly identified as *V. mangachapoi.* Mr. Symington, examining the collections in 1935, separated these out as probably a distinct species.

This species seems to be a ridge form, found at higher elevations than our other species of the genus. Collectors' notes indicate that it is found from 200 to 800 m above sea level. It is known only from the part of the Islands where there is a distinct dry season.

The species differs from *V. mangachapoi* in the smaller and differently shaped leaves, the equal calyx lobes in flower, the columnar style and capitate stigma, and the smaller fruit with short wings.

3. VATICA OBTUSIFOLIA Elmer.

Vatica obtusifolia ELMER, Leafl. Philip. Bot. **6** (1912) 1471; FOXWORTHY, Philip. Journ. Sci. § C **13** (1918) 196; MERRILL, Enum. Philip. Fl. Pl. **3** (1923) 102.

The species is known only from the original collection and the following original description:

A middle sized tree; stem 3 dm. in diam., terete straight, 12 m. high or higher, branched at the top only; wood hard, heavy, odorless and tasteless, the outer one third dingy white, the balance nearly avellaneous; the sap of the wood clear and somewhat viscid; main branches occasionally arising from near the middle but erect, numerously branched toward the ends; twigs very numerous, erect, forming dense bushes, glabrous, drying blackish brown. *Leaves* copious, alternate, elliptically oblong, the normal blades 5 cm. long, 2.5 cm. wide across the middle, frequently smaller, obtusely rounded at both ends, entire, flat, ascending, rigidly coriaceous, much paler or lighter green beneath, curing dull green, glabrate or minutely scurfy or finely pulverulent; petiole 1 cm. long, when young pulverulent, ultimately glabrous and finely verrucose; midvein brown in the dry state, prominent beneath, nearly glabrous in old leaves; lateral nerves 7 to 9 primary pairs, tips anastomosing, relatively faint, reticulations fine and quite conspicuous from both sides. *Inflorescence* paniculately racemose, terminal or from the uppermost leaf axils, strict, erect or ascending, less than 1 dm. long, frequently only 5 cm. long, branched from the middle or toward the distal end; branches few and short, only sparingly rebranched, finely scurfy or pulverulent as is also the strict peduncle; pedicel straight and slender, 5 mm. long or much less, ashy gray pulverulent; flowers faintly but sweetly fragrant, dirty yellowish green on the outer organs; calyx valvate, 5 mm. long, 3 mm. thick, erect and tubular in shape, green and covered with a yellowish gray pulverulence, united toward the base; the 5 segments 3 mm. long, narrowly oblong or ligulate, obtusely rounded at apex, 1.5 mm. wide, occasionally some of them are smaller in size, erect at first, ultimately reflexed; corolla in the bud state tubular, imbricate but straight or nearly so, 1.25 cm. long, 3 mm. thick; segments pure white, very finely puberulent on the outer exposed sides, glabrous on the ventral surface, obtusely rounded at both ends, strap-like or narrowly oblong, 4 mm. wide, the inner side subincurved and glabrous along the outer edge; stamens 15, in 2 series, upon short somewhat flattened and base expanded glabrous filaments, 5, inserted upon the inner basal portion of the 5 petals, the balance in pairs of one above the other, inserted upon the basal portion of the calyx surrounding the ovary, the upper ones upon filaments twice as long as the lower ones; anthers oblong, 0.75 mm. long, all alike, the connective ending in a fine obtuse or mucronate point, somewhat flattened, ellipsoid from the side view, also glabrous; ovary one half immersed, the upper free portion conical and merely puberulent, toward the base distinctly 5-rugose, with 3 large ovules; style and stigma 1.5 mm. long, strict, the latter somewhat thickened or capitate.

PALAWAN, Puerto Princesa, Mount Pulgar, *Elmer 12963*, April, 1911. Discovered in dry stony wooded flat at 250 feet altitude. Rare. (Isotype in the Philippine National Herbarium.)

This species is very distinct from other Philippine species by the small, obtuse leaves.

4. **VATICA PACHYPHYLLA** Merrill. **Hagakhac na itim, dadiangao, tamahuan (Camarines); manapo (Tayabas); yacal (Polillo); banic (Cagayan).**

Vatica pachyphylla MERRILL, Philip. Journ. Sci. § C 13 (1918) 311; Enum. Philip. Fl. Pl. 3 (1923) 102.

A tree reaching a height of 30 m and a diameter of 60 cm, glabrous except younger parts. Branches terete, brownish, wrinkled when dry, about 5 mm in diameter, glabrous or nearly so, branchlets densely ferruginous-furfuraceous. Leaves thickly coriaceous, elliptic to oblong-elliptic, 11 to 14 cm long, 5 to 8 cm wide, apex rather prominently acuminate, base acute to rounded, when dry olivaceous, shiny, very young leaves more or less stellate-puberulent, indumentum caducous, leaves soon entirely glabrous; lateral nerves about 12 on each side of midrib, prominent, curved, reticulations not conspicuous; petioles 1.5 to 2 cm long, when young densely and minutely furfuraceous, in age glabrous or nearly so. Inflorescences terminal, pyramidal, up to 18 cm long, lower branches up to 9 cm long, all parts densely stellate-furfuraceous, indumentum usually lemon-yellow, on younger parts shading to pale gray. Flowers numerous. Sepals oblong, obtuse, about 4 mm long and 1 to 1.5 mm wide, densely pale gray puberulent. Stamens 15, anthers less than 1 mm long. Ovary subglobose, glabrous; style 0.7 mm long or less, glabrous; stigma subcapitate, very obscurely 3-lobed.

LUZON, Camarines Norte Province, Paracale, *For. Bur. 27102 Alhambra* (type in the Philippine National Herbarium), March 12, 1918, in dipterocarp forest of the tanguile-lauan type.

This species is well characterized by its elliptic, thickly coriaceous leaves, by which it is readily distinguished from the other Philippine forms of the genus. The ferruginous indumentum of the young branchlets and the lemon-yellow to pale-gray indumentum of the inflorescences are characteristic.

The fruit was not known when the original description was prepared. Since then, fruiting material has been received and is described from *For. Bur. 27825 Alhambra,* collected at Mambulao, Camarines, October 18, 1919. The fruit is subglobose and stellate-pubescent, with persistent style and stigma, 8 mm high and about the same diameter. The two long wings are oblong to oblanceolate, rounded at the top, 5 to 7 cm long, 14 to 20 mm wide, with 5 to 7 principal longitudinal nerves. The three short wings are ovate-lanceolate, acute, 1 to 2 cm long and 5 to 8 mm wide, with 5 to 7 principal nerves.

The tree is of scattered occurrence from near sea level up to an altitude of about 250 m. The wood is said to be of good quality and quite durable. It is said to be used for house posts, flooring, and for the keels of bancas.

Distribution.—LUZON, Cagayan, Tayabas, and Camarines Provinces. POLILLO. This species has been found only in the nonseasonal part of the Islands.

5. **VATICA BLANCOANA** Elmer.

Vatica Blancoana ELMER, Leafl. Philip. Bot. 4 (1912) 1473; FOXWORTHY, Philip. Journ. Sci. § C 13 (1918) 196; MERRILL, Enum. Philip. Fl. Pl. 3 (1923) 102.

Original description:

A small slender tree or shrub-like; stem 2 dm. thick, 8 m. high, branched from the middle or toward the top only; wood moderately hard, bitter, odorless, dingy or yellowish white; bark of the same color except the smoothish gray surface, rather easily separating from the wood; branches few and freely rebranched, relatively short. *Leaves* subchartaceous, alternatingly scattered, flat, horizontal or descending, slightly paler green beneath, curing brown, glabrous, entire, the bluntly or acute to acuminate apex somewhat recurved, base obtuse, oblong, the larger blades 15 cm. long, one-third as wide across the middle; petiole subterete, stout, also glabrous, 1 to 1.5 cm. long; midvein very bold beneath, smooth and brown in the dry state; lateral nerves about 7 on a side, ascending, tips strongly curved but scarcely united, also prominent, reticulations very fine and equally visible from both sides. *Inflorescence* mostly terminal or from the uppermost leaf axils, suberect or laterally spreading, paniculately branched from the base, 1 dm. long and nearly as wide; main stalks flexible, sparsely pulverulent, alternatingly rebranched, reddish brown when fresh, the ultimate ones divaricate and subdichotomous; pedicels grayish puberulent, strict, less than 3 mm. long; *flowers* arranged in all directions, sweetly fragrant; *calyx* green, campanulate or cup shaped, 2 mm. long and nearly as thick, united toward the base, very densely grayish green puberulent, usually latericius gland dotted on the outside, adnate, the 5 segments sharply acute, straight even in anthesis; *corolla* in bud yellow, 1.25 cm. long, 4 mm. thick, tubular, strongly imbricate and twisted to the left especially toward the blunt apex, similarly cinereous puberulent on the outer exposed sides, 1.5 cm. long, 4 mm. wide, narrowly oblong or oblanceolate ligulate, apex roundly obtuse, in anthesis strongly reflexed or spreading and usually twisted, cremeus; *stamens* 15, composed of an alternating single with a double series, inserted upon the basal portion of the calyx surrounding the ovary; filaments short, flattened, expanded at the base, glabrous, that of the outer double series only one half as long; anther yellow, flattened, oblongish, 0.75 mm. long, the connective faintly apiculate; the free upper one half of the ovary conically pointed and finely puberulent, toward the base rugulose by the impression of the double stamens; style strict, glabrous, 1.5 mm. long; stigma capitate, apparently glandular.

The tree is of scattered occurrence from near sea level up to *13123* (type; isotypes in Philippine National Herbarium); also *Elmer 12754* from same locality.

The species is known only from the original collections.

6. **VATICA MINDANENSIS** Foxworthy. **Bagansusu** (Misamis); **mangisic** (Bukidnon); **narig** (Lanao); **saongsaoñgan** (Leyte); **binuñgo, liloan, malabagobo, sañganan** (Agusan).

Vatica mindanensis FOXWORTHY, Leafl. Philip. Bot. 6 (1913) 1957; Philip. Journ. Sci. § C 13 (1918) 196; MERRILL, Enum. Philip. Fl. Pl. 3 (1923) 102; VAN SLOOTEN, Bull. Jard. Bot. Buitenz. III 9 (1927) 71.

V. sorsogonensis FOXWORTHY, Philip. Journ. Sci. § C 13 (1918) 196.

A tree 12 m high, 60 cm in diameter. Young branchlets, twigs, petioles, and parts of midrib beneath covered with scattered, fine, tufted, peltate scales. Leaves very thinly coriaceous or chartaceous, glabrous except along nerves, dark green above, much lighter beneath, lanceolate or elliptic-lanceolate, long-acuminate at apex, rounded or subcuneate at base, 5 to 15.5 cm long, 2 to 5.3 cm broad; secondary nerves 11 to 14 pairs, curved, ascending, sometimes anastomosing near margin, tertiary nerves prominent on both surfaces, forming a reticulate pattern; petioles 15 to 22 mm long. Inflorescences paniculate, axillary or subterminal, 2 to 4 cm long. Flowers 1 to 1.5 cm long, white or cream-colored, fragrant. Sepals thick, coriaceous, 2.5 to 3 mm long, 1.3 mm wide, almost triangular, densely gray tomentose. Petals broadly oblong, densely tomentose without and within, about 10 mm long and 6 mm wide, with indications of 7 or 8 principal longitudinal veins. Stamens 15, arranged in groups, 1.5 mm long, 0.4 mm wide; filaments thick and broad at base, tapering to about 0.3 mm wide below anthers, total length of filament about 0.8 mm; anthers ellipsoid, inner pair shorter than outer, 0.2 to 0.3 mm long; connective blunt-conical, projecting beyond anthers for about 0.1 mm. Ovary hemispherical, partly immersed in receptacle, about 1.7 mm long, 2 mm in diameter; densely gray tomentose, with indication of division into 3 lobes; style tapering, cylindric, about 2 mm long, surmounted by capitate or obscurely 3-lobed stigma, stigma apparently glandular. Fruit gray tomentose, ovoid, 4 to 5 mm tall, sometimes with persistent style, the 2 long wings oblanceolate or oblong, 3.5 to 4.5 cm long, 9 to 11 mm wide, with 5 principal longitudinal veins; the 3 short wings lanceolate, 6 to 10 mm long, 1 to 2.5 mm wide, with pubescence so dense as to obscure longitudinal veins.

MINDANAO, Agusan Province, Mount Urdaneta, Cabadbaran, *Elmer 13680* (type in the Philippine National Herbarium), September, 1912, *Elmer 13359, 13398,* July, 1912. LUZON, Sorsogon Province, Irosin, *Elmer 16840* (type of *V. sorsogonensis* Foxw. in the Philippine National Herbarium), August, 1916.

The wood is said to be of very good quality and quite durable. Merrill [70] has reduced my *V. sorsogonensis* to this species and I believe that he is correct in so doing. The species differs from *V. mangachapoi* in its less coriaceous, more pointed leaves, its equal calyx lobes, and its stigmas, and from *V. blancoana* in the greater number of nerves in the leaves. It is rather widely distributed and of scattered occurrence in the parts of the Islands which have a nonseasonal climate, at elevations of from 300 to 1,100 m. Endemic.

Distribution.—LUZON, Rizal, Laguna, Tayabas, Camarines, and Sorsogon Provinces. LEYTE. MINDANAO, Agusan, Bukidnon, Misamis, Lanao, and Zamboanga Provinces.

7. **VATICA PAPUANA Dyer.**

Vatica papuana DYER, Journ. Bot. 16 (1878) 100; BRANDIS, Journ. Linn. Soc. Bot. 31 (1895) 127; MERRILL, Philip. Journ. Sci. 30 (1926) 411; VAN SLOOTEN, Bull. Jard. Bot. Buitenz. III 9 (1927) 112, *pl. 73, fig. 1.*

V. moluccana BURCK., Ann. Jard. Bot. Buitenz. 6 (1887) 226, *t. 26.*

V. schumanniana GILG in Engl. Bot. Jahrb. 18 Beibl. (1894) 45, 98.

Described by Van Slooten as follows:

Buds, young *shoots*, and *petioles* of young leaves coloured brownish by a dense indumentum of small stellately tufted hairs; young shoots compressed, angular by elevated ribs decurrent between the points of insertion of 2 succeeding leaves. *Stipules* oblong-lanceolate, acute, sessile with a wide, rounded base, many-nerved, the inner side slightly puberulous, up to 2 cm. long and 6–7 mm. wide. *Leaves* oblong, oblong-lanceolate or (ob)ovate-lanceolate, floral leaves often ovate, 24–46 cm. long, 8–16 cm. wide, rounded or subcordate at the base, slightly tapering towards the rounded top or attenuate and narrowed—sometimes abruptly so—into a blunt or sharp acumen up to 2½ cm. long, the upper surface shining, usually greyish when dry, glabrous or the lower part of the midrib very slightly, stellulately hairy, the lower surface dull, light brown or greyish green when dry, sprinkled throughout with shining minute stellate hairs especially on the strongly prominent midrib, very rarely becoming glabrous, with 15–20 pairs of prominent lateral nerves, tertiary nerves and veinlets reticulate and slightly prominent; *petioles* robust, comparatively short, 2–3 cm. long. *Inflorescences* terminal and in the axils of the higher leaves, together forming a single large, widely spreading, many-flowered panicle up to 25 cm.

[70] Loc. cit.

long, with large floral leaves, the partial panicles up to 20 cm. long, whether or not longer than the floral leaves, branching from the base; the axes compressed or angular, coloured light brown or greyish brown by an indumentum of minute stellate hairs as are the pedicels; the latter 2–4 mm. long, articulate; flowers rather varying in size. *Calyx*-tube ± 1 mm. long, calyx-lobes during the anthesis erect, afterwards slightly converging with recurved tops, equal in size or nearly so, ovate-oblong, 3 mm. long, at the base 1½ mm. wide, attenuate in the upper half towards the acute top, densely greyish brown tomentose on the outside, the inner side minutely puberulous. *Petals* obovate-oblong, 12–18 mm. long, 5–8 mm. wide, the inner side glabrous. *Stamens* 1¼–1¾ mm. long; filaments ½–¾ mm. long; anthers ¾–1 mm. long the very short, obtuse prolonged connective included. *Ovary* shorter than the style, rotundate-conical, ± 1 mm. high; style glabrous, 1½–2 mm. long, crowned by a capitate stigma consisting of broad and papillose lobes. Lobes of the *fruiting calyx* woody, quite reflexed, oblong-trigonous, the margins reflexed inward, 1¼–1½ cm. long, at the base up to 1 cm. wide, glabrous. *Nut* ovoid, acuminate, with 3 superficial furrows, densely and minutely granulate, 4–6 cm. long, 3–4 cm. wide, pericarp woody, up to 5 mm. thick.

The wood is said to be of good quality and the resin produced by the tree is sometimes used in the southern part of the range of the species.

A single collection (*Bur. Sci. 44349 Ramos & Edaño,* from Tawitawi) has been made in the Archipelago. The large fruits seem to be distributed by sea water. The species is recorded from East and South Borneo, the Moluccas, and New Guinea. This is the widest distribution of any Philippine species of *Vatica.*

8. **VATICA ELLIPTICA** Foxworthy sp. nov. § Isauxis. Plate 9.

Arbor mediocris. Folia coriacea, elliptica vel oblongo-lanceolata, glaberrima, superne nitida, inferne opaca, petiolis pubescentis vel tomentosis; nervi secundarii utrinque 8 ad 10 nervis intramarginalibus juncti, nervis intermediis multis brevioribus, nervis tertiariis reticulatis. Paniculae axillares pilis stellatis obtectae. Calycis segmenta triangularia, extus pilis stellatis tecta, intus pilosa. Petala oblonga, extus pilis stellatis tecta. Stamina 15. Ovarium a pilis stellatis tectum, stylo glabro, stigmate conico.

Small or medium-sized trees up to 15 m high and 30 cm in diameter. Young twigs densely ferruginous pubescent, with scattered stellate hairs. Leaves elliptic to oblong-lanceolate, shiny above and dull or lighter-colored beneath, acuminate at apex, point rounded, cuneate or acute at base, margins slightly inrolled, principal nerves about 8 to 10 pairs, anastomosing toward margin into a rather indistinct intramarginal vein, tertiary nerves reticulate; leaf blade 5 to 13.5 cm long, 1.5 to 4.5 cm wide; petiole pubescent to tomentose, 1 to 1.5 cm long. Inflorescences axillary, lax, much-branched, 4 to 8 cm long. Flowers yellowish, on pedicels 3 to 5 mm long, pedicels scurfily tomentose with numerous stellate hairs. Sepals triangular, 1.5 to 2 mm long, 0.8 mm wide at base, with same kind of tomentum as pedicel. Petals oblong, blunt, about 5 mm long and 2 mm wide, pubescent outside, with 3 or 4 principal longitudinal veins. Stamens 0.6 mm long or less, about 0.3 mm wide; anther 0.4 mm long, 0.1 mm wide; appendix to connective rather pyramidal, not longer than anther. Ovary tomentose, about 1 mm in diameter, 0.8 mm high; style columnar, 0.5 mm long, glabrous, spreading at the top to hold the conical stigma, which is about 0.2 mm high and divided into trigonous converging lobes.

MINDANAO, Zamboanga Province, Mount Kaladis, *For. Bur. 24160 Miranda* (type in the Philippine National Herbarium), June, 1915. *For. Bur. 23838 Villamil*, with flowers and young fruit, was collected in the same district May 25, 1914. The young fruit is depressed-globose, obscurely 5-sulcate, covered with a ferruginous tomentum, 3 to 4 mm in diameter, about 2.5 mm high. The calyx lobes are not in evidence and have, presumably, fallen.

The tree is said to grow on ridges and low hills near the coast at an altitude of not more than 100 m above sea level.

This species is close to *V. pedicellata* Brandis [71] of Sarawak, from which it seems to differ by the smaller size of leaves, the shorter petals, and the columnar style. Mature fruit will be needed to make certain that the species are distinct.

LITERATURE CITED

DESCH, H. E. Commercial timbers of the Malay Peninsula. Mal. For. Rec. 12 (1936) 1–73, 9 pls., 34 figs. This paper gives detailed descriptions of dipterocarp woods and their uses. It includes some species that extend to the Philippines and others that are closely related to Philippine forms.

FOXWORTHY, F. W. Dipterocarpaceae of the Malay Peninsula. Mal. For. Rec. 10 (1932) 1–289, 23 pls., 1 map. One hundred twenty-one species are described, and their relationships, distribution, uses, and common names indicated.

MERRILL, E. D. Species Blancoanae, a Critical Revision of the Species of Plants Described by Blanco and Llanos. Manila (1918). This work deals with 9 species, giving a critical consideration of the terminology and citing illustrative material.

[71] Van Slooten, Bull. Jard. Bot. Buitenz. III 9 (1927) 111, fig. 9.

MERRILL, E. D. An Enumeration of Philippine Flowering Plants. Manila 3 (1923) 88–108. Fifty species are recorded, with synonymies, bibliography, distribution, and local names.

MERRILL, E. D. Distribution of the Dipterocarpaceae, origin and relationships of the Philippine flora and causes of the differences between the floras of eastern and western Malaysia. Philip. Journ. Sci. 28 (1923) 1–34, 8 pls.

REYES, L. J. Woods of the Philippine Dipterocarps. Philip. Journ. Sci. 22 (1923) 291–344, 31 pls. Detailed descriptions are given of the woods of 24 species; the characteristics of the different commercial woods of the group are detailed and illustrated. Their uses, distribution, and common names are also listed briefly.

SYMINGTON, C. F. Notes on Malayan Dipterocarpaceae. Gardens Bulletin S. S. Singapore I 7 (1933) 129–157, 15 pls.; II, ibid. 8 (1934) 1–40, 10 pls.; III, ibid. 8 (1935) 265–292, 13 pls. These articles give detailed considerations as to synonymies, relationships, and distribution of some of the species of the Malayan region.

VAN SLOOTEN, D. F. The Dipterocarpaceae of the Dutch East Indies. I. The genus Anisoptera. Bull. Bot. Gardens Buitenzorg III 8 (1926) 1–18, 2 figs.; II, The genus Dipterocarpus. ibid. 8 (1927) 263–352, 15 figs.; III, The genus Parashorea. ibid. 8 (1927) 370–380, 3 figs.; IV, The genus Vatica. ibid. 9 (1927) 67–137, 13 figs. These articles give very complete and scholarly considerations of the species of the Netherlands East Indies, and show that a number of Philippine species are identical with those of the Netherlands East Indies. More than 90 species are described and many of them (about 40) are well figured. The literature is very completely handled and there is a very careful record of distribution and local names.

VAN SLOOTEN, D. F., ex Merrill, E. D., in Plantae Elmerianae. Univ. Calif. Publ. Bot. 15 (1929) 200–206. This paper gives brief notes on certain collections from British North Borneo.

ILLUSTRATIONS

[Drawing of figures in Plate 3 by Ricardo C. Aguilar, illustrator of the Philippine National Herbarium; photographs by Bureau of Science.]

PLATE 1

Anisoptera aurea Foxw. *For. Bur. 28359 C. Mabesa.* Type in Phil. Nat. Herb.

PLATE 2

Anisoptera aurea Foxw. *For. Bur. 10700 H. M. Curran.* Fruit in Phil. Nat. Herb.

PLATE 3

Balanocarpus cagayanensis Foxw. *For. Bur. 19987 A. Bernardo.* Type in Phil. Nat. Herb., flowering specimen. *For. Bur. 20454 A. Bernardo.* Fig. *1*, flowering twig, × 0.05; *2*, mature fruit, × 2; *3*, flower, × 6; *4*, flower, with some petals and sepals removed, × 6; *5*, ovary, × 8; *6 and 7*, sepals, × 6; *8*, petal, × 6; *9*, stamen, × 16.

PLATE 4

Shorea gisok Foxw. *For. Bur. 25657 Gailipan.* Type in Phil. Nat. Herb.

PLATE 5

Shorea astylosa Foxw. *For Bur. 13271 Foxworthy, Demesa & Villamil.* Type in Phil. Nat. Herb.

PLATE 6

Shorea malibato Foxw. *Elmer 13525.* Type in Phil. Nat. Herb.

PLATE 7

Shorea almon Foxw. *For. Bur. 11647 H. N. Whitford.* Type in Phil. Nat. Herb.

PLATE 8

Vatica Whitfordii Foxw. *H. N. Whitford 306.* Type in Phil. Nat. Herb.

PLATE 9

Vatica elliptica Foxw. *For. Bur. 24160 D. P. Miranda.* Type in Phil. Nat. Herb.

PLATE 1. ANISOPTERA AUREA FOXW.

PLATE 2. ANISOPTERA AUREA FOXW.

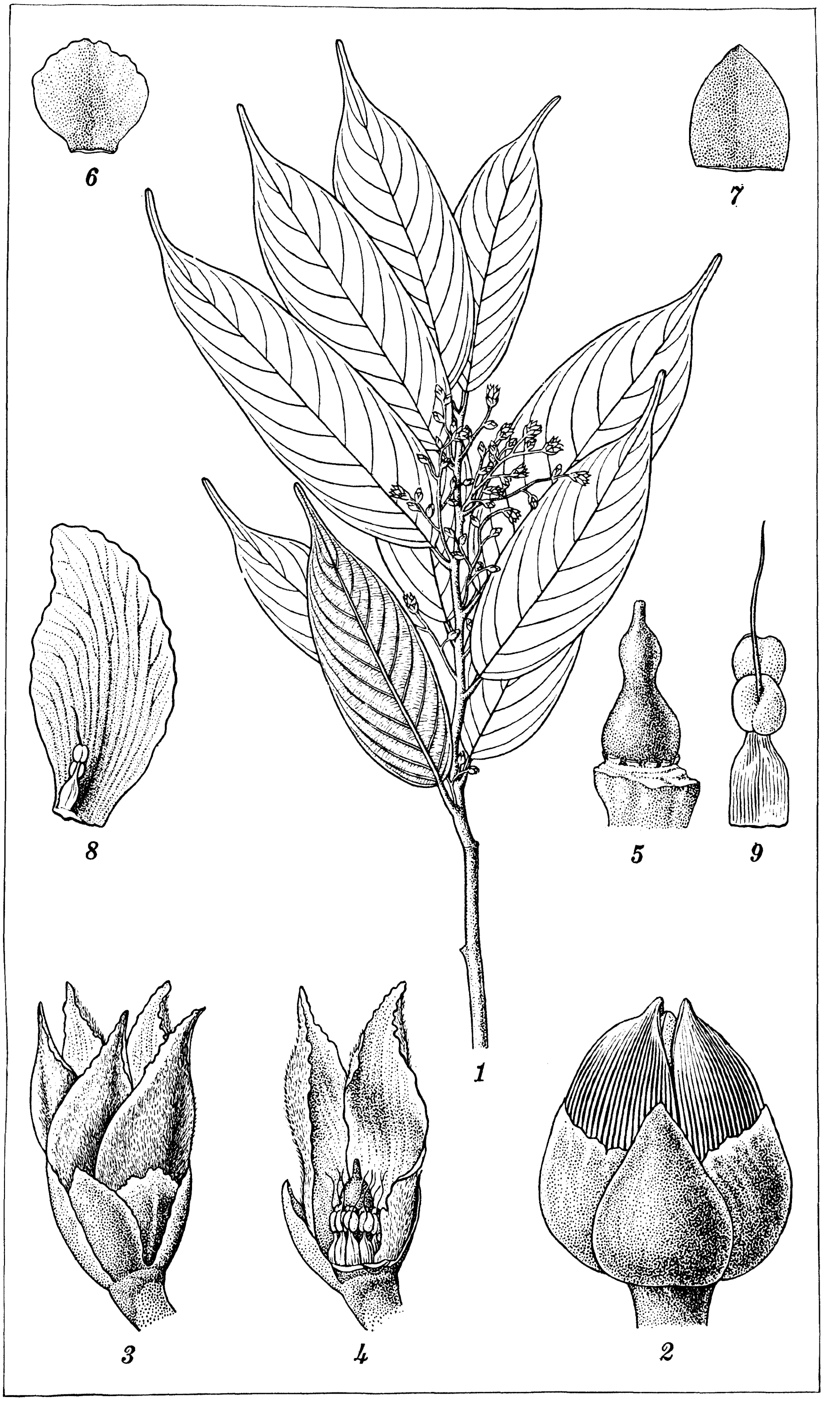


PLATE 3. BALANOCARPUS CAGAYANENSIS FOXW.

PLATE 4. SHOREA GISOK FOXW.

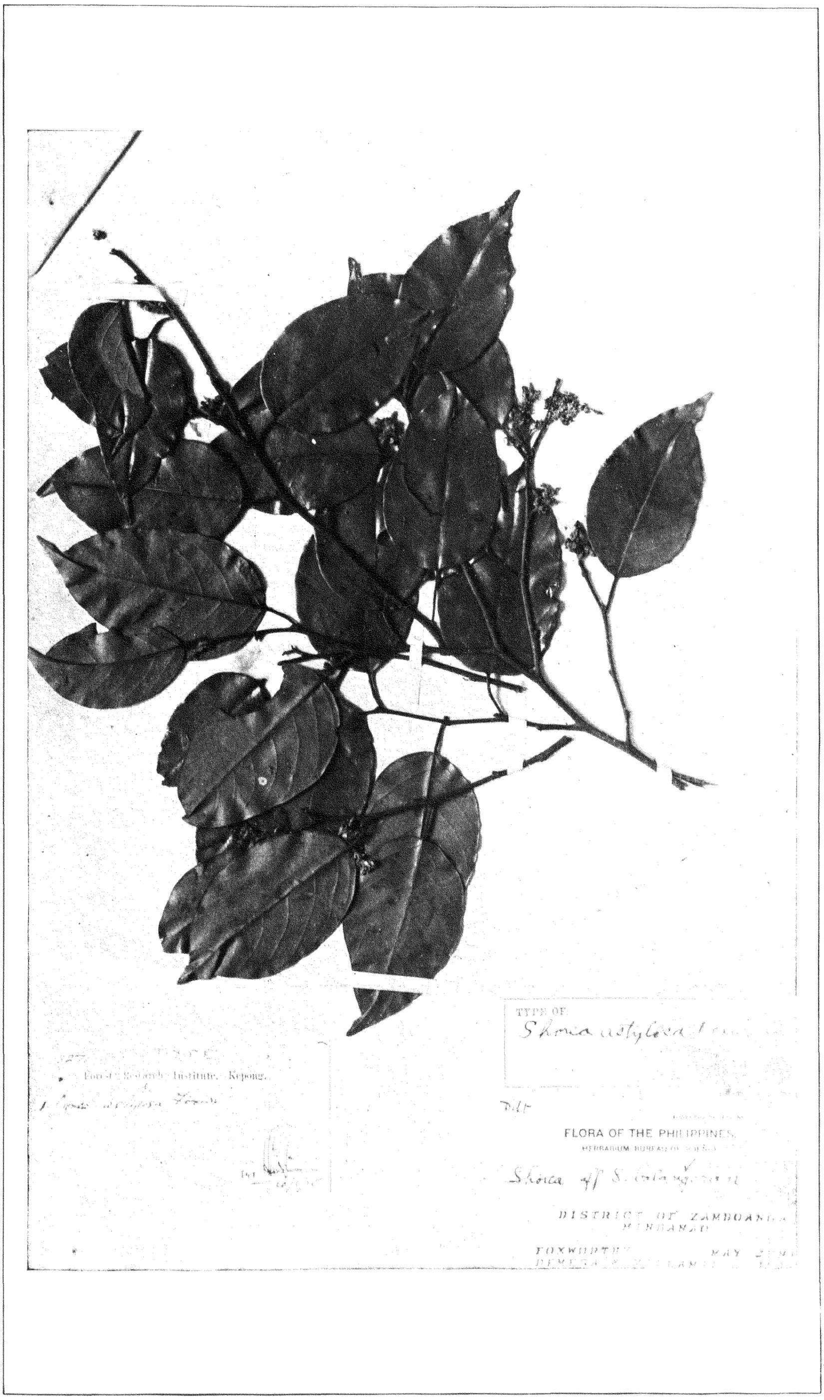


PLATE 5. SHOREA ASTYLOSA FOXW.

PLATE 6. SHOREA MALIBATO FOXW.

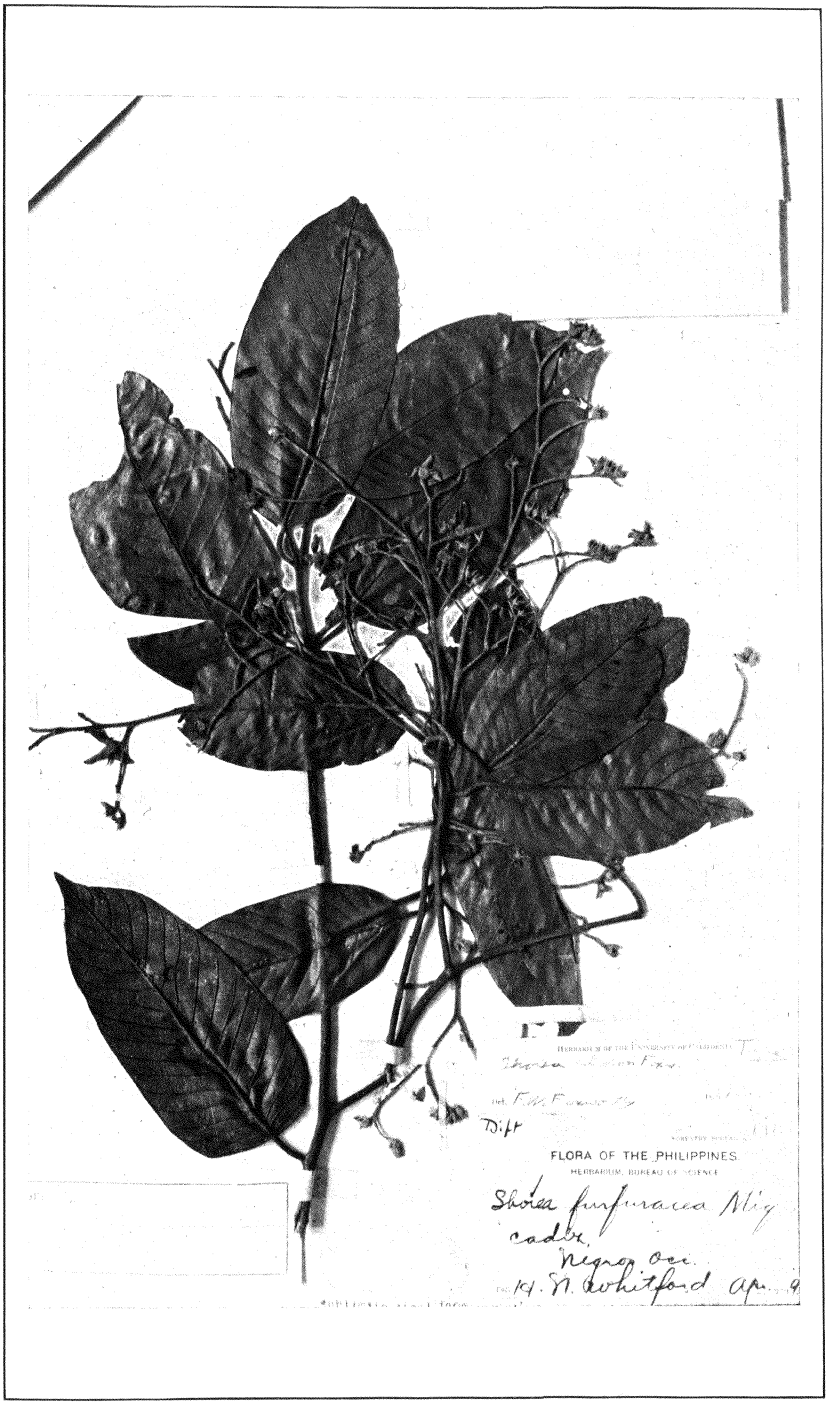


PLATE 7. SHOREA ALMON FOXW.

PLATE 8. VATICA WHITFORDII FOXW.

PLATE 9. VATICA ELLIPTICA FOXW.

THE PHILIPPINE JOURNAL OF SCIENCE

VOL. 67 DECEMBER, 1938 No. 4

STANDARDIZATION OF TIKITIKI EXTRACT

By A. J. HERMANO
Of La Tondeña Distillery, Manila

and

PANTALEON J. AGUILA
Of the Bureau of Science, Manila

FIVE TEXT FIGURES

Although for more than two decades tikitiki extract has been recognized and prescribed for the treatment of beriberi in the Philippines, the degree of potency in vitamin B_1 units, as determined by a biological assay, has not been officially standardized. In the Philippines there are sold a number of brands of tikitiki extract made by various manufacturers. These different brands vary considerably in their physical properties and chemical composition, and particularly in their potency to prevent and to cure infantile beriberi and to protect adults from beriberi.

The object of this paper was (*a*) to define and establish standard requirements for the raw material (rice bran, rice polishings, or darak) used for making tikitiki extract; (*b*) to establish standard requirements for the vitamin B_1 potency in units of locally prepared extracts; and finally (*c*) to develop a local official biological assay method for determining the vitamin B_1 potency of tikitiki extracts as an aid to the enforcement of the Pure Food and Drugs Act.

Tikitiki extract is used extensively in the prevention and cure of infantile beriberi and to some extent in the cure of malnutrition in adults. Studies in beriberi were begun about three decades ago, when this deficiency disease causing a high death rate was rampant in the Philippine Islands. When Vedder and Williams(1) reported that rice polishings contained beriberi-preventing substances, the Bureau of Science began, in the latter part of 1913, the manufacture of tikitiki extract as a remedy to prevent and to cure infantile beriberi. Del Rosario and Marañon(2) reported the physicochemical evaluation of tikitiki extract in 1919. In 1921 Wells(3) published an improved method for the manufacture of tikitiki extract.

The biological test for vitamin B_1 in the rice bran extract prepared by the Bureau of Science was made by Santos and Collado(4) in 1925. These workers reported that 0.5 cc of the extract was sufficient to supplement the lack of vitamin B_1 in the deficient basal ration of rats. Hermano and Anido(5) later published their investigation on the chemical and biological analysis of seven brands of tikitiki extract. They noted that when 0.2 cc of the extract was added daily to a basal ration deficient in vitamin B_1, the ration contained sufficient vitamin B_1 to support a growing rat.

Gargaritano, Valenzuela, and Hermano(6) published their results on the biological assay (pigeon method) of the different brands of tikitiki extracts. They reported that the amount of tikitiki extract that will cure polyneuritic pigeons ranges from 0.025 to 0.050 cc. In the same year Hermano(7) reported his concurring results that the curative dose of tikitiki extract on beriberi pigeons was between 20 and 30 milligrams.

In August, 1917, Administrative Decision No. 170–a of the Board of Food and Drugs Inspection defined and established chemical standard requirements for a tikitiki extract. About fourteen years later, September 30, 1931, the Board of Pharmaceutical Examiners and Inspectors modified the Administrative Decision by approving Resolution No. 10, specifying that a sweetening agent may be added to the extract. The amount or percentage of the sugar which might be used to dilute the tikitiki extract was not stated. The essential standard requirement for the tikitiki extract that is still wanting in the Philippines for official regulation is the vitamin B_1 potency in units. The therapeutic value or strength of the extract is mainly dependent upon this principal constituent.

MATERIALS AND EXPERIMENTAL PROCEDURE

The materials used for this investigation consisted of the crude rice bran employed in the manufacture of tikitiki extract in the Bureau of Science, the International Standard Vitamin

B_1 received from Dr. E. M. Nelson, Senior Chemist, Bureau of Chemistry and Soils, Washington, D. C., the extract of rice polishings prepared by the Bureau of Science, Manila, and eight other commercial brands of tikitiki extracts.

Crude rice bran, locally called "tikitiki," or "darak," is the product removed during the process of pounding and polishing unpolished or hulled rice kernels. According to West and Cruz(8) rice bran (polishings) comprises the seed coat, germ, and most of the outer (aleurone) layer, with some of the starchy material beneath the aleurone layer. West and Cruz recommend that rice polishings of standard quality to produce excellent tikitiki extract must contain at least 20 per cent fat, calculated on a moisture-free basis. The presence of this fat or rice-bran oil is also a criterion for the quality of the crude rice bran, because it indicates the absence of adulterants, like hulls or other foreign substances.

Tikitiki extract of the Bureau of Science is a concentrated aqueous preparation (1 cc = 14.50 grams rice bran) made from fresh clean rice bran that has no mold or other signs of deterioration and contains no foreign substances. Analysis of an average sample of the Bureau of Science tikitiki extract shows the following:(5)

BUREAU OF SCIENCE TIKITIKI EXTRACT

Specific gravity at 27.5° C		1.3189
Total solids	per cent	70.37
Ash	do	3.54
Nitrogen	do	1.21
Reducing sugars before inversion	do	28.35
Reducing sugars after inversion	do	29.99
Nonreducing sugars	do	1.27
Phosphorus as P_2O_5	do	1.68
Alkalinity of ash in 100 grams	g. KOH	0.34
Qualitative analysis of ash for basis and acidic radicals		Ca, Mg, K, Na. Cl, and S.

Chemical analyses of nine brands of tikitiki extract were made in order to have on record the different physical properties and chemical composition of these products as manufactured by various laboratories. As shown by the data in Table 1, it would be rather difficult to establish the chemical constants as standards of purity, because they vary considerably, possibly due to the quality of the rice bran, which may be fresh and pure, or adulterated, deteriorated, or excessively attacked by larvæ and weevils.

TABLE 1.—*Analysis of Philippine tikitiki extracts.*

Constituents and constants.	Samples.			
	1	2	3	4
Specific gravity at 28.5° C	1.32383	1.34091	1.32164	1.29300
Dried extract in grams per 10 cc heated to 90° C	7.06	7.39	7.22	6.16
Phosphorus as P_2O_2 per cent	0.815	1.005	0.908	0.756
Ash do	3.52	7.33	5.10	5.51
pH value	5.84	6.31	5.93	5.95
Reducing sugars before inversion per cent	35.10	20.48	23.55	18.70
Reducing sugars after inversion do	36.27	29.36	25.20	31.97
Sucrose do	1.17	8.88	1.65	13.27
Total protein do	5.18	4.49	3.77	3.25
Alkalinity of ash as $\frac{1}{10}$ n. HCl from 5 grams tikitiki extracts cc	2.265	2.85	3.18	2.66
Analysis of ash	Ca, Mg, K, Na Phosphate Sulphate Chloride	Ca, Mg, K, Na Phosphate Sulphate Chloride	Ca, Mg, K, Na Phosphate Sulphate Chloride	Ca, Mg, K, Na Phosphate Sulphate Chloride

Constituents and constants.	Samples.				
	5	6	7	8	9
Specific gravity at 28.5° C	1.28032	1.21263	1.30464	1.3437	1.3526
Dried extract in grams per 10 cc heated to 90° C	5.82	4.20	6.25	8.2909	8.7088
Phosphorus as P_2O_5 per cent	1.005	0.8937	0.804	2.04	2.18
Ash do	9.20	8.82	8.80	7.05	5.63
pH value	5.60	4.96	5.26	Not determined	Not determined
Reducing sugars before inversion per cent	17.18	22.99	20.061	22.72	35.41
Reducing sugars after inversion do	20.77	28.99	35.32	41.71	40.22
Sucrose do	3.59	5.97	15.26	18.04	4.57
Total protein do	3.88	4.86	8.92	11.49	11.95
Alkalinity of ash $\frac{1}{10}$ n. HCl from 5 grams tikitiki extract cc	2.425	4.02	6.45	Not determined	Not determined
Analysis of ash	Ca, Mg, K, Na Phosphate Sulphate Chloride	Ca, Mg, K, Na Phosphate Sulphate Chloride	Ca, Mg, K, Na Phosphate Sulphate Chloride	Ca, Mg, K, Na PO_4, SO_4, Cl	Ca, Mg, K, Na PO_4, SO_4, Cl

According to the report of the International Vitamin Conference(9) on vitamin standardization held in London from June 12 to June 14, 1934, the International Standard Vitamin B_1 is an acid-clay adsorption product of rice bran extract. Ten milligrams of this standard is equivalent to one unit.

Albino rats bred at the Bureau of Science were used for the vitamin experiments. Healthy young animals, 25 to 29 days of age, and weighing 25 to 39 grams, were selected and placed in individual metal cages.

The basal ration used for the experiments was as follows: Casein, 18 grams; butter fat, 8; purico (hydrogenated coconut oil) 6; cod liver oil, 5; agar-agar, 2; a salt mixture (No. 185) 4; and dextrin, 57. Casein, butter fat, and dextrin employed in the basal ration were prepared and purified according to the methods(10) previously published. The salt mixture was McCollum's No. 185, and the drinking water was obtained from an artesian well. This basal ration is practically free from vitamin B_1, and contains not only adequate but approximately optimal amounts for growth of rats in other respects.

The rats were divided into five groups consisting of three to five rats each. These experimental rats were fed with a basal ration free of vitamin B_1 and were weighed every two or three days. The weight curve for each animal was plotted in charts. After losing sufficient weight as a result of the lack of vitamin B_1 in the basal ration, the rats manifested characteristic symptoms of beriberi, or vitamin B_1 deficiencies, such as knotty tail, coarse hair, hunchback, and emaciation of the legs.

The first group consisted of five albino rats, placed in five separate metal cages. The growth curves of the animals are shown in text fig. 1. When the symptoms of vitamin B_1 deficiency became apparent, each animal was given daily 10 milligrams of International Standards Vitamin B_1.

Five rats were used in the second group; the chart of the growth curves is shown in text fig. 2. Each rat, after manifesting symptoms of beriberi or vitamin B_1 deficiency, was given daily 40 milligrams of tikitiki extract, Bureau of Science brand. The effect of the treatment is illustrated in text fig. 2.

The third group consisted of three rats whose growth curves before and after treatment were plotted as shown in text fig. 3. When the symptoms of vitamin B_1 deficiency and beriberi became apparent, each animal was given daily 50 milligrams of tikitiki extract, Bureau of Science brand; the results are recorded in text fig. 3.

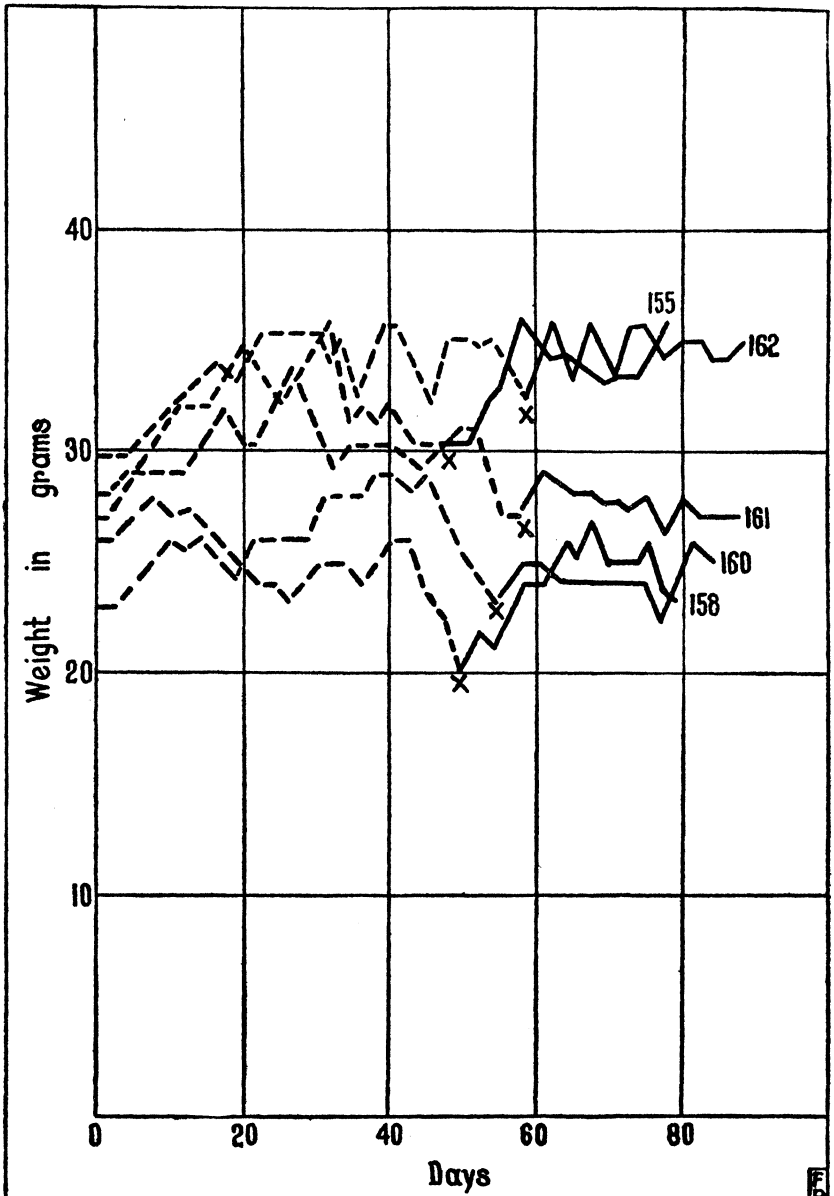


FIG. 1. Weights of albino rats Nos. 155, 158, 160, 161, and 162, fed with the basal ration until beriberi was produced. From the point X each white rat received daily ten milligrams of International Standard Vitamin B_1 in addition to the basal diet. The animals did not gain the desired weight of 3 grams a week. Broken line: Before administration of vitamin B_1; solid line: After administration of vitamin B_1.

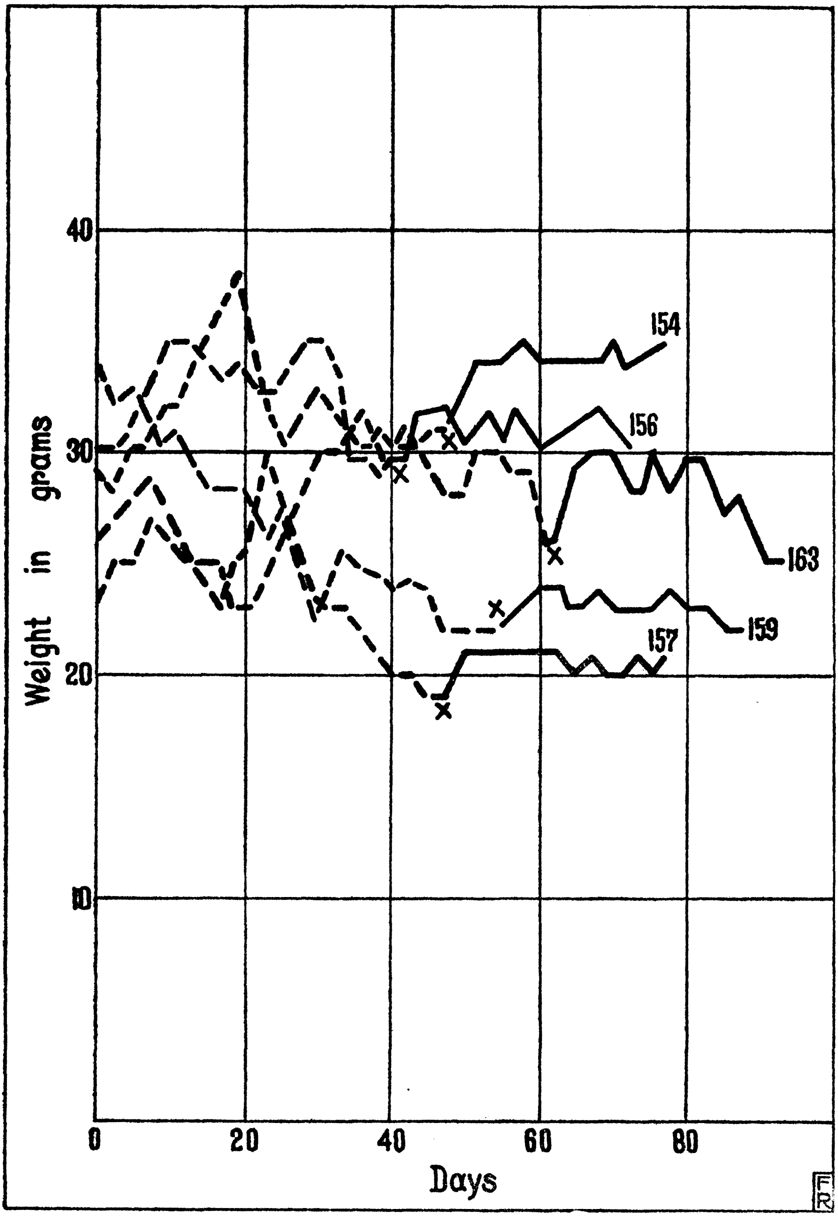


FIG. 2. Weights of albino rats Nos. 154, 156, 157, 159, and 163, fed with the basal ration free of vitamin B_1 until beriberi was produced. From the point X each white rat received daily 40 milligrams of Bureau of Science tikitiki extract in addition to the basal diet. The amount was insufficient to supplement the deficient basal ration. Broken line: Before administration of vitamin B_1; solid line: After administration of vitamin B_1.

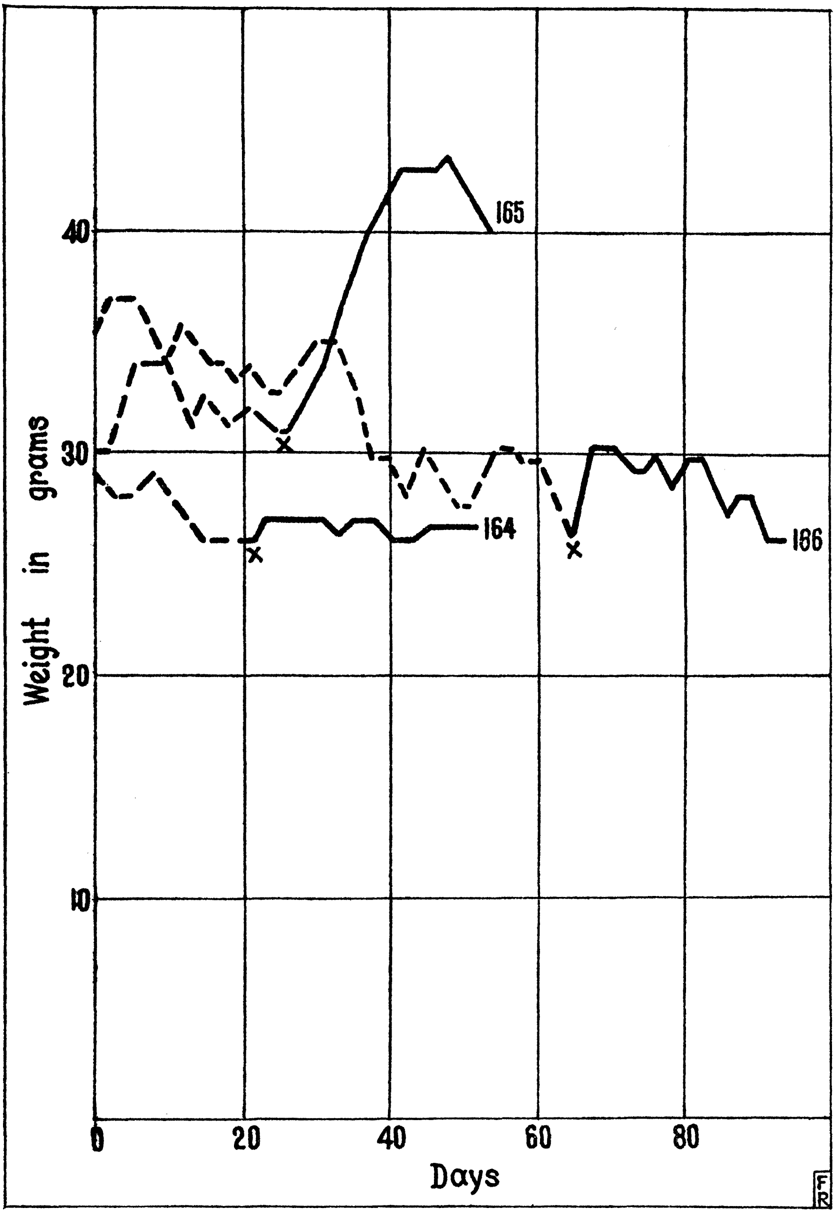


FIG. 8. Weights of albino rats Nos. 164, 165, and 166, fed with the basal ration free of vitamin B_1 until beriberi was produced. From the point X each white rat received daily 60 milligrams of Bureau of Science tikitiki extract in addition to the basal diet. The results showed that the dosage was insufficient to supplement the basal ration. Broken line: Before administration of vitamin B_1; solid line: After administration of vitamin B_1.

The fourth group contained three rats whose growth curves before and after treatment were plotted as shown in text fig. 4. After each rat showed definite symptoms of beriberi and vitamin B_1 deficiency, it was fed daily 0.05 cubic centimeter of tikitiki extract, Bureau of Science brand. The effects of the extract were remarkable.

The fifth group consisted of three albino rats. Crude rice bran, the raw material employed in the manufacture of tikitiki extract in the tikitiki plant of the Bureau of Science, was used to counteract vitamin B_1 deficiency in this group. When the rats manifested definite symptoms of beriberi and deficiency in vitamin B_1 as noted on the chart curves, each animal was fed daily 0.725 gram of rice bran. The results of the feeding were plotted in text fig. 5.

DISCUSSION AND RESULTS

In the course of the experiments the time required to produce the symptoms of beriberi and vitamin B_1 deficiency in the rats was variable, as shown by the growth curves plotted in text figs. 1 to 5. The period of 30 days is considered sufficient to cure beriberi and vitamin B_1 deficiency, and to cause their symptoms gradually to disappear. The rats then appeared to be normal again, showing that the dosage or supplement to the basal ration was satisfactory and sufficient.

Out of the five albino rats in the first group that were given or fed daily 10 milligrams each of the International Standard Vitamin B_1, four animals were able to maintain their weight with very slight increase but were not cured. One rat maintained its weight almost the same as when the treatment was started. Ten milligrams of International Standard Vitamin B_1 are considered equivalent to one International Unit. The animals did not gain the desired weight of 3 grams a week.

From the five animals in the second group that were each given daily 40 milligrams of the Bureau of Science tikitiki extract, two maintained their weight almost constantly throughout the treatment. The remaining three rats had a very slight increase in weight, an average of 0.077 gram per day. The results showed an insufficiency in the amount of extract required to supplement the deficient basal ration.

One of the three rats in the third group that were each given daily 50 milligrams of the Bureau of Science tikitiki extract was cured of beriberi with a gain in weight of 2.10 grams per week. Another showed improvement, and the third maintained

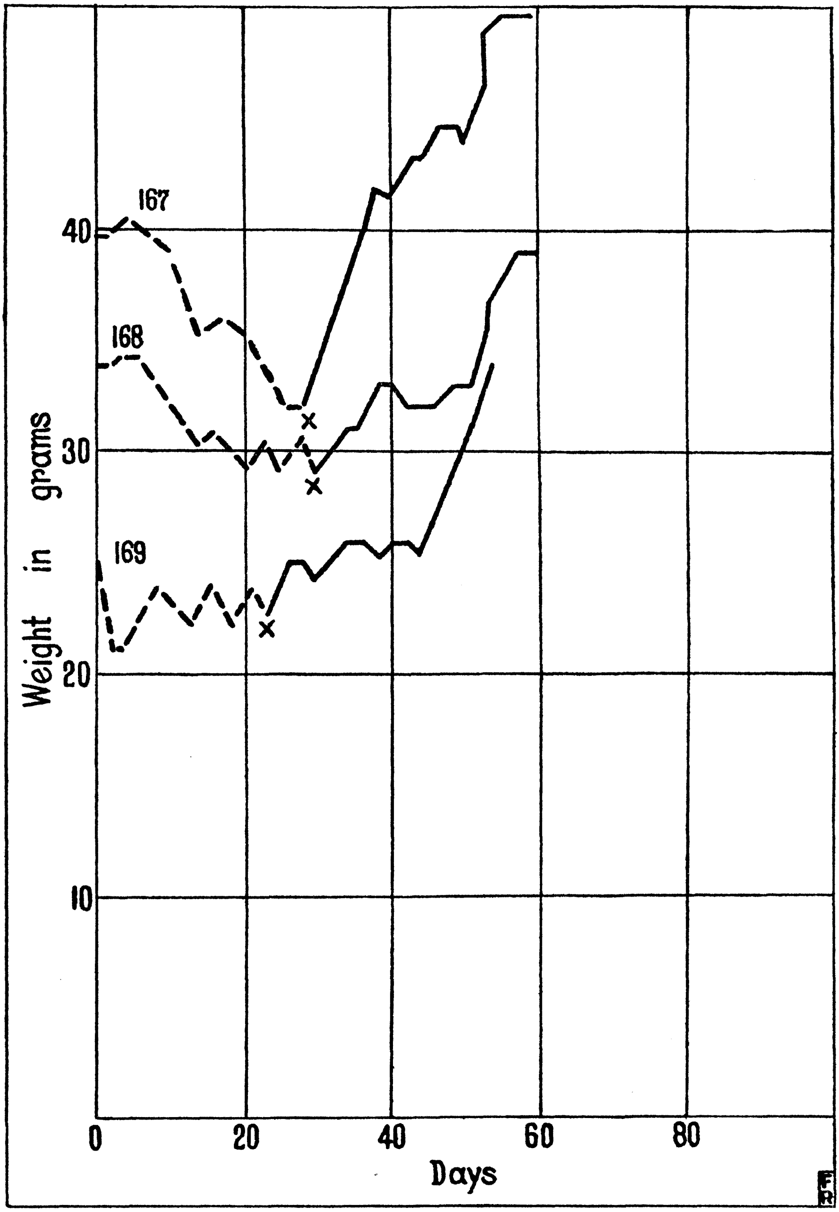


FIG. 4. Weights of albino rats Nos. 167, 168, and 169, fed with the basal ration free of vitamin B_1 until beriberi was produced. From the point X each white rat received daily 0.05 cubic centimeter of Bureau of Science tikitiki extract in addition to the basal diet. Each rat showed an average weekly gain in weight of 3.336 grams, equivalent to more than one International Unit. Broken line: Before administration of vitamin B_1; solid line: After administration of vitamin B_1.

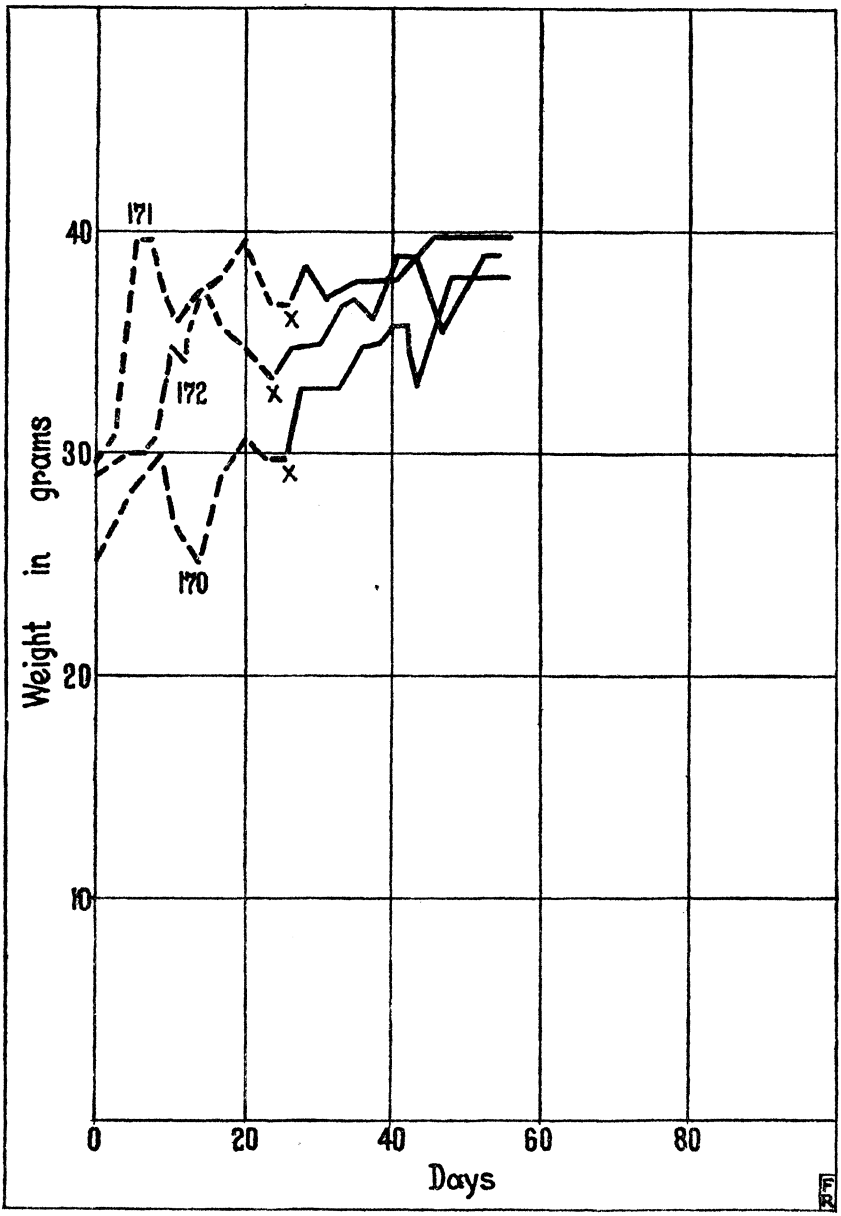


FIG. 5. Weights of albino rats Nos. 170, 171, and 172, fed with the basal ration free of vitamin B_1 until beriberi was produced. From the point X each white rat received daily 0.725 gram of crude rice bran in addition to the basal diet. The results showed that the amount was insufficient to supplement the deficient basal ration. Broken line: Before administration of vitamin B_1; solid line: After administration of vitamin B_1.

its weight almost constant. The average gain in weight a week of the three rats was 0.80 gram, showing insufficient dosage to supplement the basal ration.

The three albino rats in the fourth group that were ill with symptoms of vitamin B_1 deficiency and that were fed daily 0.05 cubic centimeter of tikitiki extract, Bureau of Science brand, recovered completely, becoming normal and very active. Each rat showed an average weekly gain in weight of 3.336 grams, equivalent to more than one International Unit.

In evaluating the crude rice bran used in the manufacture of tikitiki extract, its potency for vitamin B_1 content was determined by the same method. On the basis of the yield of extract from rice bran (14.5 grams of the rice bran produces 1 cubic centimeter of extract) calculation shows that the potency of 0.05 cubic centimeter of tikitiki extract is equivalent to that of 0.725 gram of crude rice bran.

According to the growth curves (text fig. 5) the amount (0.725 gram) of crude rice bran was not sufficient to supplement the deficiency, and to produce the average gain in weight of 3 grams weekly.

SUMMARY AND CONCLUSION

Chemical analyses were made of nine brands of tikitiki extract manufactured by different local laboratories and drug stores.

Biological analyses were also made of the crude rice bran and the tikitiki manufactured by the Bureau of Science, Manila.

The dosage of 10 milligrams of International Stantard Vitamin B_1 or an equivalent of one International Unit, did not produce an average gain in weight of 3 grams weekly in albino rats. The discrepancy may be due to the breed of albino rats used or to the effect of prevailing climatic conditions on the metabolism of the rats.

The dosage of 40 to 50 milligrams of tikitiki extract, Bureau of Science brand, fed daily to albino rats, gave results comparable with those obtained by using 10 milligrams of International Standard Vitamin B_1.

The dosage of 0.05 cubic centimeter of the Bureau of Science tikitiki extract was found to be equivalent to one International Unit. The average weekly gain in weight of each albino rat was 3.336 grams.

Since a dosage of 0.725 gram of crude rice bran was insufficient to supplement the deficiency of vitamin B_1, and produced an effect equivalent to one International Unit, it was assumed that one gram of rice bran fed daily is sufficient to effect a weekly gain in weight of 3 grams.

LITERATURE CITED

1. VEDDER, E. B., and R. R. WILLIAMS. Concerning the beriberi-preventing substances or vitamines contained in rice polishings. Philip. Journ. Sci. § B 8 (1913) 175–195.
2. ROSARIO, M. V. DEL, and JOAQUIN MARAÑON. The physico-chemical evaluation of tikitiki extract. Philip. Journ. Sci. 15 (1919) 221–223.
3. WELLS, A. H. The preparation of tikitiki extract for the treatment of beriberi. Philip. Journ. Sci. 19 (1921) 67–73.
4. SANTOS, F. O., and E. G. COLLADO. Vitamin B in tikitiki extract prepared by the Philippine Bureau of Science. Philip. Agriculturist 14 (1925) 243–245.
5. HERMANO, A. J., and FÉ ANIDO. Chemical and biological analysis of tikitiki extract. Philip. Journ. Sci. 50 (1933) 189–197.
6. GARGARITANO, MARIA LUISA, PATROCINIO VALENZUELA, and A. J. HERMANO. Biological assay (pigeon method) of the different brands of tikitiki extracts. Rev. Filip. de Med. y Farmacia 28 (1937) 287–307.
7. HERMANO, A. J. The standardization of the extract of tikitiki. Revista Filipina de Medicina y Farmacia 28 (1937) 343–346.
8. WEST, A. P., and A. O. CRUZ. Philippine rice-mill products with particular reference to the nutritive value and preservation of rice bran. Philip. Journ. Sci. 52 (1933) 1–78.
9. Quarterly Bull. Health Organization, League of Nations 3 (1934) 433.
10. HERMANO, A. J. The vitamins of Philippine foods, I. Vitamins A and B in Basella rubra, Capsicum frutescens, and Vigna sinensis. Philip. Journ. Sci. 41 (1930) 387–399.

ILLUSTRATIONS

TEXT FIGURES

FIG. 1. Weights of albino rats Nos. 155, 158, 160, 161, and 162, fed with the basal ration until beriberi was produced. From the point X each white rat received daily 10 milligrams of International Standard Vitamin B_1 in addition to the basal diet. The animals did not gain the desired weight of 3 grams a week. Broken line: Before administration of vitamin B_1. Solid line: After administration of vitamin B_1.

2. Weights of albino rats Nos. 154, 156, 157, 159, and 163, fed with the basal ration free of vitamin B_1 until beriberi was produced. From the point X each white rat received daily 40 milligrams of Bureau of Science tikitiki extract in addition to the basal diet. The amount was insufficient to supplement the deficient basal ration. Broken line: Before administration of vitamin B_1. Solid line: After administration of vitamin B_1.

3. Weights of albino rats Nos. 164, 165, and 166, fed with the basal ration free of vitamin B_1 until beriberi was produced. From the point X each white rat received daily 50 milligrams of Bureau of Science tikitiki extract in addition to the basal diet. The results showed that the dosage was insufficient to supplement the basal ration. Broken line: Before administration of vitamin B_1. Solid line: After administration of vitamin B_1.

4. Weights of albino rats Nos. 167, 168, and 169 were fed with the basal ration free of vitamin B_1 until beriberi was produced. From the point X each white rat received daily 0.05 cubic centimeter of Bureau of Science tikitiki extract in addition to the basal diet. Each rat showed an average weekly gain in weight of 3.336 grams, equivalent to more than one International Unit. Broken line: Before administration of vitamin B_1. Solid line: After administration of vitamin B_1.

5. Weights of albino rats Nos. 170, 171, and 172, fed with the basal ration free of vitamin B_1 until beriberi was produced. From the point X each white rat received daily 0.725 gram of crude rice bran in addition to the basal diet. The results showed that the amount was insufficient to supplement the deficient basal ration. Broken line: Before administration of vitamin B_1. Solid line: After administration of vitamin B_1.

STUDIES ON THE ANATOMY OF THE BAÑGOS, CHANOS CHANOS (FORSKÅL), I

THE SKELETAL SYSTEM

By DIOSCORO S. RABOR

Of the Fish and Game Administration, Bureau of Science, Manila

TEN PLATES AND ONE TEXT FIGURE

The milkfish, *Chanos chanos* (Forskål), locally known as bañgos, is the most common food fish in the Philippine Islands, where its culture is one of the most important phases of the fishing industry. Strangely enough very little is known about its anatomy. The present paper is a study on the skeletal system of the species.

Ridewood(5) in his work on the osteology of the skull of clupeoid fishes wrote that the accessory branchial organ of *Chanos* has been briefly alluded to by Müller in his work "Bau und Grenzen der Ganoiden"[1] and described and figured by Hyrtl, although its relation to the rest of the skeletal parts were not shown.[2]

Ridewood's work on the osteology of the skull of *Chanos salmoneus* describes briefly, with drawings, the most important features of this fish in contrast to those of the other members of the clupeoid group.

In the present work 7 specimens, taken from fishponds, and ranging in length from 30 to 35 centimeters, and one marine specimen, 50 centimeters long, were dissected in detail for the study of the different parts of the skeletal system. In addition, 11 pond-raised specimens were examined for the vertebral skeleton. In this study the number of abdominal and caudal vertebræ, ribs, and fin rays were noted.

Ridewood's(5) system of grouping the different elements of the skull and visceral skeleton into series or sets was followed in the present work. The grouping is rather artificial in some respects, but it has been found very convenient in the discussion of relationship between the different bones.

[1] Berlin (1846) 74, 75.

[2] Denkschr. Akad. Wiss. Wien 21 (1863) 1–10, pl. 1.

The nomenclature of Starks(7) is followed as closely as possible, with some minor exceptions.

A summary of the different bones and their possible total number on both sides is appended at the end of the discussion. Plate 6, fig. B, figures the complete skeleton, with all the skeletal elements on the right side intact, while those of the left side are detached and grouped accordingly.

SKULL AND VISCERAL SKELETON

Cranium (*Plates 1 and 2; text fig. 1*).—The term cranium, as applied here, includes the complex of not readily separable bones situated around the brain. It includes the vomer and parasphenoid, which morphologically belong to the maxillary and mandibular arches, but for convenience in discussion are included in this group.

The cranium is broad and flattened. The anterior part, at the region of the snout, is seemingly divided equally by a very narrow strip of bone, an upward and backward process of the vomer (Plate 1, *1*) which meets the rounded projecting middle part of the ethmoid. The main body of the vomer lies ventrally, forming the roof of the anterior part of the mouth. The bone when disarticulated presents a keeled dorsal surface, the keel fitting snugly into the chondrocranial cartilage of the ethmoid plate. The posterior part is prolonged into a sharply elongated keeled process, fitting exactly in the groove of the likewise keeled anterior portion of the parasphenoid. The vomer is toothless.

The ethmoid (Plate 1, *2*) lies behind the vomer on the dorsal surface of the skull. It is butterfly-shaped, with the anterior tips of the winglike processes projecting laterally from the rounded median body. Posteriorly the hind tips are overlapped by the anterior portions of the succeeding frontal bones (Plate 1, *4*).

The prefrontal (Plate 1, *3*) bones are situated behind and below the ethmoid, projecting anterolaterally on each side. The two bones do not meet medially. They are firmly embedded in the cartilages of the ethmoid plate and the trabecular portions of the chondrocranial elements.

Between the orbits, dorsally, are the broad flat frontal bones (Plate 1, *4*) joined in the middle by a suture. They form the biggest portion of the roof of the skull. They are roughly right-triangular in shape, with the right angles formed by the median suture and the posterior borders, and the most acute angle formed by the lateral and medial borders, of the bone which overlaps the posterior part of the ethmoid. The anterior portions are quite far apart, showing the cartilage layer which separates these bones from the prefrontal below.

On each side of the cranium and immediately below the preceding bones is the sphenotic (Plate 1, *5*) with its laterally projecting process. Each sphenotic forms the upper posterior border of the eye cavity. Some authors call these bones postfrontals. One half of the anterior outer half of the articulating surface for the hyomandibular (*16*) is borne on the ventral edge of the sphenotic.

Immediately behind the middle portion of the posterior border of each frontal and partially overlapped by it, lies the small parietal (Plate 1, *6*). The left and right parietals are widely separated, but a sensory-canal scale of the transverse commissural system on each side usually fuses with each of them and they with each other, producing a false union over the supraoccipital (*8*). Morphologically the scales belong to the lateral line system and not to the cranium proper. In three quite young specimens dissected the scales were easily separable from the parietals proper; in the other five specimens the two elements were well fused, appearing as single bones on each side.

The epiotic (Plate 1, *7*) lies immediately behind each of the preceding bones. Obliquely and medially, it meets a posterolateral limb of the supraoccipital. Laterally, it sends out a limb meeting the dorsomedial limb of the pterotic (*9*). Ventrally it meets the ventromedial portion of the pterotic, the dorsolateral wing of the exoccipital (*11*), and the dorsal limb of the opisthotic (*10*). The epiotic forms a sharp angle on the dorsal portion of the cranium on either side of the supraoccipital spine (Plate 1, *sup cr;* text fig. 1, *sup cr*).

Forming the most posterior element on the dorsal part of the cranium and separating the two parietals, lies the median supraoccipital (Plate 1, *8*). Posteriorly it is prolonged into a supraoccipital crest, more fittingly called supraoccipital spine. This spine projects posteriorly and divides into two sets of brushlike fine bony filaments of from 8 to 12 on each side. The brushlike bony filaments are situated between the left and right sets of epaxial muscles. The supraoccipital forms the dorsal portion of the brain-case backwall.

The pterotic (Plate 1, *9*) forms the posterior angle on each side of the skull and is produced into a spine sloping backward, outward, and downward, and extending down to the posterior end of the posttemporal (*54*). On its ventrolateral region it bears the posterior half of the articulating surface of the hyomandibular. Of all the elements of the cranium, the pterotic articulates with the most bones. Anterodorsally it meets the frontal and the parietal; dorso- and ventromedially, the epiotic; ventromedially, the exoccipital; anteroventrally, the sphenotic; ventrolaterally, the prootic (*15*) and exoccipital; and posteroventrally, the opisthotic.

The opisthotic (Plate 1, *10*) is a small bone applied closely to the ventromedial region of the pterotic spine of each side. It meets the epiotic dorsally and the exoccipital medially. This bone is easily removed with the removal of the posttemporal, the tip of its opisthotic limb being well joined by fibrous connections with the opisthotic.

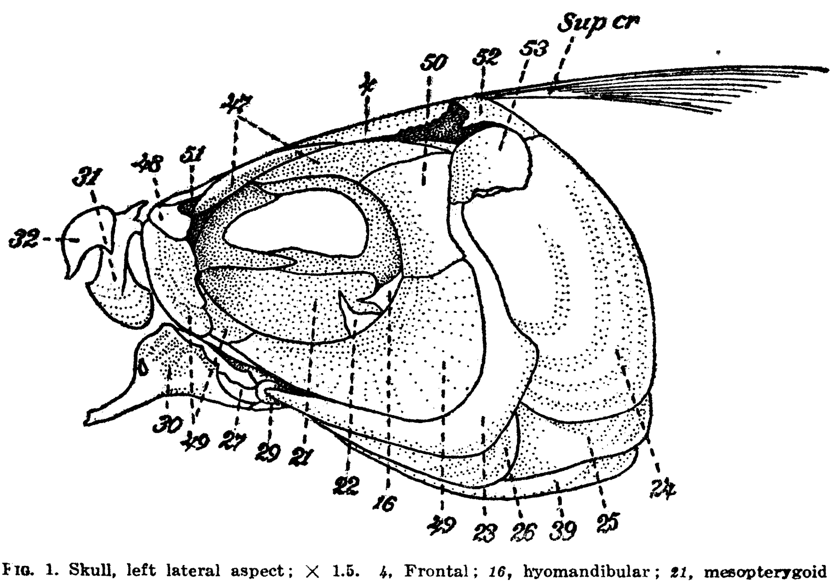


FIG. 1. Skull, left lateral aspect; × 1.5. *4*, Frontal; *16*, hyomandibular; *21*, mesopterygoid; *22*, metapterygoid; *23*, preopercle; *24*, opercle; *25*, subopercle; *26*, interopercle; *27*, articular; *29*, angular; *30*, dentary; *31*, maxillary; *32*, premaxillary; *39*, branchiostegal; *47*, supraorbitals; *48*, preorbital; *49*, suborbitals; *50*, postorbital; *51*, nasal; *52*, supratemporal; *53*, subtemporal; *sup cr*, supraoccipital crest or spine.

The remaining portion of the brain-case backwall is formed by the exoccipital (Plate 1, *11*) bones which lie closely together along the median line, immediately below the supraoccipital. The bone on each side is prolonged into a pointed plate which slopes upward and backward, and meets the other plate in the median line, forming a roof which fits over the neural arch of the first vertebra. It affords a safe protection for the hind portion of the brain and the immediately succeeding portion of the spinal cord. The anterodorsal wing of the bone, as stated above, forms the remaining portion of the hind wall of the brain case; the anteroventral wing, the hinder portion of the floor of the brain case. Each bone possesses a facet at the point of junction of its three wings. These facets lie very close together in the median line but do not fuse totally, forming the anterior floor of the foramen magnum (Plate 2, *for mag*). Each facet has a ventral and a posterior articulating surface, the former for the articulation of the real basioccipital (*12*) and the latter for the reception of the half centrum which has come to be a part of the basioccipital.

The basioccipital (Plate 1, *12*) is the single median bone forming the posteromedian ventral region of the floor of the brain cavity. It also forms the floor of the foramen magnum, and directly receives the articulation of the vertebral column by means of its half centrum.

Anteriorly articulated with the vomer and posteriorly with the basioccipital, the narrow elongated parasphenoid (Plate 1, *13*) extends into the median ventral region of the cranium, forming the posterior portion of the roof of the buccal cavity. The bone is sharply bent at about the middle of its length. At this point there is an oval depression on its ventral surface for the reception of the suspensory cartilage (Plate 5, *45*) of the branchial apparatus. At the same level on either side, the ascending dorsal wings rise moderately in front of the prootics.

The anterolateral wall on each side of the brain case is formed by the alisphenoid (Plate 1, *14*). Dorsomedially each bone sends out a limb which is closely applied to the ventral surface of the frontal. These two limbs connect with each other by means of a cartilaginous plate, which in turn connects posteriorly with the anterior border of the supraoccipital. This plate can be clearly seen if the frontals are detached. Posteriorly, the alisphenoid is closely applied to both the sphenotic and the prootic. Ridewood(5) in his description of the skull did not mention the presence of the alisphenoid, nor did he include the bone in the labelling of his figures.

There are no basisphenoid and orbitosphenoid bones.

Forming the anteroventrolateral walls of the brain case on each side are the prootics (Plate 1, *15*), which establish connection with each other in their middle portions by means of medial limbs which meet in the median line forming the anterior portion of the floor of the brain cavity. At the same time they form the roof of the myodome or eye-muscle canal.

The back portion of the cranium is much hollowed out, presenting a median depression just between the two epiotics. On each side of this median depression is a large, completely roofed-in cavity, known as the posterior temporal fossa. The median depression is filled up in life by thick trunk muscles which are divided into left and right sets by the brushes of the supraoccipital spine. The posterior temporal fossa ends blindly, anteriorly. Its inner wall is formed by the supraoccipital and the epiotic; its sloping roof, by the frontal, parietal, pterotic, and epiotic; its floor and outer wall, by the sphenotic and pterotic. The fossa is likewise filled up in life by muscles which extend up to its very anterior portions.

Immediately dorsal to the projecting process of the sphenotic is the lateral temporal groove, roofed over by the frontal and the pterotic. In life this groove is filled up with muscles.

The articulating surface for the hyomandibular slopes downward and forward, seemingly making an acute angle, directed posteriorly, with the lateral temporal groove. The articulating surface is borne on the sphenotic, pterotic, and prootic.

Immediately below the brain case and separated from it by the fused medial wings of the prootics is the myodome or eye-muscle canal. The wall on each side is formed by the descending wing of the prootic, and its floor, by the parasphenoid. The canal ends blindly posteriorly.

Temporal and preopercular series (Plates 3 and 4; text fig. 1).—The supratemporal (Plates 3 and 4; text fig. 1, *52*) is a flat scalelike bone found on the hind portion of the skull immediately over the space formed by the epiotic limb of the posttemporal and the pterotic spine. It is easily removed with the thick skin of the head. It is roughly triradiate in shape and bears on its surface a corresponding triradiate sensory canal. One branch goes upward, connecting with the sensory canal borne by the sensory-canal scale of the transverse commissural system which has come to fuse with the parietal; another goes posteriorly and connects with the canal of the posttemporal; the last goes anteriorly downward, connecting with the canal borne by the bone below, the subtemporal.

The subtemporal (Plate 3; text fig. 1, *53*), is a flat, scalelike thin bone, overlapping the anterosuperior portion of the opercle (Plate 3; text fig. 1, *24*). It bears near its anterior border a sensory canal which continues downward into the preopercle.

The posttemporal (Plates 3 and 4, *54*) is a small rounded bone with two limbs, a dorsal epiotic and a ventral opisthotic limb.

The tip of the dorsal limb fits snugly in a groove on the epiotic and supraoccipital bones. The ventral limb, as stated previously, articulates rather firmly with the opisthotic bone, its connection being strengthened by fibrous attachments. The body of the bone is so sculptured that it fits exactly into the corresponding sculptured tip of the supraclavicle (Plates 3 and 4, *55*), resulting in the tendency of the two bones to fuse. Most writers include the posttemporal and supratemporal with the elements of the pectoral girdle. The present work adopts the same idea, but for convenience in discussion they are artificially grouped with the bones of the skull.

The preopercle (Plate 3; text fig. 1, *23*) is a large curved bone which fits closely over the anterior border of the broad opercle. It has along its anterior edge a sensory canal which is connected with the canal of the subtemporal. It is covered to a large extent by some elements of the circumorbital series.

The interopercle (Plate 3; text fig. 1, *26*) lies immediately below the preceding bone and is partly covered by it. It has a sensory canal along its ventral border.

The bones of the preopercular series are sensory-canal bones, differentiated from the opercle and subopercle which are not.

Circumorbital series (Plate 3; text fig. 1).—There are usually eight elements in the circumorbital series, forming a complete orbital ring, which include two supraorbitals (Plate 3; text fig. 1, *47*), one postorbital (Plate 3; text fig. 1, *50*), three suborbitals (Plate 3; text fig. 1, *49*), one preorbital (Plate 3; text fig. 1, *48*), and one nasal (Plate 3; text fig. 1, *51*). In two specimens a triangular flake is separated off the upper border of the postorbital, making the number of the series on the left side nine instead of eight, although the number on the right side is normal. This variation, however, has no special significance.

The anterior element of the supraorbital is a thick curved bone, very unlike the other bones of the series which are normally thin and scalelike.

The nasal (text fig. 1, *51*) is very small, situated in front of the anterior tip of the thickened supraorbital and easily overlooked in dissection.

Sensory canals are found in most of the elements of the circumorbital series.

Maxillary series (Plate 3).—Both elements of the maxillary series, the premaxillary (Plate 3; text fig. 1, *32*) and the maxillary (Plate 3; text fig. 1, *31*) are short and broad, very much reducing the gape. Normally only the premaxillary bounds the buccal opening above, the anterior portion of the maxillary being well hidden by the former. Both are thin and curved bones with sharp lower edges but devoid of teeth.

The maxillary is partly hidden by the most anterior suborbital elements and can only be fully seen when the mouth is forcibly opened wide.

There is no surmaxillary.

Mandibular series (*Plates 3 and 4; text fig. 1*).—The dentary (Plate 4; text fig. 1, *30*) is a curved rod anteriorly and a broad irregularly shaped plate posteriorly, both portions being devoid of teeth. On its inner side are closely applied the articular (Plates 3 and 4; text fig. 1, *27*) and the tiny but distinct sesamoid articular (Plate 4, *28*), the latter lying on the anterodorsal part of the former. Cartilaginous elements, the remains of Meckel's cartilage, make the articular appear thicker than it actually is. The posterior portion of the articular can be distinctly seen through the notch in the posterior border of the coronoid process of the dentary. The articular bears the articulating surface on its posterior part. Immediately below this point the small but very distinct angular (Plate 4; text fig. 1, *29*) is attached.

Hyopalatine series (*Plates 3 and 4*).—The hyomandibular (Plates 3 and 4; text fig. 1, *16*) articulates with the cranium by a single elongated head. Its upper edge, instead of being horizontal, slopes downward and forward. At about one-third of its length downward, on its posterior border, is a well-rounded head for the articulation of the opercle. Along its entire length on the outer surface, near its posterior border, the bone is produced into a curving ridge producing a well-defined hollow for muscle attachments. Nearer the ventral half and directed anteriorly is a spiny process which touches the metapterygoid (*22*), visible from the outside on the hind wall of the eye cavity (text fig. 1, *16*). The inner surface of the bone is flat.

Attached to the distal portion of the hyomandibular is the narrow and elongate symplectic, and above it, the moderately broad metapterygoid. A thin but strong transparent membrane stretches in the space between these two bones.

The symplectic (Plates 3 and 4, *17*) meets the elongated spine-like posterior process of the quadrate (Plates 3 and 4, *18*) along the lower border of its anterior half. The quadrate is placed so far forward as to almost separate completely from the symplectic and metapterygoid, perhaps in close relationship to the reduction of the buccal opening. The quadrate articulates with the articular at the lower angle of its anterior broad portion.

The main body of the thin, flat, and almost transparent pterygoid (Plates 3 and 4, *19*) lies immediately behind the expanded portion of the quadrate. It is prolonged anteriorly into a rod which is closely applied to the ventral border of the palatine (*20*) for nearly its whole length. The posterior angle of the pterygoid extends beyond the quadrate and can be discerned from the outer aspect through the thin transparent membrane stretching between the quadrate and the contiguous bones. It is clearly seen from the inner aspect of the series. Its tip merely touches the metapterygoid border.

The palatine (Plates 3 and 4, *20*) is a thick bone whose anterior tip fits into a depression in the cartilage of the ethmoid region, immediately lateral to the vomer. It becomes expanded posteriorly, and articulates with the whole anterior border of the mesopterygoid.

The mesopterygoid (Plates 3 and 4; text fig. 1, *21*) is a thin and almost transparent bone forming the main floor and wall of the orbit. Posteriorly it articulates with the bony metapterygoid.

The main body of the metapterygoid (Plates 3 and 4; text fig. 1, *22*) is of the same size and shape as the quadrate. A medial process meets the posterior border of the mesopterygoid but can be clearly distinguished from this bone. The process can be seen externally in the hind wall of the orbit.

Opercular series (Plates 2 and 3; text fig. 1).—The opercle (Plate 3; text fig. 1, *24*) is the broadest and most prominent bone on the lateral part of the skull. Its anterosuperior border is partly hidden by the subtemporal, and the whole of its anterior border is covered by the preopercle. It possesses a prominent articulating socket on the inner surface of its upper anterior portion, for the reception of the corresponding head in the hyomandibular.

Immediately ventral to the opercle and partly concealed by it is the curving subopercle (Plate 3; text fig. 1, *25*). It curves forward and upward into a sharp spine provided with a groove along its posterior edge which receives the anteroventral edge of the opercle as if spliced together with it. Frequently these two bones come off together in a single piece, the more ventral subopercle appearing like a mere ventral extension of the opercle.

Below the subopercle and mostly covered by it is the most posterior and outermost branchiostegal (Plate 2; text fig. 1, *39*). There are four branchiostegals on each side, gradually diminishing in breadth and becoming more pointed mesially. They are all flat, thin, and lamellate. The two inner elements are attached to the lower half of the outer face of the ceratohyal (*35*), the two outer bones, to the same region in the epihyal.

The elements of the opercular series grade off regularly into the subopercle and opercle, while the preopercle and interopercle seem not to fit in it.

Hyobranchial series (*Plates 2 and 5*).—There is no mistaking the hyoid portion of the hyobranchial series, because it is the most anterior in position and much stouter in structure than the rest.

The glossohyal (Plates 2 and 5, *37*), forming the framework of the tongue, projects forward from the median region of the hyoid, immediately between the closely articulated two-layered hypohyals (*36*). It is mainly cartilaginous, but the posterior half is covered by a thin membrane bone which extends a little backward, covering the anterior portion of the 1st basibranchial.

There are two sets of hypohyals (Plates 2 and 5, *36*), one on top of the other. The dorsal parts are roughly circular in form and smaller in size than the ventral set.

The ceratohyal (Plates 2 and 5, *35*) extends backward and outward from the hypohyals, followed still more posteriorly by the epihyal (Plates 2 and 5, *34*) which is in length roughly only one-half the ceratohyal. The most posterior tip of the epihyal, a little nearer the dorsoposterior border, bears a small nodule of cartilage, the interhyal (Plates 2 and 5, *33*), which articulates the ventral half of the hyoid arch with its dorsal half, the hyomandibular.

The large urohyal (Plates 2 and 5, *38*) articulates with the posterior median portion of the hypohyals. Posteriorly it comes in close contact with the anterior border of the clavicular parts of the pectoral girdle, in such an intimate manner that its dorsal ridge merges gracefully into the median ridge formed by the clavicles (*56*).

There are three basibranchials (Plate 5, *40*), the 1st and 2d of about equal size, and the 3d the largest of them all. A small flake of bone develops over the cartilage in the posterior half of the 1st basibranchial (Plate 5, 40_1), partly covering the anterior portion of the 2d. The 2d basibranchial (Plate 5, 40_2) possesses a similar flake of bone in the same region as the 1st, which in turn partly covers the anterior part of the 3d. The 3d basibranchial (Plate 5, *40_3*) is very much enlarged by the fusion with it of the bases of the 3d hypobranchials (Plate 5, *41_3*). The lines of fusion, however, can easily be discerned, especially in the inferior aspect of the branchial apparatus.

There are three pairs of hypobranchials (Plate 5, *41*) one pair attached to each of the three basibranchials. They gradually diminish in length posteriorly, the 1st pair (*41_1*) being the longest and the 3d (*41_3*) the shortest.

There are five pairs of ceratobranchials (Plate 5, *42*), the first three pairs being directly joined to the three corresponding hypobranchials and the last two pairs directly and indirectly to the posterior portions of the 3d basibranchial by means of median cartilage strips. The 4th (Plate 5, *42_4*) and 5th ceratobranchials (Plate 5, *42_5*) are greatly modified, having their posterior portions greatly enlarged, in accordance with the modifications suffered by the other parts in this region for the support of the branchial apparatus. The two 5th ceratobranchials are fused along the greater part of their length, proximally, forming a median symphysis. Their posterior portions are separate, and together with the expanded bases of the 4th are attached to a broad plate of combined cartilage and membrane. From this plate two broad cartilaginous processes extend backward and upward, forming the real backwall of the branchial region.

Four pairs of epibranchials (Plate 5, *43*) join the first four ceratobranchials by means of long cartilaginous connections which permit of certain movement. The 4th pair (Plate 5, *43_4*) are very much modified, each one possessing in its dorsal extremity a backwardly projecting process which is joined to the main body by a broad transparent membrane. This is another modification to support the branchial organs.

Three pairs of small and slender cartilaginous pharyngobranchials (Plate 5, *44*) articulate with the dorsal extremities of the first three corresponding pairs of epibranchials. Each of the 4th epibranchial pair joins the slender medial bony process which projects from near the dorsal extremity of the 3d epibranchial, and also establishes cartilaginous connections with the 3d pharyngobranchials.

On each side all three pharyngobranchials unite with each other by means of cartilaginous connections; anteriorly both sides join and are prolonged into the suspensory cartilage (Plate 5, *45*) which suspends the dorsal parts of the branchial apparatus to the parasphenoid.

The inner surfaces of the hypobranchials, ceratobranchials, and epibranchials bear numerous fine gillrakers of moderate length, and their posterior outer surfaces bear the gill filaments.

VERTEBRAL COLUMN AND RIBS

Vertebral column (Plate 6, fig. A; Plate 7; Plate 9; Plate 10).—Jordan(2, p. 205) reported seventy-two vertebræ in *Chanos chanos.* In the present study so far only forty-three vertebræ were found as the common normal number for the species, with forty-four as a variation having been found in three of the nineteen specimens studied. The sole marine specimen dissected possessed forty-four vertebræ.

The vertebral column is divisible into an anterior, abdominal, region and a posterior, caudal, region. The presence of a complete hæmal arch was used as the criterion for distinguishing the caudal vertebræ (Plates 6, *66*, and 7) from the real abdominal vertebræ (Plate 6, *65*). In one specimen a complete hæmal arch was formed on the 17th vertebra; in thirteen specimens, including the marine form, on the 18th; and in another five specimens, on the 19th vertebra. On the basis of the above facts, there must be from sixteen to eighteen abdominal vertebræ and from twenty-five to twenty-seven caudal vertebræ, including the last or hypural vertebra.

After the first two abdominal vertebræ the remainder bear movable ribs (Plates 6 and 7, *74*); the first twelve to fifteen caudal vertebræ also bear movable ribs.

Plate 7 shows the structures of vertebræ taken from different levels of the vertebral column. Plate 7, fig. H, is a typical abdominal vertebra (the 11th), with the parts disarticulated to show details (front view). The roughly cylindrical dice-box-shaped centrum (Plate 7, *67*) is deeply concave at both the anterior and posterior faces, with a tiny hole perforating its center in an anteroposterior direction. The edges of adjacent centra are joined together by ligaments, the junction being further strengthened by articulations between little bony processes, the zygapophyses (Plate 7, *72*). From about the 18th vertebra until the 40th, four sets of such zygapophyses enter in the articulation of succeeding centra, the dorsal anterior and posterior neural zygapophyses and the ventral anterior and posterior hæmal zygapophyses. These are very clearly seen in the typical caudal vertebra (Plate 7, fig. G). In the fresh specimen the resulting cavity between two successive centra is filled up with a gelatinous substance, the remains of the primitive notochord.

The neurapophyses (Plate 7, *68*) are attached to the dorsal surface of the centrum, by ligamentous articulation in the anterior fifteen or sixteen vertebræ and by permanent ankylosis in the remaining posterior vertebræ. The left and right neurapophyses meet in the median dorsal portion, forming the neural arch, which encloses the neural canal. The neural arch is prolonged dorsad and backward into the neural spine (Plate 7, *69*) which may be single or double, depending on the extent of union of the neurapophyses. In the first six or seven vertebræ the neural arches can be totally separated into distinct right and left elements with their corresponding neural spines. This condition results in the presence of double neural spines in the vertebræ concerned. The remaining posterior vertebræ possess single neural spines with the tips of the first few spines cleft to show the remains of fusion. The spines are all directed backwards and dorsad and are longest in the region of the 25th to the 31st vertebræ.

Attached to the ventrolateral regions of the centrum are projections known as parapophyses (Plate 7, *73*) for the articulation of the ribs. They are biggest on the 3d vertebra and gradually diminish in size and prominence posteriorly until the 16th or 18th vertebra, when with the formation of the first complete hæmal arch they disappear. Correspondingly, the ribs of the first sixteen or eighteen vertebræ are articulated to the parapophyses. Posteriorly they are attached to the sides of the developing hæmal arches, and more backwards until the last rib-bearing vertebra (30th or 31st), they are borne on the still diverging tips of the newly-formed hæmal spine (Plate 7, *71*).

The epipleurals (Plate 7, *75*), or double ribs, are attached to the dorsolateral regions of the centrum by fibrous connections.

Typical caudal vertebræ are pictured in Plate 7, figs. F and G. A typical caudal vertebra does not possess ribs or epipleurals. The hæmapophyses (Plate 7, *70*) are joined together ventrally, forming the hæmal arch which encloses a canal, the hæmal canal. The arch is prolonged downward and backward into a hæmal spine.

The first vertebra, the atlas (Plate 7, fig. A) is modified for the articulation of the vertebral column with the half centrum of the basioccipital. The centrum is smaller than the centra of the more posterior vertebræ. The neurapophyses are the broadest in the whole column. The neural spine as stated previously is double. There are beginnings of the parapophyses on its ventrolateral regions, although in younger specimens these cannot be seen. Between the bases of the neurapophyses and the centrum the delicate epipleurals are articulated.

The second vertebra, the axis (Plate 7, fig. B), is also differentiated from the others and closely resembles the atlas in structure. The neurapophyses, although smaller than those of the atlas, are larger than those of the succeeding vertebræ. The neural spine is likewise double. The parapophyses are always present. The axis possesses a pair of epipleurals.

The 3d vertebra (Plate 7, fig. C), is more of a typical abdominal vertebra with all its parts, than the first two. The ribs are the biggest in the whole column. The neural spine is double.

Plate 7, fig. D, is the 17th vertebra, or last abdominal vertebra. The structure is similar to that of the typical vertebra already described above.

Plate 7, fig. E, is the 18th, or the 1st caudal vertebra. Except for the complete hæmal arch and the corresponding attachment of the ribs to the bases of this structure instead of to the parapophyses which are no longer present, the vertebra resembles in many respects the typical abdominal vertebra.

Plate 7, fig. F, is the 32d, or the 2d real caudal vertebra with no movable ribs attached.

Plate 7, fig. G, is the 31st, or the 1st real caudal vertebra, showing the structures from the lateral aspect.

The last four or five caudal vertebræ are included in the attachment of the caudal fin. The last three vertebræ, especially, are well modified. The neural arches and spines are very much enlarged. Just at the point of fusion of the neurapophyses of the 41st vertebra there is a prominently projecting anterior process which fits tightly into the back of the neural arch of the preceding vertebra. The hæmal arch possesses a similar projecting anterior process, also at the point of fusion of the hæmapophyses, which likewise fits tightly into the back part of the hæmal arch of the preceding vertebra.

The neural arch and spine of the 42d vertebra possesses the same anterior process at the same place. In addition to this, there is an interneural which fits tightly between the neural spines of the 41st and 42d vertebræ. In two specimens, instead of these modifications, there were two neural arches and spines for the 42d vertebra. The hæmal arch with its spine is very much enlarged and is movably articulated with the centrum.

The 43d or hypural vertebra is the most modified of all the vertebræ (Plate 10, figs. D and E). The centrum tapers obliquely upward and backward, and continues imperceptibly into the neural arch and its spine. The elements of the neurapophyses are separate. The hæmal arch with its spine suffers the same modification as that of the 42d vertebra, only that its base rises more obliquely upward, corresponding to the modified nature of the centrum.

These different modifications and specialized arrangements of the last few caudal vertebræ result in a strong rigid articulation of these structures, and yet permit a certain degree of movement corresponding to the movements demanded of the caudal fin.

There are six hypurals (Plates 6 and 10, *81*) which differ remarkably in size. The 1st hypural is small and slender, and fits tightly between the last neural spine and the 2d hypural. The 2d hypural is a little larger than the 1st and articulates with the curving upturned base of the 3d hypural. The 3d hypural is large, and articulates with a posterior projection from the base of the neural arch of the 43d vertebra. The 4th hypural is a little larger than the 3d, and articulates with the tapering tip of the centrum of the 43d vertebra. The 5th hypural articulates with both the centrum and the most posterior tip of the base of the hæmal arch of the 43d vertebra. This and the 4th hypural form the middle portion of the caudal fin skeleton. The 6th hypural is the largest and broadest of all the hypurals. It articulates with the hæmal arch and spine of the 43d vertebra.

All the hypurals as shown by the 4th and the 6th, have the tendency to be wedge-shaped. The whole set together with the last few vertebræ are greatly strengthened by cartilage reënforcements.

Ribs (Plates 6, 7, and 9).—Movable ribs (Plates 6 and 7, *74*), or subperitoneal ribs, are found on the twenty-eighth or twenty-ninth vertebræ after the axis. They encircle the abdominal cavity and are situated immediately under its parietal peritoneum. There is a gradual decrease in the length and breadth of the ribs from the first pair to the last. The span between the pairs remains practically the same throughout the first thirteen or fourteen pairs and then gradually becomes less posteriorly until the last six or seven pairs, where the elements of both sides come close together nearly in a parallel line. This variation in the span of the ribs corresponds to the gradual decrease in the size of the abdominal cavity as it proceeds posteriorly. The last four pairs of ribs are modified in position to support more efficiently the posterior portion of the air bladder.

Epipleurals (*Plate 9, figs. C and D*).—At the junction of the epaxial and hypaxial muscles, along the myocommata and in the plane of the embryonic horizontal skeletogenous septum, the paired epipleurals (Plate 7, *75*) are situated. As has been stated previously, they are attached by fibrous connections to the dorsolateral regions of the centra of the first twenty-three to twenty-six vertebræ.

Two strong tendon bones project backward and outward from each side of the occipital region, their course roughly parallel to that of the subperitoneal ribs. The second of these two bones is very much enlarged, and possesses several slender branches which are spread among the muscles of the anterior part of the trunk (epaxial region) in the manner of the multiple filamentous branches of the intermuscular bones. It arises from the dorsolateroposterior part of the basioccipital, or, to be exact, at that region of the basioccipital half centrum. The first bone is much smaller than the second, but is still considerably larger than any of the real epipleurals. It arises at the proximal portion of the posterolateral region of the exoccipital. In a well-prepared skull they are not detached and seem to be a real part of it. Ridewood(5) considered them as intermuscular bones. These two bones help form the support of the roof of the bronchial region and at the same time support the thick muscles at the back of the skull. From their function, location, and structure, they are halfway between the real epipleurals and the intermusculars (Plate 9, figs. A and B), so I propose to call them epipleurointermuscular bones.

The real epipleurals are borne by the vertebræ, beginning with the atlas, to the 23d or 26th; consequently, twenty-one to twenty-four vertebræ, except the atlas and axis, bear double ribs. The first fifteen to nineteen pairs are usually bifid, with the dorsal branch going along the curve of the epaxial muscles, and the ventral, in the direction of the hypaxial muscles. The remaining epipleurals are delicate slender single pieces which decrease in length in the posterior vertebræ. In the last four or five epipleurals the ossification has not been completed, so that their proximal portions are still fibrous and only a small portion of the distal end is ossified. Sometimes this ossified portion is only about 1 mm long, and, of course, easily overlooked in dissection. The number of epipleurals on both sides varies, but this variation is not significant.

GIRDLES AND FINS

Shoulder girate and fins (*Plate 3; Plate 4, figs. B and D*).—The uppermost bone of the shoulder girdle is the supratemporal (Plates 3 and 4; text fig. 1, *52*) which is followed ventrally by the posttemporal (Plate 4, *54*). These two bones of the temporal series have already been dealt with. Both serve to connect the remaining ventral elements of the shoulder girdle to the skull, although the latter, through its dorsal epiotic limb and ventral opisthotic limb, performs the greater part of the work.

Below the posttemporal, extending downward and backward, is the slightly curved flattish supraclavicle (Plates 3 and 4, *55*), shaped like the blade of a knife. Its entire posterior border is thin and sharp. Its posterior third is closely but not immovably applied to the outer anterior border of the ascending dorsal limb of the clavicle.

The clavicle (Plates 3 and 4, *56*) is long and runs forward and downward. Its curving ventral portion is expanded mesially, the thin expanded portions of both clavicles closely meeting but not totally fusing in the median line, producing a prominent ridge.

Behind the base of the clavicles at the curve, the small, thin, and slender scalelike postclavicle (Plates 3 and 4, *57*) is slightly attached. Its posterior end is also applied closely along the whole length of the short posterior dorsal spine of the hypercoracoid (*58*), somewhat strengthening its slight attachment. It extends backward and downward through the muscles of the base of the pectoral fin. Unless great care is taken in the dissection of these parts, the postclavicle is easily lost.

Two irregularly flat bones, the hypercoracoid (Plates 3 and 4, *58*) and the hypocoracoid (Plates 3 and 4, *59*) the former slightly smaller and placed posterodorsad of the latter, are immovably articulated with the clavicle. The former articulates with the clavicle by means of a broad anterodorsally directed limb, and with its mate, through its ventral region. It possesses a large foramen on its anterior part. The hypocoracoid articulates with the base of the clavicle in two places; posteriorly, by means of a posterodorsal projection which meets a similar posteroventral projection of the clavicular base, and anteriorly, through its pointed anterior tip which meets an anteroventral projection of the clavicle.

A slender and curved mesocoracoid (Plate 4, *60*), visible only on the medial side of the girdle, serves to join the last three elements of the girdle.

Articulating with the hypercoracoid and the hypocoracoid and directed posteriorly are four or five small bones, the actinosts (Plates 3 and 4, *61*), which, except the two dorsal cuboid elements, are all irregularly slender.

The fifteen to seventeen cartilaginous pectoral rays (Plate 4, *62*) articulate with the actinosts by means of cartilaginous nodules which are firmly fixed and held between their widely diverging bases. The number of rays may slightly vary on each side.

Pelvic girdle and fins (Plate 3; Plate 4, figs. C and D).—The skeletal support of the ventral fins is entirely free from the rest of the skeletal system. The ventral fin on each side is supported by a single bone, the pelvic girdle (Plates 3 and 4, *63*). Each bone possesses a medially directed posterior projection which meets that of the other side in the median line and is joined to it by cartilage. The ten to twelve ventral rays (Plates 3 and 4, *64*) are indirectly attached to the girdle by similar cartilaginous nodules that are found in the pectoral fins.

Vertical fins and their skeleton (Plate 10).—The vertical fins include the dorsal, anal, and caudal fins. They are connected to the skeleton by bones placed loosely in the flesh, which have merely slight fibrous attachments to the nearest skeletal parts, or none at all.

The dorsal rays (Plate 10, *78*) are supported by a series of fourteen such free bones which are known as interneurals (Plate 10, *77*), being situated at the interspaces between the neural spines. The 1st interneural of the dorsal fin is situated between the 14th and 15th neural spines. It is very much enlarged. Attached to it are the first four or five dorsal rays which are so closely placed one after the other that they seem to form externally a single big ray. The remaining interneurals gradually decrease in length posteriorly, the tips of the last six or seven no longer reaching those of the nearest neural spines. The articulations between the interneurals and the dorsal rays are by means of cartilaginous nodules, the same as those in the pectoral and ventral fins, and are typical for all the fins, both paired and vertical (Plate 10, fig. F).

Not all the interneurals, however, are concerned with the support of the dorsal fin. The first thirteen interneurals, which are placed loosely in the first thirteen interspaces between the neural spines of each of the corresponding first fourteen vertebræ, are entirely free and not in the least connected to other parts of the skeletal system.

The anal fin is likewise supported and loosely connected to the skeleton by seven or eight such free bones known as interhæmals (Plate 10, *79*) because they are situated in the interspaces between the hæmal spines. At the level of the hæmal spine of the 31st vertebra the quill-shaped and much enlarged 1st interhæmal articulates by fibrous connections with the anterior face of this hæmal spine. Sometimes the next interhæmal is totally ankylosed to the first, except for the basal portion which stays clearly distinct. The next two slender interhæmals, which are very close together, are likewise attached with fibrous connections to the posterior face of this same hæmal spine. The next two also, very close together, are closely applied to the posterior face of the succeeding hæmal spine. The next two are situated in the interspace between the hæmal spines of the 33d and 34th vertebræ, while the last, a very short bone, is exactly at the tip of the hæmal spine of the 34th vertebra. The eleven cartilaginous anal rays (Plate 10, *80*) are articulated with the interhæmals in the same way as in the dorsal fin. The 1st interhæmal is modified to receive the posterior end of the air bladder. The last three or four pairs of movable ribs, the first three interhæmals, and the hæmal spine of the 31st vertebra, all aid in the support of the posterior portion of the air bladder.

The skeletal support for the caudal fin has already been discussed, except for the actual articulation between the caudal rays and these bony skeletal parts (Plate 10, figs. D and E). There are from thirty-six to forty caudal rays (*82*), the dorsal and ventral lobes possessing equally eighteen to twenty rays each. The rays are articulated to the hypurals, and the neural and hæmal spines of the last few vertebræ, by thick cartilaginous pads which form a strong cementing substance between the fin rays and the bones. The cartilaginous rays grasp the bony supports between their diverging bases, these bony supports being inserted deepest in the seven or eight longest rays of each lobe.

INTERMUSCULAR BONES

Situated in the myocommata of both the epaxial and hypaxial muscles are fine tendon bones, known as intermuscular bones (Plates 8 and 9, *76*). They are very much branched in the anterior regions where the muscles are thickest, and gradually decrease in their branchings posteriorly, until in the tail region they are single bones. They do not connect with any part of the skeleton except perhaps through the fibrous myosepta where they are situated. They are responsible for the extremely bony nature of the species.

Epaxial intermuscular bones (*Plate 8*).—There are from forty-three to forty-five epaxial intermuscular bones on each side, corresponding to the same number of myocommata. The 1st is usually much smaller than the rest, but possesses the most filamentous branches. Sometimes it possesses as many as ten branches at each end. The number of branches gradually decreases posteriorly, until the 30th or 31st myocomma, where the bones are unbranched. The last six or seven do not follow a backward and upward course but are roughly parallel to the long axis of the body corresponding to the position of the muscle masses in this region. The number of these bones may slightly vary on the two sides, but no undue significance need be attached to this variation.

Hypaxial intermuscular bones (*Plate 9, figs. A and B*).—In the myocommata of the hypaxial muscles intermuscular bones are likewise found. There are from twenty-two to thirty such bones on each side. These bones are not as branched as those in the epaxial region. The first one to four intermuscular bones are very delicate, fine, and unbranched, requiring a great deal of care in dissecting them out. The next eight to twelve possess two branches at their distal ends; the rest are unbranched. As in the dorsal region, the number may slightly vary on the two sides, as also the number of branched and unbranched bones. Similarly, no undue significance need be attached to this difference.

TABLE 1.—*Summary of parts in the skeleton of Chanos chanos* (*Forskål*).

Region.	Structure.	Total number, both sides.
Skull and visceral skeleton	Vomer	1
	Ethmoid	1
	Prefrontal	2
	Frontal	2
	Sphenotic	2
	Parietal	2
	Epiotic	2
	Supraoccipital	1
	Pterotic	2
	Opisthotic	2
	Exoccipital	2
	Basioccipital	1

TABLE 1.—*Summary of parts in the skeleton of Chanos chanos (Forskål)*—Continued.

Region.	Structure.	Total number, both sides.
Skull and visceral skeleton	Parasphenoid	1
	Alisphenoid	2
	Prootic	2
	Hyomandibular	2
	Symplectic	2
	Quadrate	2
	Pterygoid	2
	Palatine	2
	Mesopterygoid	2
	Metapterygoid	2
	Preopercle	2
	Opercle	2
	Subopercle	2
	Interopercle	2
	Articular	2
	Sesamoid articular	2
	Angular	2
	Dentary	2
	Maxillary	2
	Premaxillary	2
	Interhyal	2
	Epihyal	2
	Ceratohyal	2
	Hypohyals	4
	Glossohyal	1
	Urohyal	1
	Branchiostegals	8
	Basibranchials	3
	Hypobranchials	6
	Ceratobranchials	10
	Epibranchials	8
	Pharyngobranchials	6
	Suspensory cartilage	1
	Supraorbitals	4
	Preorbital	2
	Suborbitals	6
	Postorbital	2
	Nasal	2
	Subtemporal	2
Girdles and fins (paired and vertical fins and their skeletal supports)	Supratemporal	2
	Posttemporal	2
	Supraclavicle	2
	Clavicle	2
	Postclavicle	2
	Hypercoracoid	2
	Hypocoracoid	2

TABLE 1.—*Summary of parts in the skeleton of Chanos chanos (Forskål)*—Continued.

Region.	Structure.	Total number, both sides.
Girdles and fins (paired and vertical fins and their skeletal supports)	Mesocoracoid	2
	Actinosts	8–10
	Pelvic girdle	2
	Pectoral rays	30–34
	Ventral rays	20
	Dorsal rays	15–16
	Anal rays	10–11
	Caudal rays	36–40
	Interneurals	27
	Interhæmals	8
	Hypural	6
Vertebral column and ribs	Vertebræ	43–44
	Ribs	56–58
	Epipleurals	46–52
Intermuscular bones	Epaxial intermusculars	86–90
	Hypaxial intermusculars	44–60
	Epipleurointermusculars	4
Possible total		590–619

ALPHABETICAL INDEX

ALPHABETICAL INDEX—continued

NUMERICAL INDEX

1. Vomer
2. Ethmoid
3. Prefrontal
4. Frontal
5. Sphenotic
6. Parietal
7. Epiotic
8. Supraoccipital
9. Pterotic
10. Opisthotic
11. Exoccipital
12. Basioccipital
13. Parasphenoid
14. Alisphenoid
15. Prootic
16. Hyomandibular
17. Symplectic
18. Quadrate
19. Pterygoid
20. Palatine
21. Mesopterygoid
22. Metapterygoid
23. Preopercle
24. Opercle
25. Subopercle
26. Interopercle
27. Articular
28. Sesamoid articular
29. Angular
30. Dentary
31. Maxillary
32. Premaxillary
33. Interhyal
34. Epihyal
35. Ceratohyal
36. Hypohyals
37. Glossohyal
38. Urohyal
39. Branchiostegals
40. Basibranchials
41. Hypobranchials
42. Ceratobranchials
43. Epibranchials
44. Pharyngobranchials
45. Suspensory cartilage
46. Epipleurointermuscular bone
47. Supraorbitals
48. Preorbital
49. Suborbitals
50. Postorbital
51. Nasal
52. Supratemporal
53. Subtemporal
54. Posttemporal
55. Supraclavicle
56. Clavicle
57. Postclavicle
58. Hypercoracoid

NUMERICAL INDEX—continued

59. Hypocoracoid
60. Mesocoracoid
61. Actinosts
62. Pectoral rays
63. Pelvic girdle
64. Ventral rays
65. Abdominal vertebræ
66. Caudal vertebræ
67. Centrum
68. Neurapophyses
69. Neural spine
70. Hæmapophyses
71. Hæmal spine
72. Zygapophyses
73. Parapophyses
74. Rib
75. Epipleurals
76. Intermuscular bones
77. Interneurals
78. Dorsal rays
79. Interhæmals
80. Anal rays
81. Hypural
82. Caudal rays

REFERENCES

1. GOODRICH, E. S. Vertebrata. Craniata (First Fascicle: Cyclostomes and Fishes.) A Treatise on Zoölogy edited by Ray Lankester. Adam and Charles Black, London (1909) pt. 9.
2. JORDAN, DAVID STARR. A Guide to the Study of Fishes. Henry Holt & Co., New York 1 (1905).
3. KINGSLEY, J. S. Outlines of Comparative Anatomy of Vertebrates. P. Blakiston's Son & Co., Philadelphia (1917).
4. PARKER, T. JEFFERY, and WILLIAM A. HASWELL. A Textbook of Zoölogy. Macmillan & Co., Ltd. London 2 (1921) 194–203.
5. RIDEWOOD, W. G. On the cranial osteology of the fishes of the families Elopidæ and Albulidæ, with remarks on the morphology of the skull in the lower teleostean fishes generally. Proc. Zoöl. Soc. London 2 (1904) 35–81.
6. RIDEWOOD, W. G. On the cranial osteology of the clupeoid fishes. Proc. Zoöl. Soc. London 2 (1904) 448–493.
7. STARKS, EDWIN C. Synonymy of the fish skeleton. Proc. Wash. Acad. Sci. 3 (1901) 507–539.
8. WIEDERSHEIM, ROBERT. Comparative Anatomy of Vertebrates. Adapted by W. N. Parker. 3d ed. Macmillan & Co. London (1907).

ILLUSTRATIONS

[Photographs from actual specimens by Angbengco and Panlilio; text fig. 1 is a drawing from actual specimen by N. Dimanlig, Jr.]

PLATE 1. SKULL, × 1

FIG. A. Dorsal aspect.
B. Ventral aspect.
C. Left lateral aspect.
1, Vomer; *2*, ethmoid; *3*, prefrontal; *4*, frontal; *5*, sphenotic; *6*, parietal; *7*, epiotic; *8*, supraoccipital; *9*, pterotic; *10*, opisthotic; *11*, exoccipital; *12*, basioccipital; *13*, parasphenoid; *14*, alisphenoid; *15*, prootic; *sup cr*, supraoccipital crest or spine; *br art*, articulating surface for branchial apparatus; *hyo art*, articulating surface for head of hyomandibular.

PLATE 2. SKULL, × 1

FIG. A. Posterior aspect. *6*, Parietal; *7*, epiotic; *8*, supraoccipital; *9*, pterotic; *10*, opisthotic; *11*, exoccipital; *13*, parasphenoid; *for mag*, foramen magnum; *art*, facets for articulation of half centrum. (The half centrum was detached to show the basioccipital).
B. Hyoid arch with attached branchiostegals, superior aspect.
C. Same structure, inferior aspect.
33, Interhyal; *34*, epihyal; *35*, ceratohyal; *36*, hypophyals; *37*, glossohyal; *38*, urohyal; *39*, branchiostegals.

PLATE 3

Circumorbital series, left side, outer aspect; × 0.7. *47*, Supraorbitals; *48*, preorbital; *49*, suborbitals; *50*, postorbital; *51*, nasal.

Maxillary series, left side, outer aspect; × 0.7. *31*, Maxillary; *32*, premaxillary.

Mandibular series, left side, outer aspect; × 0.7. *27*, Articular; *29*, angular; *30*, dentary.

Hyopalatine series, left side, outer aspect; × 0.7. *16*, Hyomandibular; *17*, symplectic; *18*, quadrate; *19*, pterygoid; *20*, palatine; *21*, mesopterygoid; *22*, metapterygoid.

Opercular series, left side, outer aspect; × 0.7. *23*, Preopercle; *24*, opercle; *25*, subopercle; *26*, interopercle; *39*, branchiostegals.

Temporal series, left side, outer aspect; × 0.7. *52*, Supratemporal; *53*, subtemporal; *54*, posttemporal.

Pectoral girdle and rays, left side, outer aspect; × 0.7. *55*, Supraclavicle; *56*, clavicle; *57*, postclavicle; *58*, hypercoracoid; *59*, hypocoracoid; *61*, actinosts; *62*, pectoral rays.

Pelvic girdle and rays, left side, outer aspect; × 0.7. *63*, pelvic girdle; *64*, ventral rays.

PLATE 4

FIG. A. Mandibular and hyopalatine series, left side, inner aspect; × 0.7. *16*, Hyomandibular; *17*, symplectic; *18*, quadrate; *19*, pterygoid; *20*, palatine; *21*, mesopterygoid; *22*, metapterygoid; *27*, articular; *28*, sesamoid articular; *29*, angular; *30*, dentary.

B. Pectoral girdle and rays (some parts of temporal series included), left side, inner aspect; × 0.7. *52*, Supratemporal; *54*, posttemporal; *55*, supraclavicle; *56*, clavicle; *57*, postclavicle; *58*, hypercoracoid; *59*, hypocoracoid; *60*, mesocoracoid; *61*, actinosts; *62*, pectoral rays.

C. Pelvic girdle and rays, left side, inner aspect; × 0.7. *63*, Pelvic girdle; *64*, ventral rays.

D. Disarticulated bones of pectoral and pelvic girdles; × 0.6. *52*, Supratemporal; *54*, posttemporal; *55*, supraclavicle; *56*, clavicle; *57*, postclavicle; *58*, hypercoracoid; *59*, hypocoracoid; *60*, mesocoracoid; *63*, pelvic girdle.

PLATE 5. HYOBRANCHIAL APPARATUS, × 1

FIG. A. Superior aspect.

B. Inferior aspect, with hyoid arch extended forward. *33*, Interhyal; *34*, epiphyal; *35*, ceratohyal; *36*, hypophyals; *37*, glossohyal; *38*, urohyal; 40_1, 1st basibranchial; 40_2, 2d basibranchial; 40_3, 3d basibranchial; 41_1, 1st hypobranchial; 41_2, 2d hypobranchial; 41_3, 3d hypobranchial; 42_1, 1st ceratobranchial; 42_4, 4th ceratobranchial; 42_5, 5th ceratobranchial; 43_1, 1st epibranchial; 43_4, 4th epibranchial; 44_1, 1st pharyngobranchial; 44_3, 3d pharyngobranchial; *45*, suspensory cartilage; *a*, bony portion of glossohyal; *car*, cartilage; *m*, membrane.

PLATE 6

FIG. A. *65*, Abdominal vertebræ; *66*, caudal vertebræ; *74*, ribs; *81*, hypurals; *82*, caudal rays; *a*, atlas; *b*, axis.

B. Complete skeleton from the right side. Intermusculars of right side held in place by fine wires which can be seen on close scrutiny; × 0.2.

PLATE 7

Figures 0.6 actual size.

FIG. A. Atlas, left lateral aspect.

B. Axis, left lateral aspect.

C. Third vertebra and ribs, anterior aspect.

D. Seventeenth vertebra; last abdominal vertebra, anterior aspect.

E. Eighteenth vertebra; 1st caudal vertebra, anterior aspect.

F. Thirty-second vertebra; a typical caudal vertebra, anterior aspect.

G. Thirty-first vertebra; 1st caudal vertebra without ribs, left lateral aspect.

H. Eleventh vertebra; disarticulated to show parts of typical abdominal vertebra, anterior aspect.

67, Centrum; *68*, neurapophyses; *69*, neural spine; *70*, hæmapophyses; *71*, hæmal spine; *72*, zygapophyses; *73*, parapophyses; *74*, rib; *75*, epipleural.

PLATE 8

Figures 0.5 actual size.

FIG. A. Epaxial intermuscular bones of left side.
B. Epaxial intermuscular bones of right side.
76, Intermuscular bones. *a*, First intermuscular bone; *b*, last intermuscular bone.

PLATE 9

Figures 0.5 actual size.

FIG. A. Hypaxial intermuscular bones of left side.
B. Hypaxial intermuscular bones of right side.
76, Intermuscular bones; a_1 first intermuscular bone; a_2, last intermuscular bone.
C. Epipleurals of left side.
D. Epipleurals of right side.
46, *a*, *b*, Epipleurointermuscular bones; *c*, first real epipleural; *d*, last epipleural.

PLATE 10

FIG. A. Free interneurals; × 0.5. *77*, Interneural; *a*, first interneural; *b*, last interneural.
B. Dorsal fin and skeleton, left lateral aspect; × 0.5. *77*, Interneural; *78*, dorsal rays; *a*, first interneural of fin; *b*, last interneural of fin.
C. Anal fin and skeleton, left lateral aspect; × 0.5. *79*, Interhæmal; *80*, anal rays; *a*, modified 1st interhæmal; *b*, last interhæmal.
D. Detailed structure of caudal region; × 0.7. *66*, Caudal vertebræ 42d and 43d; *81*, hypurals.
E. Caudal region showing tail attachment; × 0.7. *82*, Caudal rays.
F. Structure of a typical fin skeleton (2d dorsal fin skeleton); × 0.06. *77*, Interneural; *78*, dorsal ray; *car*, cartilaginous nodule.

TEXT FIGURE

FIG. 1. Skull, left lateral aspect; × 1.5. *4*, Frontal; *16*, hyomandibular; *21*, mesopterygoid; *22*, metapterygoid; *23*, preopercle; *24*, opercle; *25*, subopercle; *26*, interopercle; *27*, articular; *29*, angular; *30*, dentary; *31*, maxillary; *32*, premaxillary; *39*, branchiostegal; *47*, supraorbitals; *48*, preorbital; *49*, suborbitals; *50*, postorbital; *51*, nasal; *52*, supratemporal; *53*, subtemporal; *sup cr*, supraoccipital crest or spine.

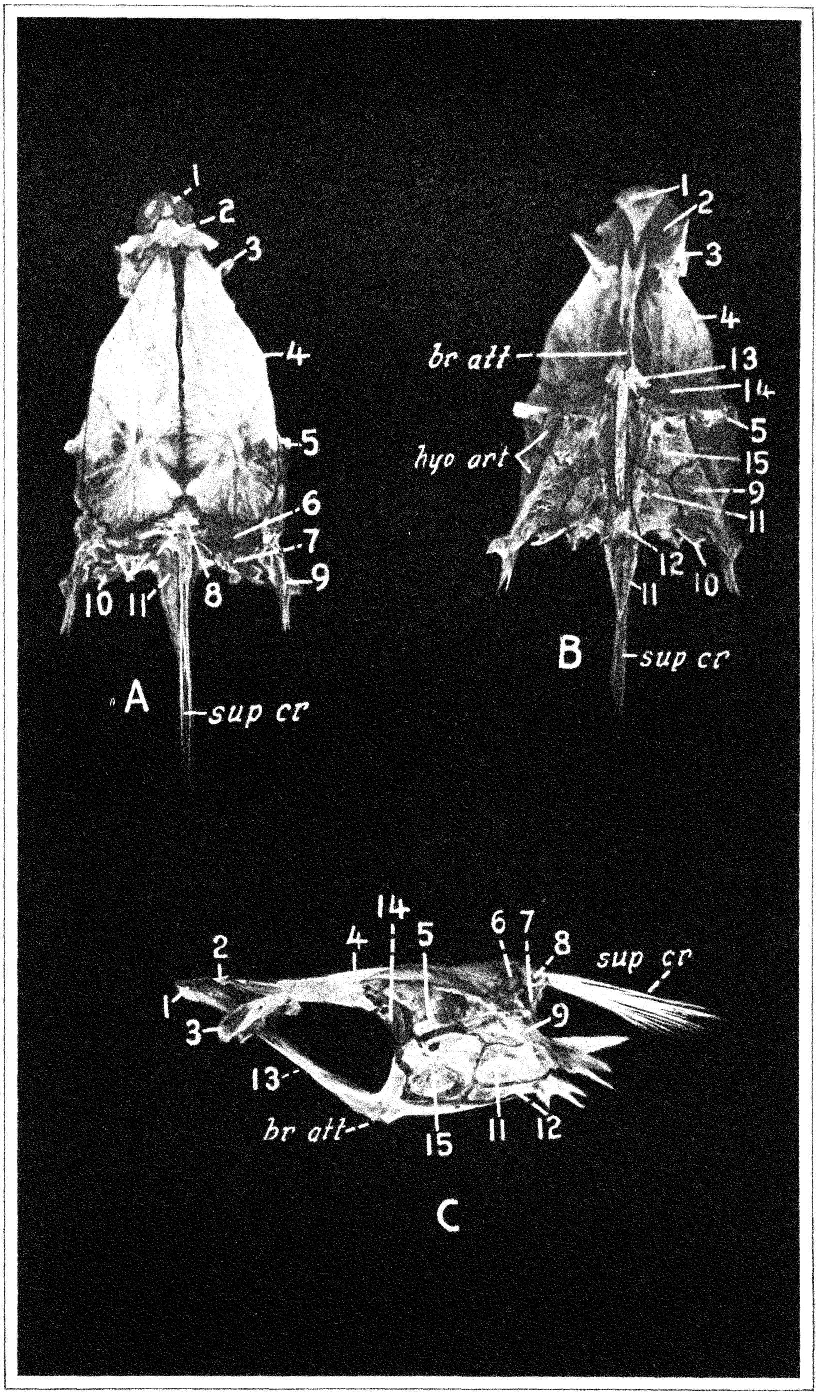

1
2
3
4
5
6
7
8
9
10
11
sup cr
A
1
2
3
4
br att
13
14
5
hyo art
15
9
11
12
10
11
B
sup cr
14
2
4
5
6
7
8
sup cr
1
3
9
13
br att
15
11
12
C

PLATE 1.

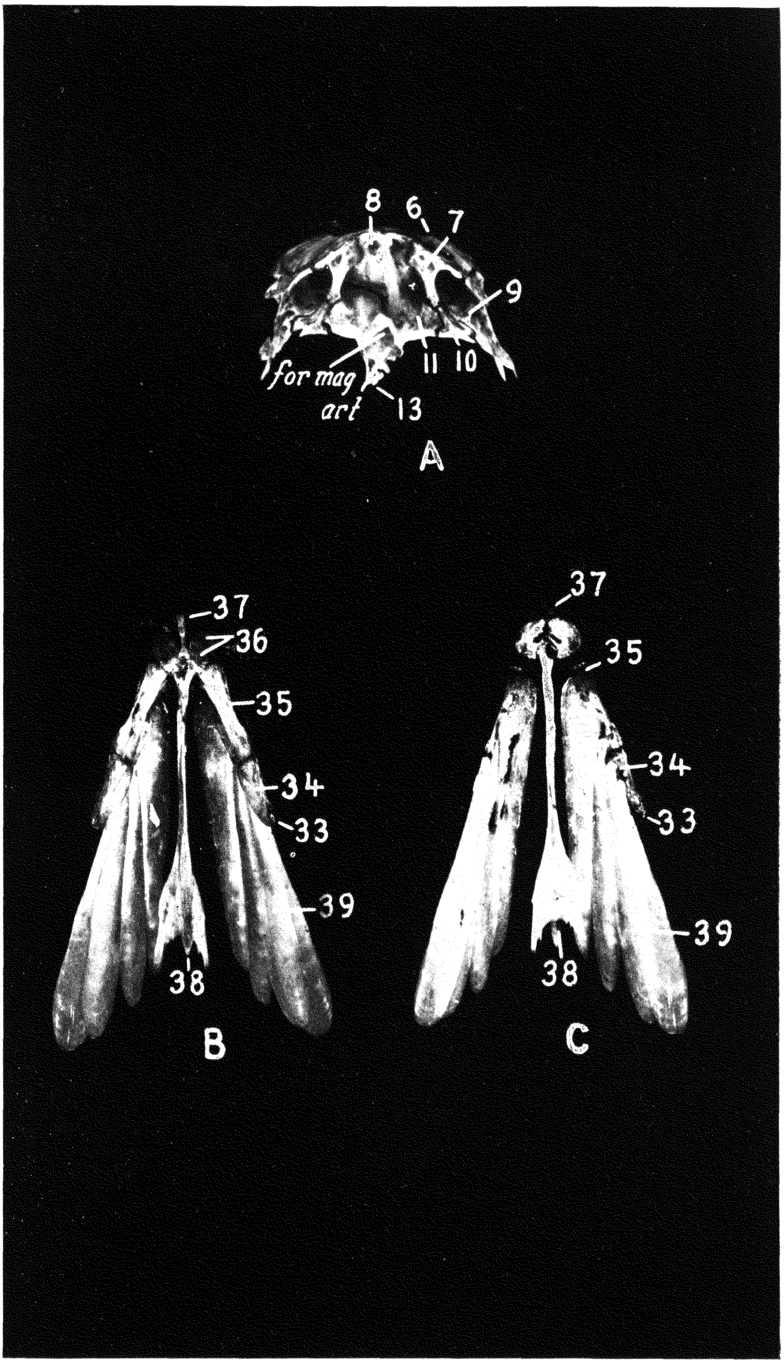


PLATE 2.

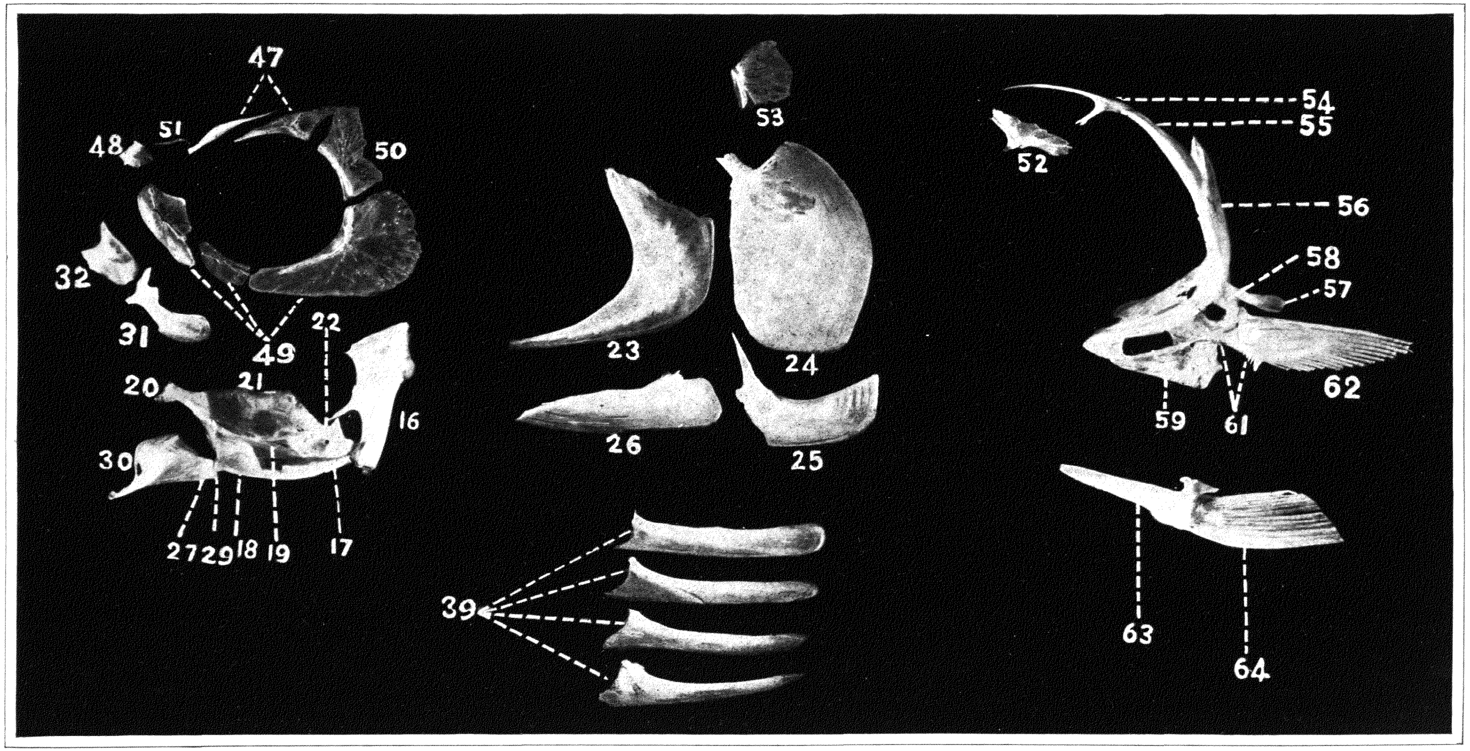

47
48
51
50
32
31
49
22
20
21
16
30
27
29
18
19
17
53
23
24
26
25
39
54
55
52
56
58
57
62
59
61
63
64

PLATE 3.

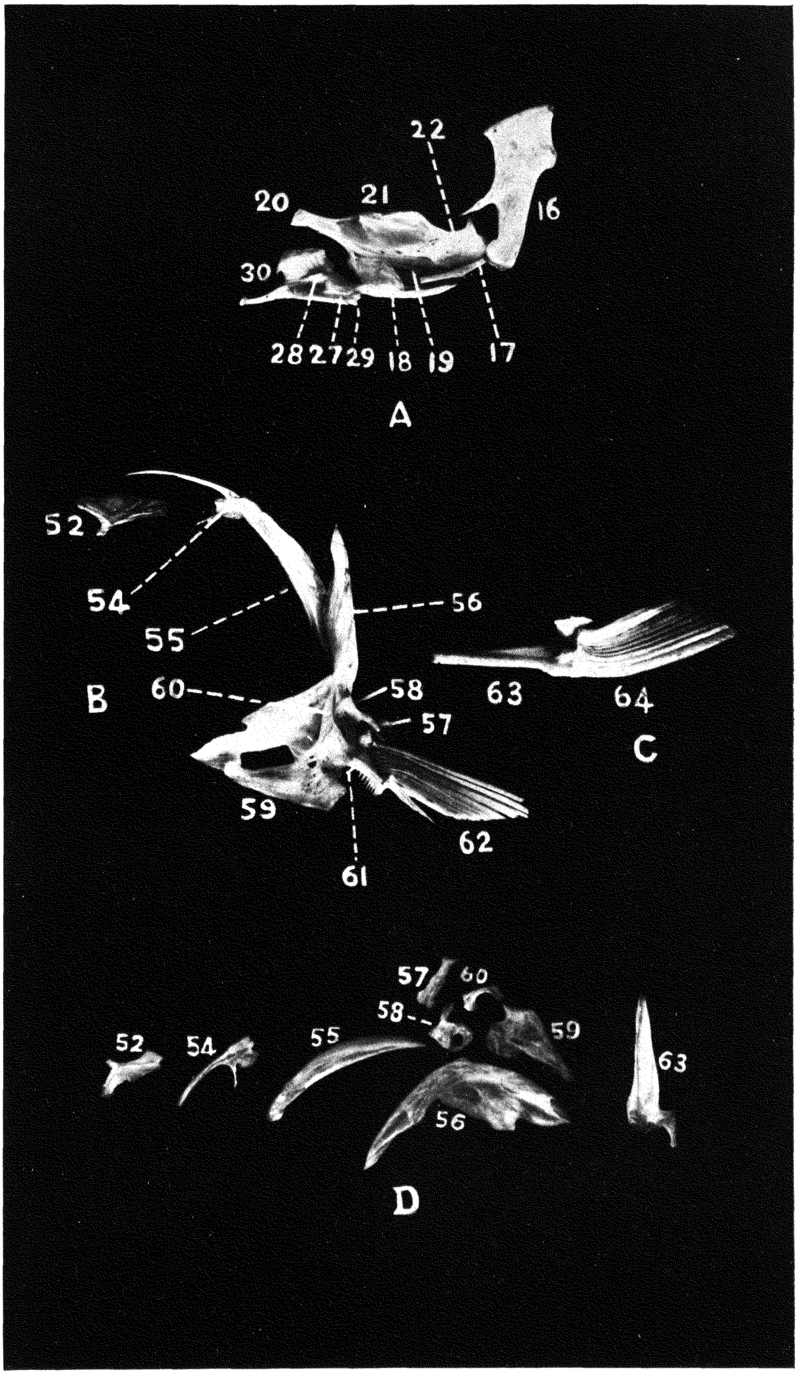

22
20
21
16
30
28 27 29 18 19 17
A
52
54
55
56
B
60
58
57
63
64
C
59
61
62
57
60
58
59
52
54
55
56
63
D

PLATE 4.

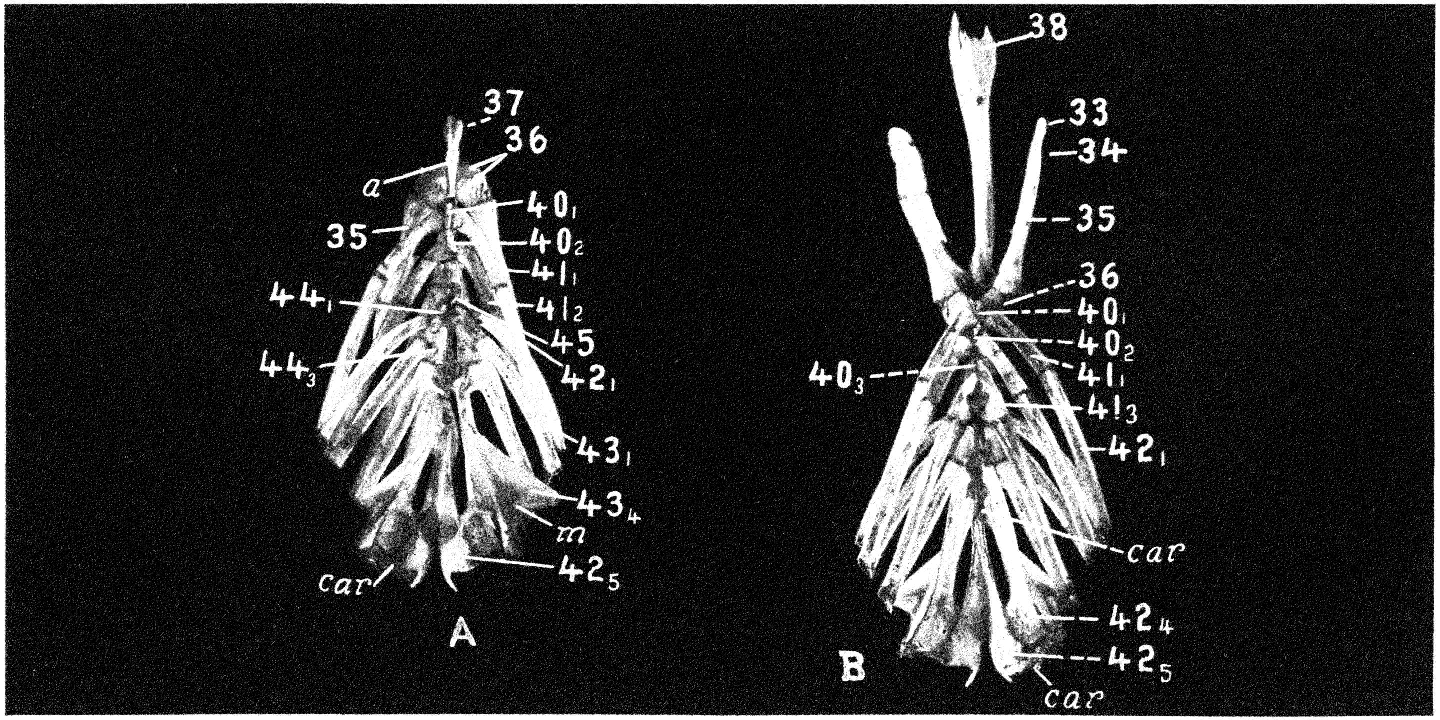

37
36
a
40₁
35
40₂
41₁
44₁
41₂
45
44₃
42₁
43₁
43₄
m
car
42₅
A
38
33
34
35
36
40₁
40₂
40₃
41₁
41₃
42₁
car
42₄
42₅
B
car

PLATE 5.

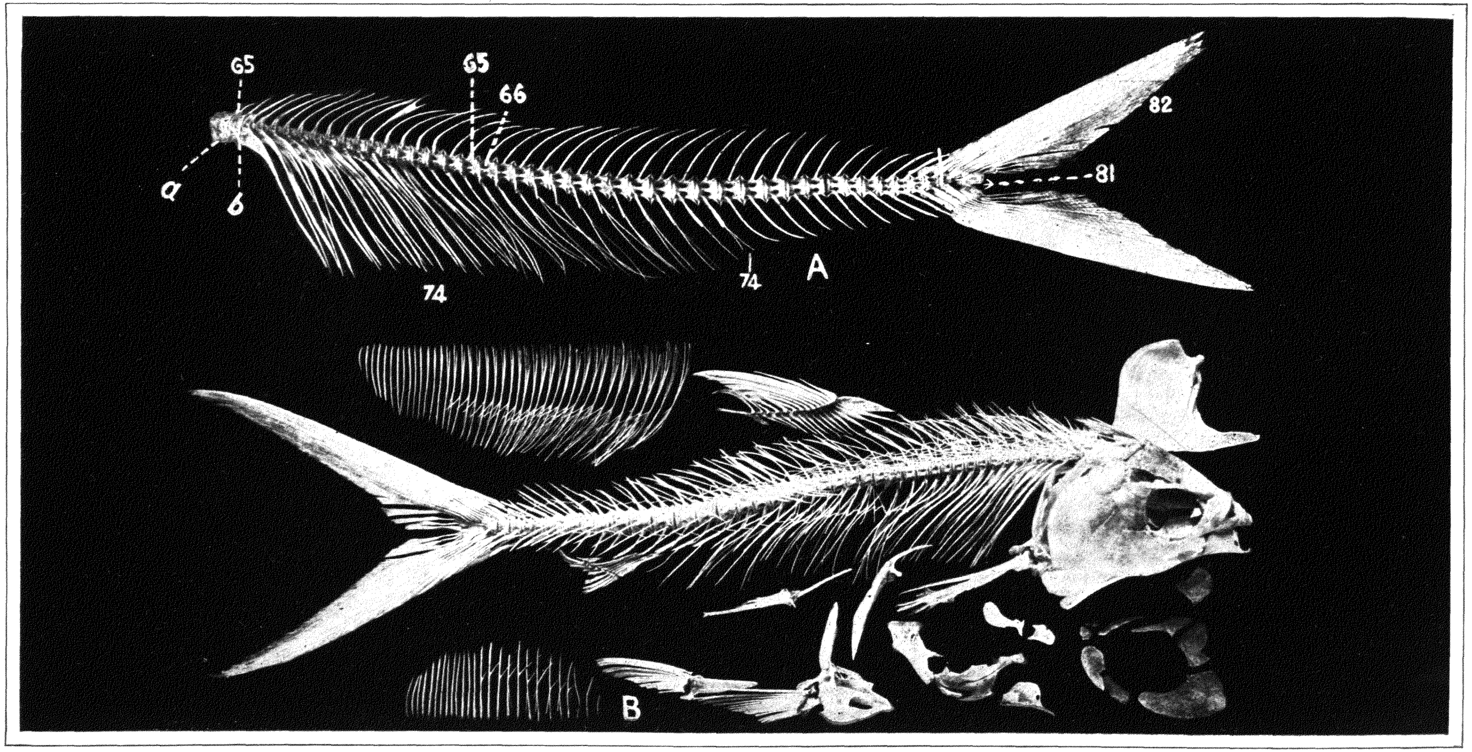


PLATE 6.

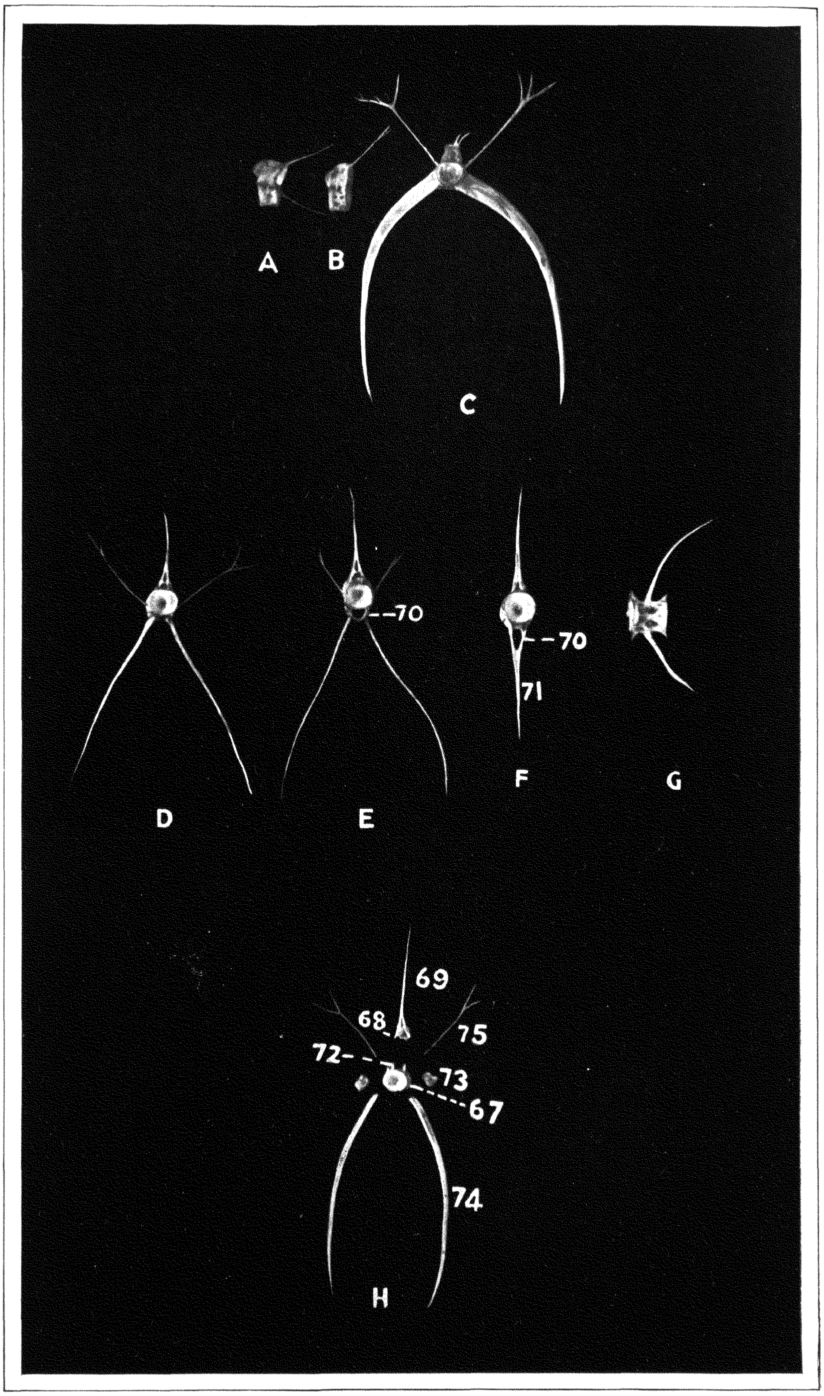
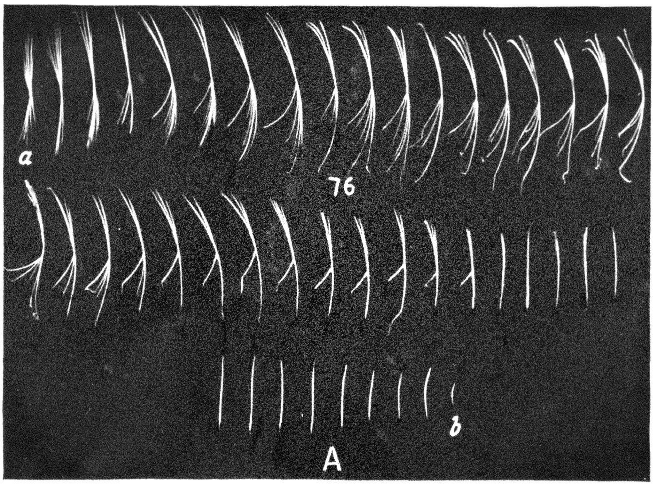


PLATE 7.



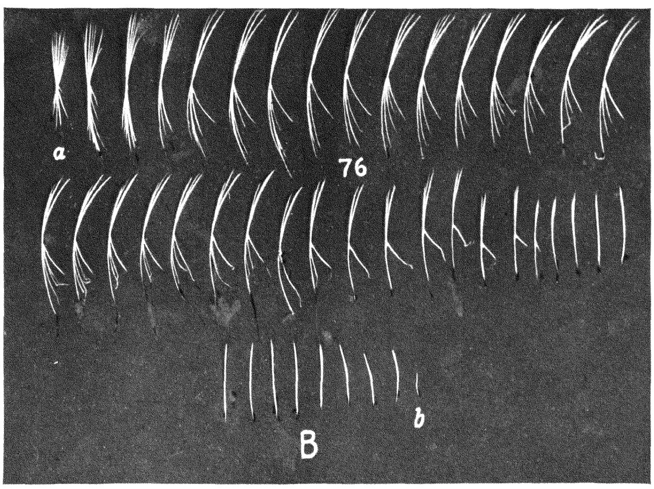


PLATE 8.

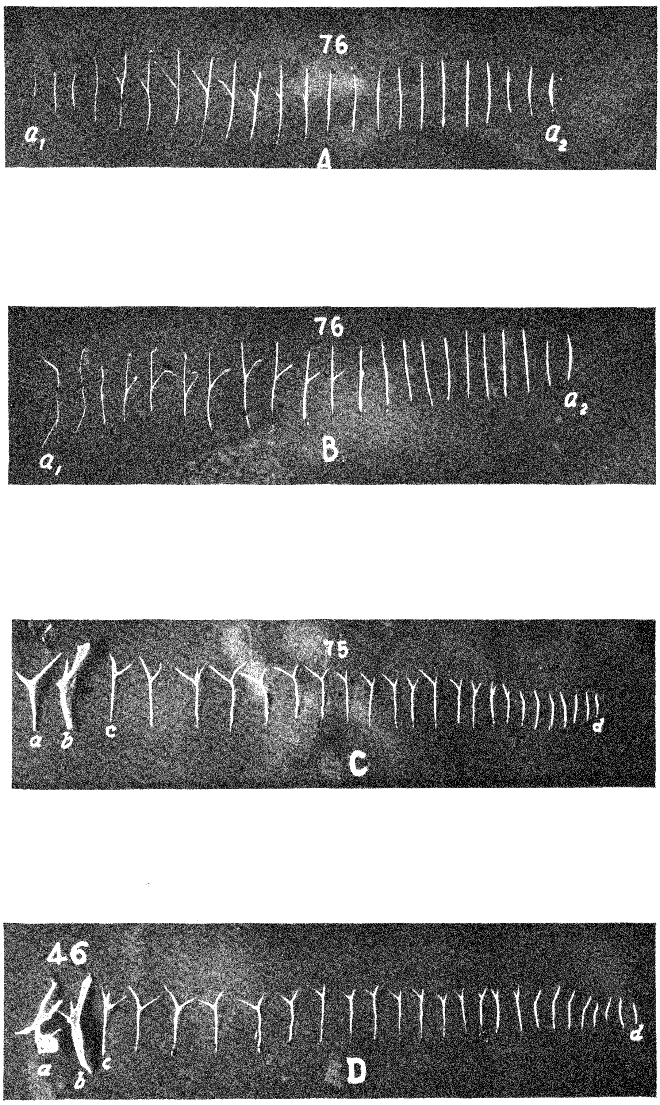


PLATE 9.

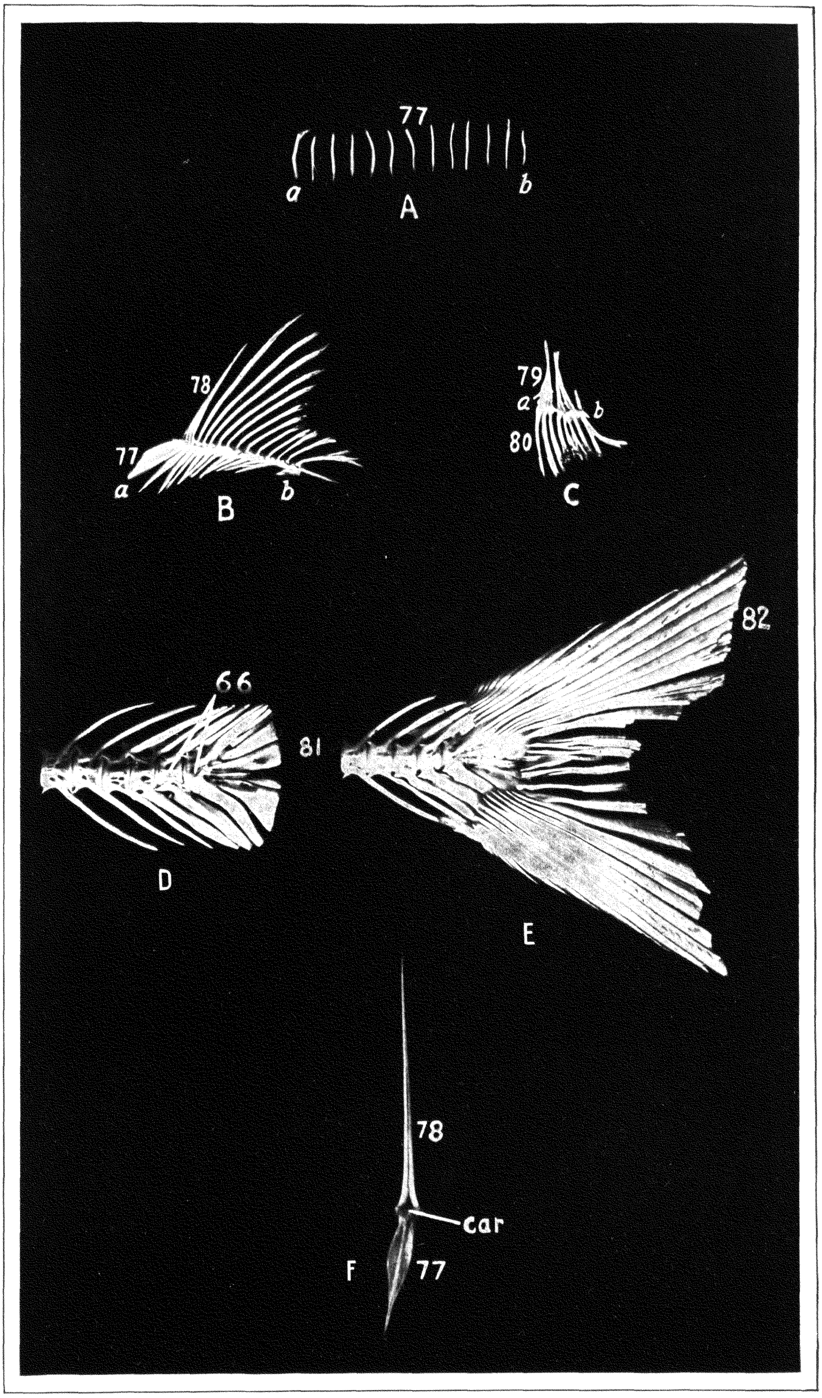


PLATE 10.

EARLY LIFE HISTORY OF THE VIVIPAROUS PERCH TÆNIOTOCA LATERALIS AGASSIZ [1]

By GUILLERMO J. BLANCO

Of the Fish and Game Administration, Bureau of Science, Manila

FIVE PLATES

This paper presents a study of the early development of the viviparous blue perch, *Tæniotoca lateralis,* family Embiotocidæ, covering the morphological structure of the ovary and the larval development of the young.

The material on which this study is based consists of mature specimens with various stages of ovaries of *Tæniotoca lateralis,* collected in Puget Sound, Washington, from 1929 to 1932, by the faculty and students of the Department of Fisheries, University of Washington.

An adult female of *Tæniotoca lateralis* was dissected to determine the position of the ovary in the body cavity. Other dissections were made to study the morphological structure of the ovary.

Female specimens of *T. lateralis* caught in September, October, and November, 1932, were found to contain eggs in various cleavage stages, and from December, 1932, to July, 1933, various stages of the larvæ and young were also found.

The eggs were removed from the ovarian sacs, washed in water to remove formalin, passed through various concentrations of alcohol up to 100 per cent, cleared with Beechwood creosote, and then placed in concave glass slides for examination.

The ordinary methods of killing, staining, and clearing the tissues and embryos were used.

The cross sections of an ovary fixed with formalin were prepared by the paraffin method, stained with hæmatoxylin and eosin, and cleared with xylene.

The larvæ preserved in formalin were washed with water, stained with borax carmine overnight, destained with 70 per

[1] A portion of a thesis presented for the degree of Master of Science (Fisheries) in 1933, prepared under the direction of Dr. Leonard P. Schultz, formerly with the University of Washington, Department of Fisheries.

cent acid alcohol, cleared with Beechwood creosote, and then mounted on glass slides.

The eggs were measured with a filar micrometer eyepiece and the data recorded.

All drawings were made with the aid of a camera lucida and projection drawing apparatus at known magnifications.

The writer wishes to express his thanks to Dr. Leonard P. Schultz, formerly with the Department of Fisheries, University of Washington, for furnishing part of the material and for his kind suggestions and helpful criticism.

HABITS OF TÆNIOTOCA LATERALIS

Tæniotoca lateralis Agassiz is found from Vancouver Islands to San Diego, rarely southward (Eigenmann and Ulrey, 1894) from the latter point.

The secondary sexual characters of the male and female *Tæniotoca lateralis* are similar to those found in *Cymatogaster aggregatus, Damalichthys vaca,* and the related species *Amphigonopterus aurora,* of the family Embiotocidæ. The anal fin in the female is unmodified, and the anal fin of the male has on each side a glandlike structure with a free duct pointing forward. The males of *Amphigonopterus aurora, Cymatogaster aggregatus,* and *Micrometrus minimus,* have well-developed glands and testes soon after birth, but Hubbs (1921) found that one-year-old males of *Embiotoca lateralis* (=*Tæniotoca lateralis*) were immature.

The breeding habits of the blue perch are not definitely known. Probably all the viviparous perches inhabiting the shores along the entire coast from San Diego to Puget Sound have more or less similar breeding habits, with a slight variation in the time of breeding during the summer (Hubbs, 1917, 1921).

The breeding habits of *Cymatogaster aggregatus* were observed by Hubbs (1917) July 5, 1916, in a shallow channel of an estuary in Santa Barbara County, California. His description, quoted below, serves as an example of the process of copulation in the viviparous perches.

> Attention was first directed to a slight disturbance about twenty feet offshore, where two "Shiners" were swimming with their backs just out of the water. Very soon the pair were joined by six others, which judging from their small size, were likely males. The original pair swam slowly towards shore, their caudal regions in close proximity. The largest of the supernumerary fishes immediately preceded the pair, while the others followed a short distance behind. Occasionally the male turned partly

unto his side. After the fishes had proceeded thus shoreward about six feet, there ensued a commotion, of which the details were not observed, and then all but the first pair swiftly made for deeper water offshore.

The pair, now alone, then proceeded against the tide in a semi-circular course of about five feet, frequently pausing while the male, turning upon his side, applied his anal region to that of his mate. Finally reaching the shelter of a stone in about a foot of water, the pair halted and copulation ensued. With their heads in the same direction and their anal regions in contact the pair remained quite motionless for a few seconds, seeming to balance in the water. The male turned over to a nearly horizontal position, the female much less. For several seconds the male moved rather slowly about half an inch back and forth, paused, then resumed the vibratory movement for a few seconds and finally darted off without warning into deeper water.

James Blake's suggestion that the ventral surfaces are appressed, the heads of the fish pointing in opposite directions during copulation, is contrary to the observations of Hubbs (1916).

The time of breeding of *Tæniotoca lateralis* can be determined from a study of the eggs and larval stages. Eigenmann (1904) stated that copulation of *Cymatogaster* takes place during June or the early part of July, but the eggs are not fertilized until the following December. He based his conclusion on the seasonal behavior of the males and females, the stages of development of the testes in the males, and the presence of spermatozoa in the ovarian follicles in summer and late fall. Hubbs (1917) verified the evidence of his first observations on the copulation of *Cymatogaster* and added that delayed fertilization of the eggs probably happens in all of the viviparous perches.

In *Tæniotoca lateralis* ovaries of the materials of 1933 examined in October and November showed that the eggs were in late cleavage, blastula, gastrula, and embryonic stages. In December there were minute larvæ 1 mm long. The successive larval stages from December, 1932, to July, 1933, measure from 1 mm to 51 mm in total length.

Since the larvæ remain in the ovary from October to June and July, it is thought that the period of copulation of the blue perch probably is from June to August. The spermatozoa are retained in the ovary of the females until fertilization takes place in September.

STRUCTURE OF THE OVARY

The normal position of the ovary in the body cavity of a *Tæniotoca lateralis* 11.5 inches long and 5.2 inches deep is shown in Plate 1, fig. 1. The ovary, 13 mm long, is suspended from the dorsal wall of the abdomen by a mesovarium on its anterior portion and by a mesorectum on its posterior portion.

The ovary is a spindle-shaped bag in its early stages of development, from October to June, and in July becomes oblong as the developing embryos within increase in size (Plate 1, figs. 2 to 9). The anterior part of the ovary is divided into two arms or horns, indicating that the ovary has a bilateral origin. The left arm of the ovary, like the left arm of the ovary of *Cymatogaster aggregatus,* is usually much smaller than the right arm; the blood vessel entering the shorter left arm is likewise smaller. There are some cases where the two arms of the ovary are symmetrical. The ovaries of the sides have been united on the posterior region above the rectum, so that only the left and right anterior arms show the bilateral external structure.

Plate 2, figs. 10 and 11, show the structure of the ovarian sacs and their compartments. Two sacs are suspended from the inner upper margin of the ovarian wall. A cross section through the ovary at an early stage in October shows definitely how portions of the ovarian sacs come in contact with the inner upper margin of the ovarian wall, and the manner of arrangement of the compartments of the ovarian sacs (Plate 2, fig. 12). The sacs have their open ends at the posterior end of the bag. The left sac has a single vertical partition, thus being divided into two compartments c_1 and c_2, while the right sac of the ovary has two vertical partitions making three compartments, c_3, c_4, and c_5. The two ovarian sacs of *Tæniotoca lateralis* have usually five compartments compared with the four compartments of the ovarian sacs of *Cymatogaster aggregatus.* There are, however, exceptions to the five-compartment arrangement in *Tæniotoca lateralis.*

The ovarian sacs and their vertical partitions are highly vascular. A great number of blood vessels (*rbv*) and capillaries radiate from the right and left anterior arms and traverse the ovarian sheets towards their open ends.

The histological structure of the ovarian walls and the ovarian sheets of *Cymatogaster aggregatus* has been described by Eigenmann (1894). Since there is a very distinct similarity of the morphological structure of the ovaries of *Cymatogaster aggregatus, Tæniotoca lateralis,* and other related species of the family Embiotocidæ, it is probable that the histological structure of the ovarian wall and ovarian folds are also identical in all the related species in this family. The following quotation describes the histological structure of the ovarian wall and ovarian folds of *Cymatogaster aggregatus:* (6)

The ovarian walls are composed first of the thin peritoneal membrane; second, of a layer of longitudinal muscle fibers; third, of a layer of circular muscle fibers, inside of which there is in places, another layer of longitudinal fibers; fourth, a very thin layer of cells with flattened, deeply stainable nuclei; fifth, of a layer of epithelium. This layer is derived from the peritoneum. The cavity of the ovary arises as a groove on the lateral portion of the germinal ridge. The raised margins of the groove unite and form the ovarian cavity, which remains for some time connected with the body cavity by a ciliated opening. The inner linings of the ovary are thus of peritoneal origin. Laterally and ventrally the two inner layers form simple thin linings; dorsally they are thrown up into a number of low ridges. Besides these ridges there are on either side of the median dorsal line three broad sheets which are simply ridges enormously exaggerated. These sheets are united to form the sacs mentioned above. Cross-sections of these sheets show them to be composed externally of a continuation of the epithelium lining the ovarian sheath and internally by a continuation of the membranous tissue lying immediately outside the lining epithelium of the ovarian walls. In other words Nos. 4 and 5 of the structures enumerated above are raised and greatly prolonged to form these sheets. Ventrally the three sheets of each side have become united. The inner layers of these sheets sometimes form a solid tissue, but frequently they are well separated or connected by occasional fibers only. The latter is probably an artificial condition.

The blood vessels found in the sheets lie between the two inner layers of cells and are surrounded by tissue derived exclusively from the ovarian walls. They are always quite distinct from the surrounding tissues.

GENERAL DEVELOPMENT OF THE EGGS AND THE LARVÆ IN THE OVARY

Oögenesis takes place in the ovarian sheets, and as soon as maturation is complete, the ova are freed from the ovarian follicles. Cross sections through the ovary in October indicate various stages of maturing eggs. Plate 3, figs. 16 and 17, are cross sections through 1-celled eggs, which were free in the ovarian follicles but not free in the ovarian compartments.

Eigenmann (1894) states that the eggs are freed from the follicles before segmentation begins, and fertilization takes place just before or after they are set free in the ovarian compartments. I was unable to verify this point owing to the lack of material in September and October. Only the postembryonic stages of the eggs were available in November

(Plate 3, figs. 19 to 24). The fertilized eggs and the larvæ are not connected with any part of the ovary during their development.

ARRANGEMENT OF THE LARVÆ IN THE OVARY

Examination of several ovaries containing various stages of larvæ of *Damalichthys vaca* and *Tæniotoca lateralis* indicated that there was no definite arrangement of the larvæ in the ovarian compartments. A similar condition was found in *Cymatogaster.* The embryos were tightly packed against the ovarian walls and ovarian folds, some directed forward and others backwards. Eigenmann (1894) found that when the larvæ had well-developed gills and were about ready to be born, their heads were towards the origin of the oxygenated blood supply at the anterior end of the ovary.

NUMBER OF LARVÆ IN THE OVARY

It is generally known that the larger females of any given species of fish (oviparous or viviparous) are more prolific than the smaller females. Eigenmann (1894) found the number of larvæ in the ovary of *Phanerodon lateralis* (= *Tæniotoca lateralis*) to vary from 21 to 80, the largest number being found in the older females. Hubbs (1921) gave the number of larvæ in different sizes of *Embiotoca lateralis* as follows: First specimen, 257 mm long, contained 26 larvæ 46 to 49 mm long; second specimen, 265 mm long, contained 26 larvæ 50 to 54 mm long; third specimen, 200 mm long, contained 10 larvæ 55 to 58 mm long, but Hubbs suspected that some of the larvæ had been born earlier. My counts of the Puget Sound material ranged from 18 to 92 larvæ, depending on the size of the specimen.

NOURISHMENT AND RESPIRATION OF THE YOUNG

The small amount of the yolk in the small egg, absorbed early during the larval period, is not sufficient for the growth of the embryo and the larva. Eigenmann (1894) states that there is a general surface absorption of ovarian fluid throughout the ovarian life, so that the process of absorption by the general surface supplies the necessary food of the larva until the first gill slit is open. He observed that a continuous stream of ovarian fluid which entered through the first gill slit into the intestinal canal was accounted for by the ciliary movements in the intestinal canal and also by the motility of the tails of the spermatozoa found in the ovary and inner surface of the intestinal tract during early gestation. The hind gut containing long hollow vascular villi found in the embryos of *Tæniotoca lateralis* and in other genera of the family has been described long ago as the region of food absorption at the time of the opening of the mouth of the embryo.

The ovarian fluid described by Eigenmann (1894) and other writers consists of solid cell particles which are derived from the epithelial lining of the ovarian folds.

The embryos and larvæ are always in contact with the ovarian structures which obtain their blood supply directly from the gills. The presence of the highly active spermatozoa in the ovarian fluid and in the intestinal tract of the larva accounts for the distribution of the oxygenated albumen in all parts of the ovary. The highly vascular fins in the later stages are in direct contact with the same highly vascular ovarian folds, thus obtaining their oxygenated albumen (Eigenmann 1894, Hubbs 1921, and Ryder 1885).

DEVELOPMENTAL STAGES

The mature egg within the ovarian follicle (Plate 3, fig. 18) is spherical, having a diameter of about 0.3 mm. It has a distinct thin, vitelline membrane, enclosing unequal-sized oil globules evenly distributed.

The manner of cell division has not been observed for lack of complete series of segmenting eggs.

Plate 3, fig. 19, illustrates an early stage of differentiation of the germ ring. The egg measured 0.69 mm in diameter; blastoderm, 0.47; yolk, 0.36; and yolk nucleus, 0.23.

Plate 3, fig. 20, shows the blastoderm of an egg with fully developed germ ring and the beginning of the embryonic shield. The head of the embryo develops from the posterior pole of the embryonic shield. The diameter of the egg measured 0.67 mm; blastoderm, 0.47; yolk, 0.36; and the yolk nucleus, 0.22.

The embryo is coiled around the yolk (Plate 3, fig. 21). The diameter of the egg is 0.75 mm; the coiled embryo, 0.69; yolk, 0.46; and the yolk nucleus, 0.19.

Plate 3, fig. 22, is a lateral view of an embryo with several somites. The diameter of the egg measured 0.79 mm; the coiled embryo, 0.71; yolk, 0.52; and the nucleus, 0.23.

In the ventral view of an embryo (Plate 3, fig. 23) the diameter of the egg measured 0.79 mm; embryo, 0.61; yolk, 0.39; the yolk nucleus, 0.22.

Plate 3, fig. 24, is an advanced stage of an embryo which has distinct eyes before hatching. The diameter of the embryo measured 0.79 mm; embryo, 0.67; yolk, 0.35; yolk nucleus, 0.22.

The diameters of 22 eggs in October ranged from 0.67 to 0.79 mm, and in November, 27 eggs from 0.79 to 0.81 mm.

The embryo before hatching encircles the yolk; the head region is larger than the caudal region.

A larva 3 mm long (Plate 4, fig. 25) is straight and has 36 segments; it has narrow dorsal and ventral fin folds but its protocercal caudal fin has no trace of the fin fold at its tip. The protruding hind gut is well extended beyond the yolk sac which contains a small amount of yolk material. The heart is a slender tube extending from the dorsal wall of the pericardium. There are four gill slits; the first slit to open was found in a larva 4 mm long, in which the auditory capsule is very distinct in the developing cranium, but the lens of the eye is not well differentiated. The notochord is a straight cartilaginous rod extending from the hind brain to the end of the protocercal caudal fin.

In a larva 7 mm long (Plate 4, fig. 26) the notochord extends to the axial lobe of the caudal; the dorsal fin fold is narrower than the ventral fin fold. The intestine is coiled and has no elongated saclike hind gut containing numerous villi in its inner side. The liver has now occupied the former place of the yolk sac. The chambers of the heart are indistinct. The air bladder is an outgrowth of the dorsal wall of the œsophagus and is located dorsal to the intestine. The coracoscapular cartilages traverse the thoracic region.

In a larva 12 mm long (Plate 4, fig. 27) the maxillaries, eyes, brain, and opercles are well developed. The alimentary tract and circulatory system do not show further development. The dorsal and ventral fin folds posterior to the abdominal region are wider than those of the caudal peduncle. The ventral lobe of the caudal fin is larger than the upper axial lobe.

A larva 16 mm long, (Plate 5, fig. 28) has well-developed dorsal and anal fins, but retains traces of the fin folds in the region of the caudal peduncle. The homocercal caudal fin has the beginnings of cartilaginous epurals and hypurals and these are not fused with the chordal axis. The caudal fin has grown larger.

A larva 21 mm long (Plate 5, fig. 29) has enlarged dorsal and anal fins which are highly vascular. The vertebræ are indistinct in toto mounts, and the coracoscapular cartilages still persist. The short intestine runs posteriorly, then curves to the right and runs forward between the lobes of the liver, turning in another curve upwards, then into a short posterior curve to the much enlarged hind gut. The air bladder is dorsal to the liver and intestine in the body cavity.

A larva 41 mm long (Plate 5, fig. 30) has 11 spinous rays and 23 soft rays in the dorsal fin and 3 spinous rays and 30 soft rays in the anal fin. The dermotrichia of the caudal fin originate on top of the 3 dorsal caudal radials and hypurals. The pectoral and ventral fins are well developed. The intestine with a much reduced hind gut now lies in the body cavity. The heart has three well-developed chambers, sinus venosus, auricle, and ventricle. The vertebræ, which are very prominent, number between 35 and 37. The lateral line and scales have already appeared, the latter showing a few growth rings around their foci.

The development of the homocercal caudal of *T. lateralis* was previously published in this journal.(2)

SUMMARY

1. *Tæniotoca lateralis* Agassiz is a viviparous perch, found in shallow waters along the entire coast between San Diego, California, and Vancouver Island, Canada.

2. The secondary characters of the male and female *Tæniotoca* are similar to those found in *Cymatogaster;* the male has a glandlike structure on the sides of the anal fin, while the female has a normal anal fin. The males of *Tæniotoca* do not mature until more than one year old.

3. The ovary in the body cavity is spindle-shaped in its early stage, and becomes gradually oblong as the larvæ increase in size. The anterior arms of the ovary are usually unequal, the left being smaller. The ovary has two distinct sacs with five compartments.

4. The maturation of the eggs takes place in the ovarian follicles, and their development starts when they are freed in the ovarian compartments.

5. The eggs and larvæ are not connected with any part of the ovarian structures during their development.

6. The number of larvæ in the ovary ranges between 18 and 92, the larger numbers occurring in the larger fishes. The larvæ have no definite arrangement within the ovary and are able to change their position even when nearing extrusion.

7. The food absorbed and digested by the growing larva consists of the ovarian fluid and solid cell-like particles which are the products of the epithelial lining of the ovarian folds. The ovarian fluid is aërated by circulation within the ovarian follicles. The highly vascular fins in the later larval stages are always in contact with the highly vascular ovarian folds, thus obtaining their oxygenated albumen. The gills are well developed and undoubtedly become functional in later stages of the young while the latter are still in the ovary.

8. The young, when born, possesses nearly all of the adult characters of the parent fish.

REFERENCES

1. AGASSIZ, A. On the young stages of some osseous fishes. I. Development of the tail. Proc. Amer. Acad. Arts and Sci. **13** (1878) 117.
2. BLANCO, G. J. The Development of the homocercal caudal of the blue perch, Tæniotoca lateralis Agassiz. Philip. Journ. Sci. **56** (1935) 41–45, pl. 1, figs. 1–10.
3. EIGENMANN, CARL H. On the viviparous fishes of the Pacific Coast of North America. Bull. U. S. Fish Comm. **12** (1894) 381–478, pls. 92–118.
4. EIGENMANN, CARL H. Development of sexual organs in Cymatogaster. Proc. Indiana Acad. Sci. (1894) 133.
5. EIGENMANN, CARL H. The history of sex-cells from the time of segregation to sexual differentiation in Cymatogaster. Trans. Amer. Micros. Soc. **17** (1896) 172, 173.
6. EIGENMANN, CARL H., and ALBERT ULREY. A review of the Embiotocidæ. U. S. Fish Comm. **12** (1894) 400.
7. FISH, MARIE POLAND. Contributions to the early life history of sixty-two species of fishes from Lake Erie and its tributary waters. Bull. U. S. Bur. of Fish. **52** (1932) 293–398.
8. HUBBS, CARL L. The breeding habits of Cymatogaster aggregatus. Copeia No. 47 (1917) 72–74.
9. HUBBS, CARL L. A review of the viviparous perches. Proc. Biol. Soc. Wash. **31** (1918) 9–13.
10. HUBBS, CARL L. The ecology and life-history of Amphigonepterus aurora and of other viviparous perches of California. Biol. Bull. (4) **40** (1921) 181–209.
11. JORDAN, DAVID STARR. Guide to the Study of Fishes. **1** Viviparity in Fishes (1905) 124–130, figs. 91–96; **2** Embiotocidæ (1905) 372–379, figs. 306–312.
12. KUNTZ, A. The embryology and larval development of Bairdiella chrysura and Anchovia mitchilli. Bull. U. S. Bur. Fish. **31** (1913) 1–20.
13. KUNTZ, A. Notes on the habits, morphology of the reproductive organs and embryology of the viviparous fish Gambusia affinis. Bull. U. S. Bur. of Fish. (1913) 177–190.
14. KUNTZ, A. Notes on the embryology and larval development of five species of teleostean fishes. Bull. U. S. Bur. Fish. **34** (1914) 407–430.

15. RIDDLE, M. C. Early development of the chinok salmon, Puget Sound. Mar. Sta. Publ. 1 (1915–1917) 319–339.
16. RYDER, J. A. A contribution to the development and morphology of lophobranchiates Hippocampus antiquarum. The sea horse. Bull. U. S. Fish. Comm. 1 (1881) 191–199.
17. RYDER, J. A. Development of the Spanish mackerel (Cybium maculatum). Bull. U. S. Fish. Comm. 1 (1881) 135–170.
18. RYDER, J. A. Evolution of the fins of fishes. Report of Comm. of Fish and Fisheries. Washington (1884) 981–1107.
19. WHITEHOUSE, F. H. The caudal fins of fishes. Preliminary paper. Proc. Roy. Soc. B. **82** (1910) 134–143.
20. WHITEHOUSE, F. H. The caudal fin of the Teleostomi. Proc. Zool. Soc. London, No. 2 (1910) 590–625, pls. 47–50, figs. 1–33.

ILLUSTRATIONS

[*a*, Anus; *aaos*, anterior arm of ovarian sac; *ab*, air bladder; *au*, auditory capsule; *bc*, body cavity; *br*, branchial gill slit; *bv*, blood vessel; c_1, c_2, c_3, c_4, c_5, compartments 1, 2, 3, 4, and 5; *csc*, coracoscapular cartilage; *dos*, division of ovarian sac; *e*, egg; *es*, embryonic shield; *gr*, germ ring; *ht*, heart; *hg*, hind gut; *i*, intestine; *l*, liver; *m*, mesentery; *me*, mesovarium; *mr*, mesorectum; *n*, nucleus; *o*, ovary; *oc*, ovarian cavity; *of*, ovarian follicle; *og*, oil globule; *op*, ovarian partition; *ow*, ovarian wall; *rbv*, radial blood vessel; *umos*, upper margin of ovarian sac; *v*, villi; *ys*, yolk sac.]

PLATE 1. TÆNIOTOCA LATERALIS AGASSIZ

FIG. 1. Normal position of the ovary in the body cavity.
2. Stage of the ovary, October 22, 1932.
FIGS. 3 and 4. Stages of the ovary, November 14, 1932.
FIG. 5. Stage of the ovary, January, 1932.
6. Stage of the ovary, February 11, 1932.
7. Stage of the ovary, March 8, 1932.
FIGS. 8 and 9. Stages of the ovary, July, 1932.

PLATE 2. TÆNIOTOCA LATERALIS AGASSIZ

FIG. 10. Ovarian compartments of an ovary with arms of equal size, July 1, 1930.
11. Ovary, diagrammatic arrangement of two sacs and five compartments.
12. Cross section through an ovary, October 22, 1932.
13. Cross section through a portion of the inner lining of an ovarian wall.
14. Cross section through the posterior region of an ovary.

PLATE 3. TÆNIOTOCA LATERALIS AGASSIZ

FIG. 15. Cross section through an ovarian follicle; arrangement of two maturing eggs, a blood vessel, and cuboidal cells bordering each side of follicle.
16. Cross section through a 1-cell egg stage within the ovarian follicle.
17. Cross section through an egg, early stage.
18. Cross section through an egg, later stage.
FIGS. 19 and 20. Gastrula stages of the eggs, October 22, 1932.
21 and 22. Lateral views of early embryos, November 14, 1932.
FIG. 23. Ventral view of an embryo, November 14, 1932.
24. Lateral view of an embryo, advanced stage, November 14, 1932.

PLATE 4. TÆNIOTOCA LATERALIS AGASSIZ

FIG. 25. Larva 3 mm long, December 21, 1929.
26. Larva 7 mm long, November 29, 1929.
27. Larva 12 mm long, February 2, 1932.

PLATE 5. TÆNIOTOCA LATERALIS AGASSIZ

FIG. 28. Larva 16 mm long, March 8, 1932.
29. Larva 21 mm long, March 21, 1932.
30. Larva 41 mm long, July, 1932.

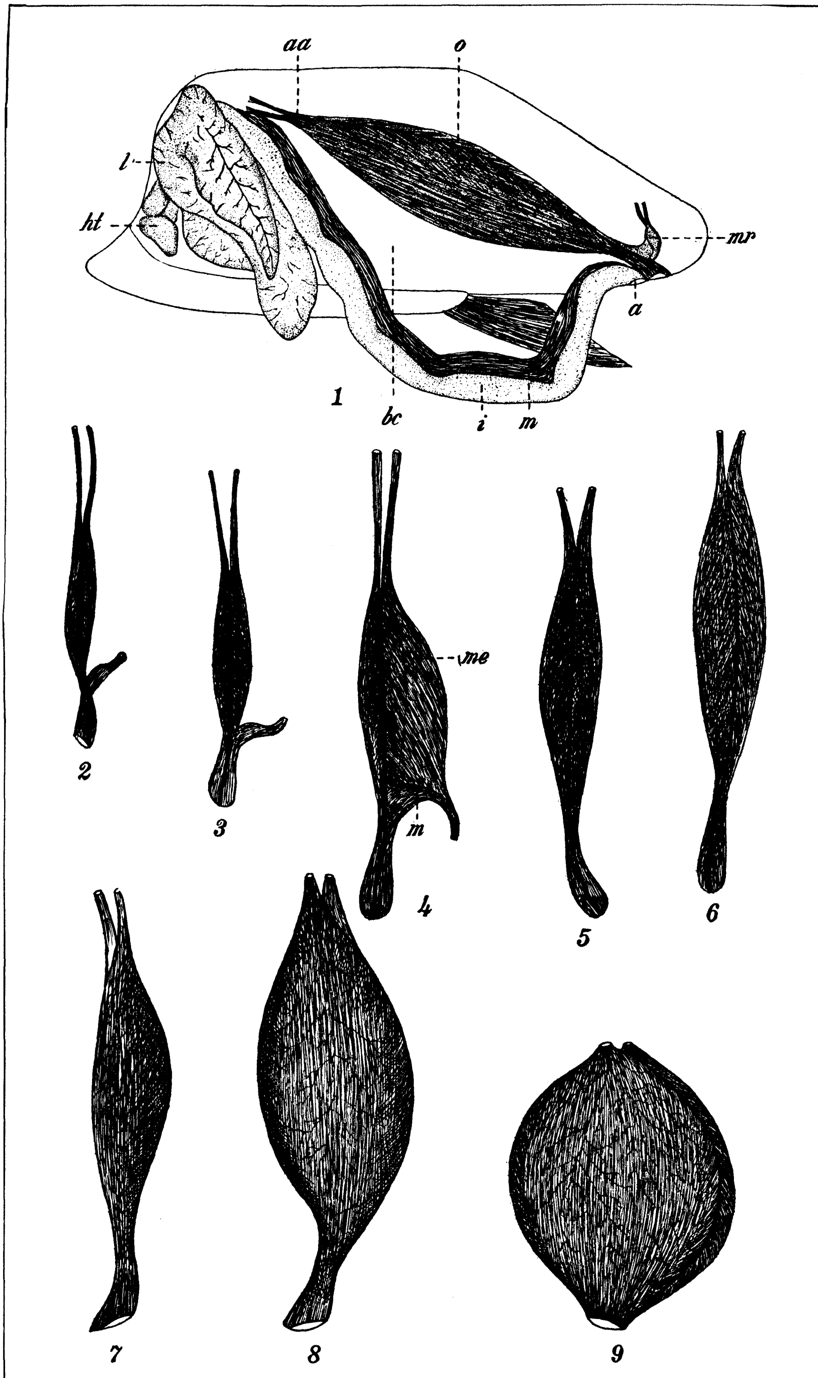


PLATE 1.

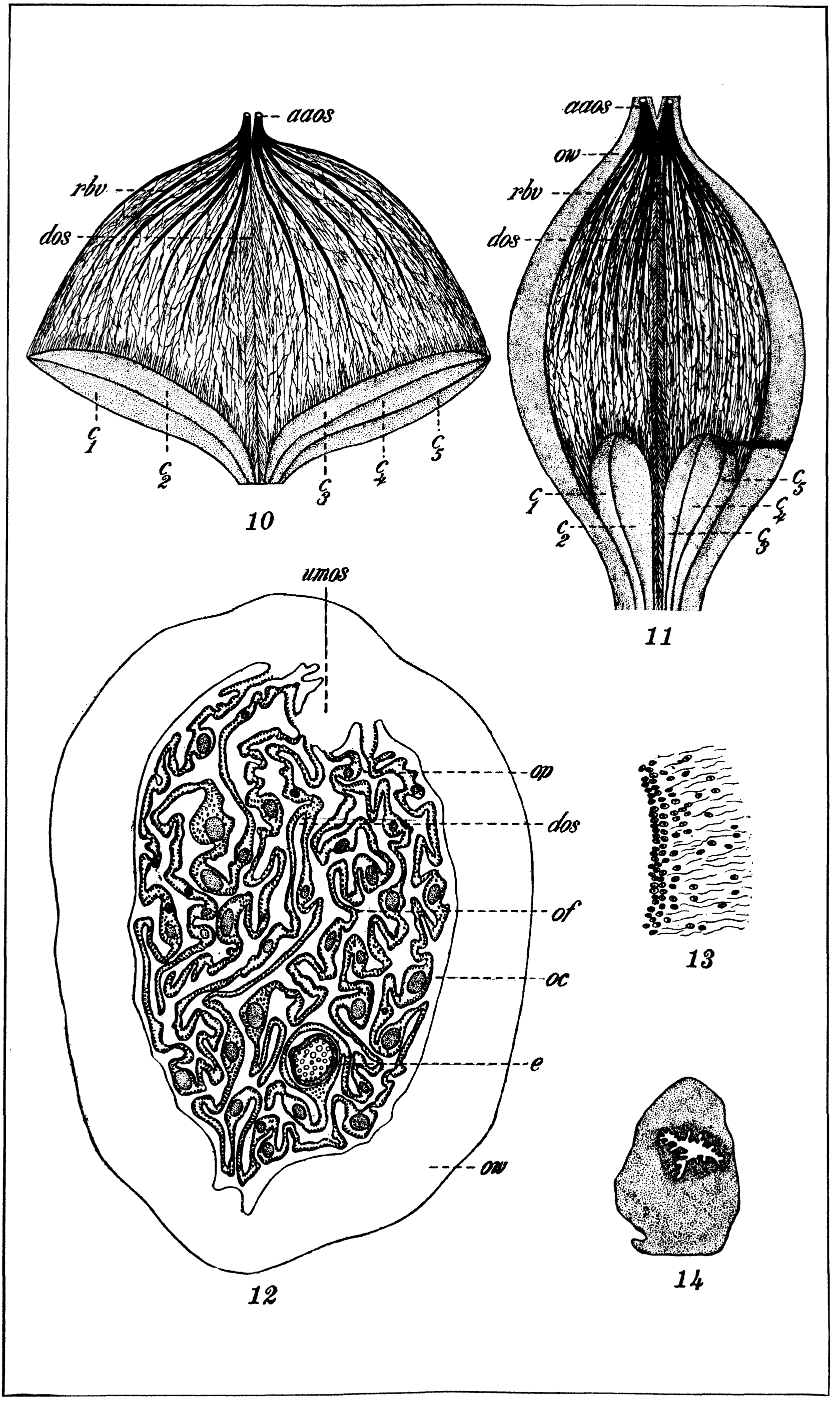

aaos
rbv
dos
c 1
c 2
c 3
c 4
c 5
10
aaos
ow
rbv
dos
c 1
c 2
c 3
c 4
c 5
11
umos
op
dos
of
oc
e
ow
12
13
14

PLATE 2.

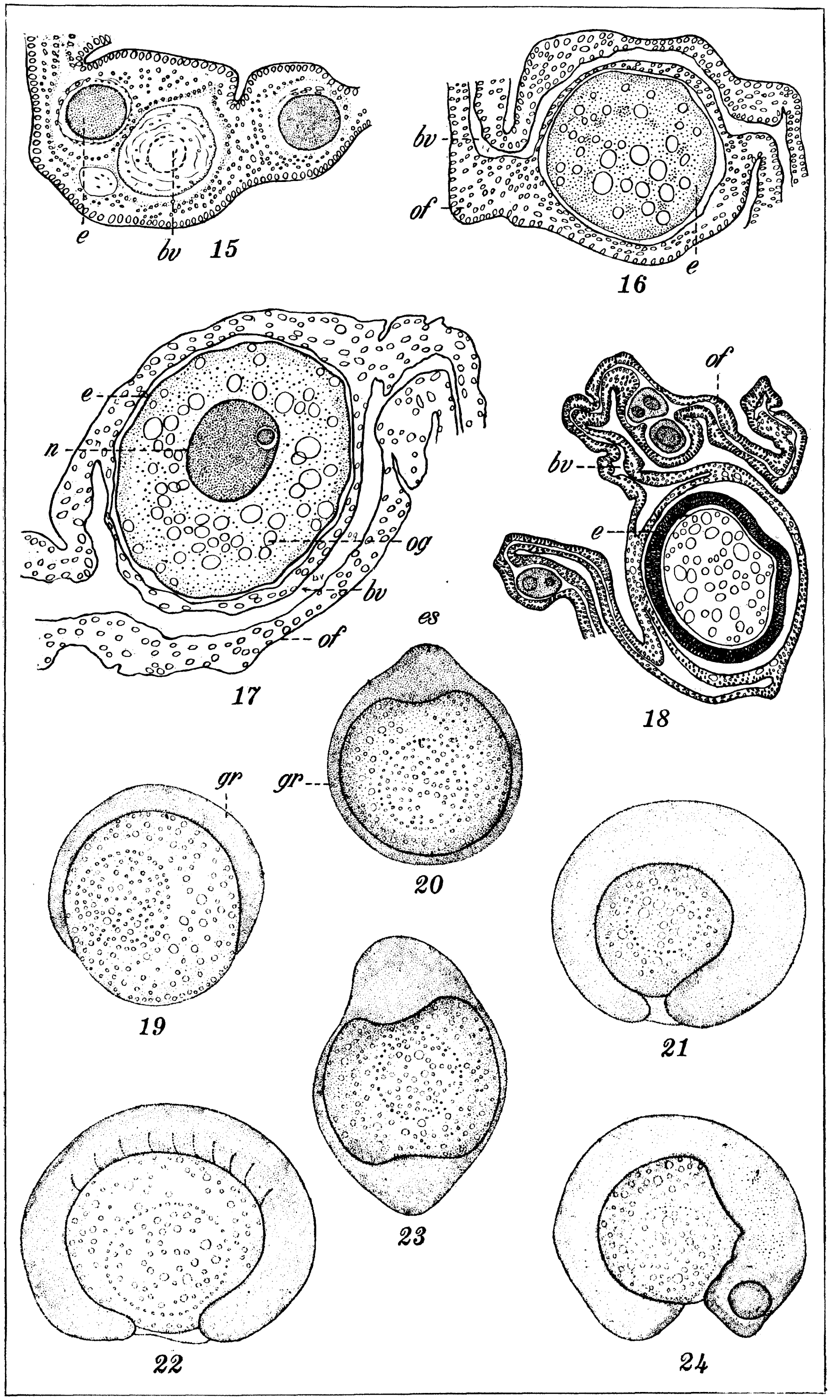
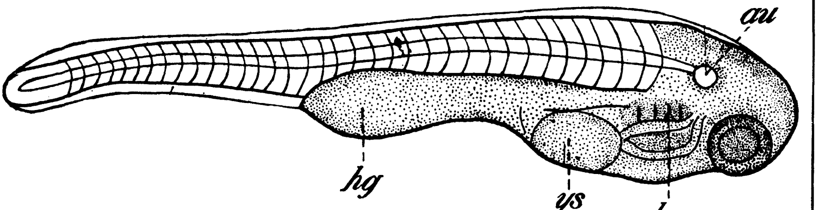
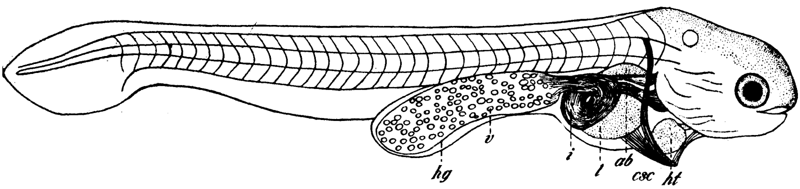


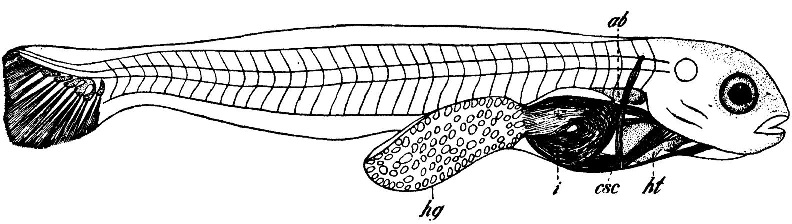
PLATE 3.



25

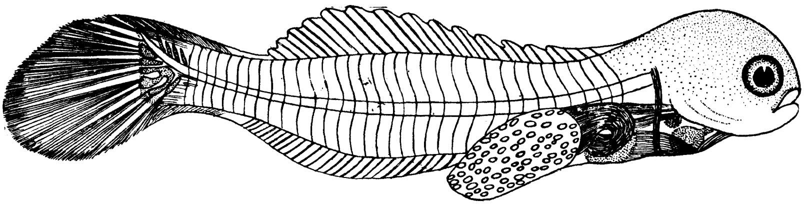


26

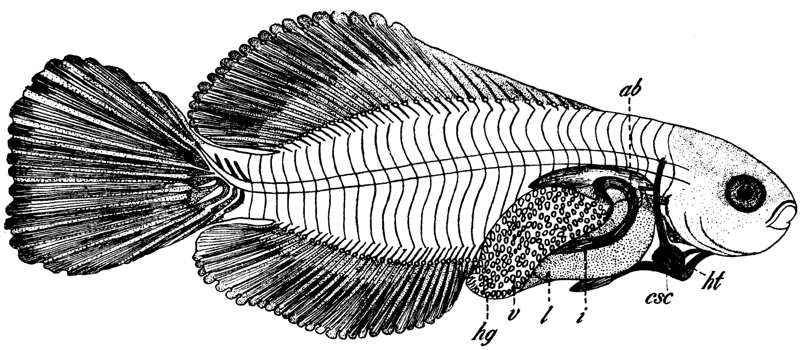


27

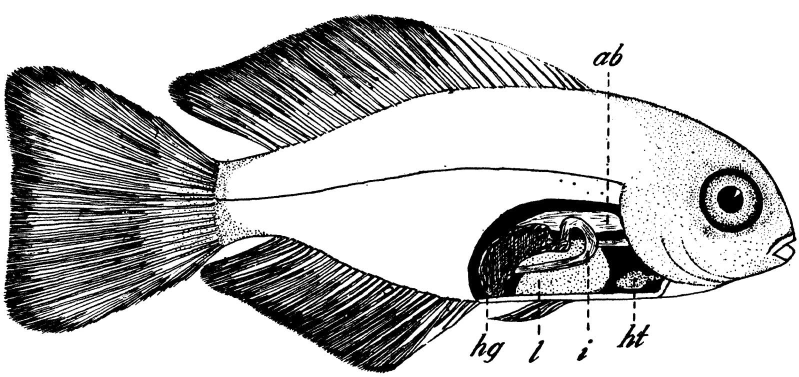
PLATE 4.



28



29



30

PLATE 5.

ANIMALS DESTRUCTIVE TO OYSTERS IN BACOOR BAY LUZON

By DEOGRACIAS V. VILLADOLID and DOMICIANO K. VILLALUZ
Of the Fish and Game Administration, Bureau of Science, Manila

FOUR PLATES

Oyster farming in Bacoor Bay has in recent years been carried on a commercial scale. Along the entire coast of the Bay in Cavite Province, from Bacoor to Caridad, are extensive oyster beds (*pabiayan*). The methods now employed in oyster culture in Bacoor Bay are the stake method and the hanging method. The latter method was introduced in Bacoor Bay in 1935 by the Bureau of Science, and is now practiced by most of the oyster farmers, for it increases their harvest by 25 per cent over that secured by the stake method. During the harvest season of 1937 oysters gathered from Bacoor Bay seemed to meet the local demand for oyster meat in Cavite Province.

Although the oyster farms in Bacoor Bay are not yet menaced seriously by animals destructive to oysters, it is a necessary safeguard on the part of oyster raisers to be acquainted with the enemies of the oyster industry. In some oyster farms of the United States these animals have become serious enough pests to make their control a real problem. In New Jersey alone the estimated yearly damage caused by oyster drills amounts to more than one million dollars (Nelson, 1931).

OYSTER DRILL

The oyster drill (Plate 1, fig. 2) is a snaillike mollusc known among oystermen as screw borers. The most common species destructive to oysters in Bacoor Bay is *Urosalpinx ficula* Reeve. The shell of this mollusc is hard and exhibits different colors, from light brown to yellowish gray. The oyster drill possesses a powerful rasping tongue or radula, which it uses in boring holes through the shells of oyster. Once a hole has been made in the shells of the oyster, the radula is retracted and the proboscis, a slender fine tube, is protruded into the shell cavity, where it remains until the death of the oyster is effected.

Young oysters are the most common victims of the oyster drill, and the holes are bored into the thinnest part of the shell.

Oyster drills lay their eggs in groups, preferably on oyster shells (Plate 1, fig. 1). The eggs are contained in elongated capsules perpendicularly attached to the substratum by means of a solid expanded base. The egg cases are filled with a jelly-like substance which protects the eggs from mechanical injury.

STING RAYS

Sting rays (Plate 1, fig. 4) are cartilaginous fishes belonging to the genus *Dasyatis*. They are known to fishermen as whip ray, stingaree, and clam cracker. The most common species caught in the oyster farms in Bacoor Bay is the blue-spotted sting ray, *Dasyatis kuhli* (Müller and Henle). The body of this fish is disclike in form, dark brown to grayish brown above. The dorsal surface of the disc is marked with circular blue spots with black margins. The tail is brownish olive, and possesses a keel above and a fold below.

Rays often attack oysters during high tide, when they are able to enter oyster farms by swimming over the bamboo stakes surrounding them. They crack open the oysters so that only halves of oyster shells cemented to the stakes remain. Plate 6, fig. 3, shows a bamboo stake with oyster shells that have been attacked by sting rays. Stakes of this kind are commonly seen in oyster farms in Bacoor Bay.

SALT-WATER MUSSELS

Salt-water mussels (Plate 2, fig. 1) are bivalved molluscs, belonging to the family Mytilidæ. The most common edible species found living with oysters in Bacoor Bay is *Modiolus metcalfei* Hanley. The shell of this mussel is triangular, oblong, and swollen, greenish to yellowish brown outside with a band radiating from the umbo, smooth, finely striated and half covered towards the periphery with hairy brown covering.

Shortly after they are hatched, the mussels attach themselves to any stationary hard material, like growing oysters, by means of slender threads called byssi. As they mature these threads increase in number, and become stouter and shorter until the whole shell is firmly attached to the object. The mussels are gregarious, so that oysters are covered by the dense mats of their byssus threads, tending to limit the surface available for the oysters in feeding. Moreover, the mussels feed on the same organisms as the oysters, and as they grow they enter into keen competition with the latter as regards feeding activities. A great many of the oysters in bunches heavily infested with *Modiolus metcalfei* die, and those that survive are stunted in growth and possess lean meat.

POLYCLAD TURBELLARIAN

The turbellarian worm, *Pseudoceros* sp. (Plate 2, figs. 3 to 5) is known among oystermen as sea wafer or leech. This animal is thin and leaflike in shape and of a sinuous outline. The anterior margin is folded into S-shaped loops, and the posterior end is somewhat rounded. The dorsal surface is dark brown. This flat worm finds its way between the open valves of the oyster and feeds upon its meat. It appears in the oyster farms in Bacoor Bay during March and April, when the salinity of the water is quite high.

BORING MOLLUSC

The boring mollusc, *Martesia striata* Linn. (Plate 2, fig. 2), is known among oyster raisers as the boring "piddock." Its body is cylindrical, and the shell gaping. The dorsal edge is protected by two accessory valves, the anterior and the posterior valves. The beaks are covered, and the siphons unite in the form of a cylindrical tube with cilia at the end. The foot is stout and short.

The boring molluscs are indirectly injurious to oysters. After a brief period of free-swimming life the young burrowing shell fish settles down for the rest of its life in a burrow bored into the wood railings of the oyster plots (Plate 4, fig. 2). The burrows are often very near each other, so that the wood railings are dotted with holes. The latter appear externally as small openings, but internally the chambers are big, fitting closely with the outline of the animal shell. The wood railings attacked by these borers are very much weakened, and always fall to the bottom with the loads of oysters they bear. More than one-half of the oysters making up the oyster bunches have been observed to die once they drop to the bottom. During the harvest season of 1936 the oyster farmers in Bacoor Bay complained that they were able to gather only half of the oysters raised for that year due to the falling down of the railings attacked by these wood borers.

BARNACLES

The barnacles (Plate 4, fig. 1) are crustaceans belonging to the family Balanidæ. Those that are commonly found in Bacoor Bay are *Balanus rostratus* Hoek. The shells are almost smooth and sometimes ribbed in places. The walls and opercular plates are almost entirely white, and the orifice, which is egg-shaped, is about half as long as the base. These barnacles are very destructive to oysters, especially to the spats that have just set. They grow very close to each other and in large numbers where oyster spats have settled, so that the latter die due to lack of space for growth and feeding. Barnacles also grow abundantly on shells of mature oysters (Plate 1, fig. 3). The effect is detrimental to the oysters, whose growth is inhibited and who consequently often possess thin meat.

CONCH

The most common conch in Bacoor Bay is *Melongena pugilina* Born (Plate 3, figs. 1 and 2). The egg cases of this conch are very much flattened and filled with jellylike fluid which protects the eggs from mechanical injury. These molluscs open the oysters by inserting the edges of their snouts between the gaping valves. The oysters are finally killed by the radula or the rasping tongues of the conch. In Bacoor Bay conches do not occur in great enough numbers to destroy many oysters.

Melongena pugilina is inflated, thick, and mango-shaped. Its shell is dark brown, and provided with hairy velvety epidermis. The whorls are lined with tubercles and spirally ridged towards the apex.

LITERATURE CITED

CHURCHILL, E. P. JR. The oyster and the oyster industry of the Atlantic and Gulf coasts. U. S. Bur. Fish. Doc. No. 890 (1920) 36–40.

DANGLANDE, ERNEST. The flatworm as an enemy of Florida oysters. U. S. Bur. Fish. Doc. No. 869 (1918) 1–8.

FEDERIGHI, HENRY. Study on the oyster drill (Urosalpinx cinerea Say). U. S. Dept. Comm. Bur. Fish. Bull. No. 4 47 (1931) 85–111.

KABURAKI, TOKIO. The polyclad turbellarians from the Philippine Islands. Smiths. Inst. U. S. Nat. Mus. Bull. No. 100, pt. 10 1 (1923) 635–649.

NELSON, J. R. Trapping the oyster drill. New Jersey Agric. Exp. Station Bull. No. 523 (1931) 2–12.

NELSON, T. C. Rept. of Dept. of Biol. New Jersey Agric. Coll. Exp. Station (1923) 204–209.

PILSBURY, HENRY A. Barnacles of Japan and Bering Sea. Bull. U. S. Bur. Fish. Doc. No. 739 (1911) 73–84.

ROGERS, JULIA E. The Shell Book. New York, Doubleday, Page & Co. (1908) 315, 316.

STAUBER, LESLIE A., and GEORGE M. LEHMUTH. Costs and profits in oyster drill control. New Jersey Agric. Exp. Station Bull. No. 624 (1927) 3–10.

TALAVERA, FLORENCIO. Edible mollusks of Manila. Bur. Sci. Pop. Bull., Manila (1933) 22–24.

TYRON, GEORGE W., JR. Manual of Conchology 2 (1880) 154.

ILLUSTRATIONS

PLATE 1

FIG. 1. Egg capsules of *Urosalpinx ficula* Reeve.
2. *Urosalpinx ficula* Reeve.
3. Barnacles growing on mature oysters.
4. *Dasyatis kuhli* (Müller and Henle).

PLATE 2

FIG. 1. *Modiolus metcalfei* Hanley.
2. *Martesia striata* Linn.
FIGS. 3 to 5. *Pseudoceros* sp.

PLATE 3

FIG. 1. Egg capsules of *Melongena pugilina*.
2. *Melongena pugilina* Born.

PLATE 4

FIG. 1. String of oysters covered with barnacles.
2. Wood railing attacked by *Martesia striata* ("piddock").
3. Bamboo stake with oysters attacked by sting ray.

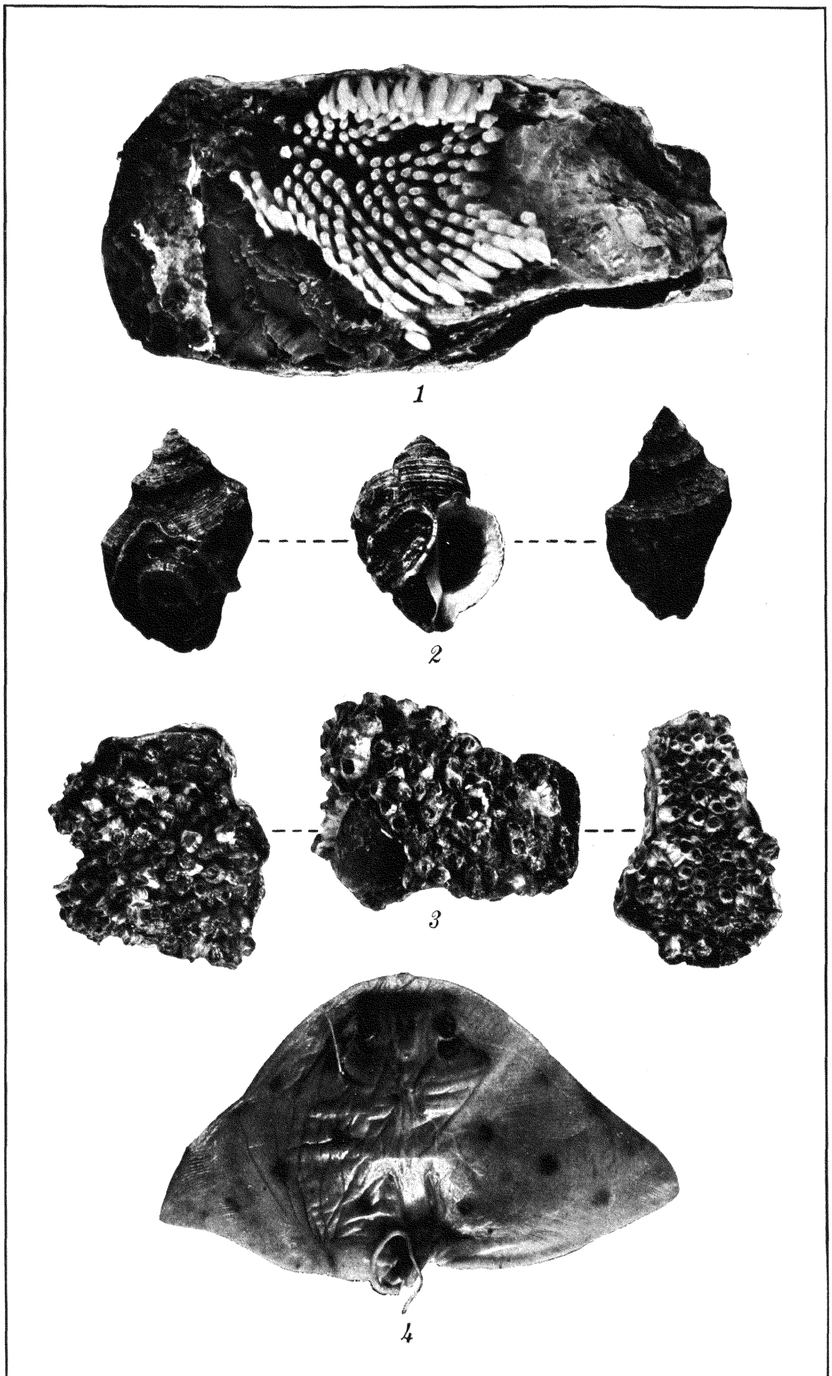


PLATE 1.

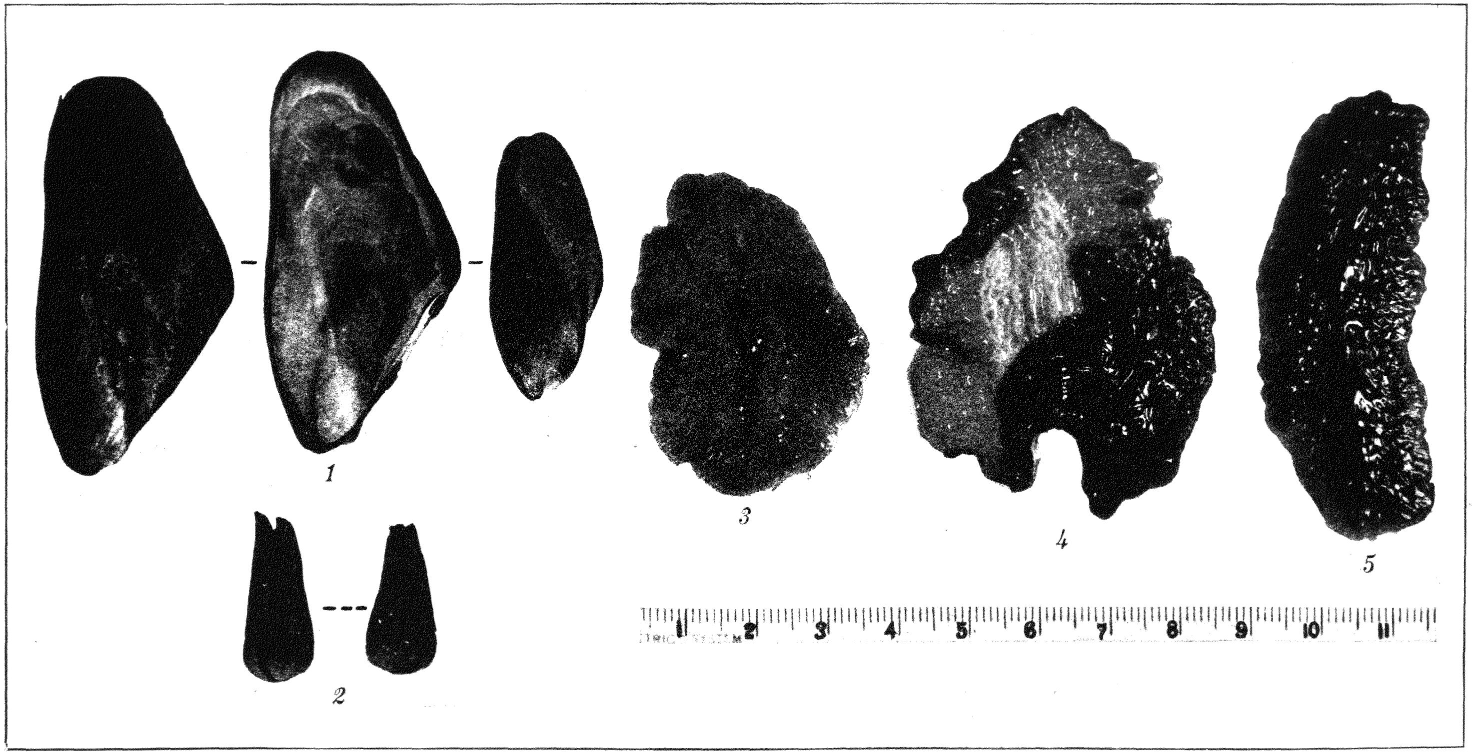


PLATE 2.

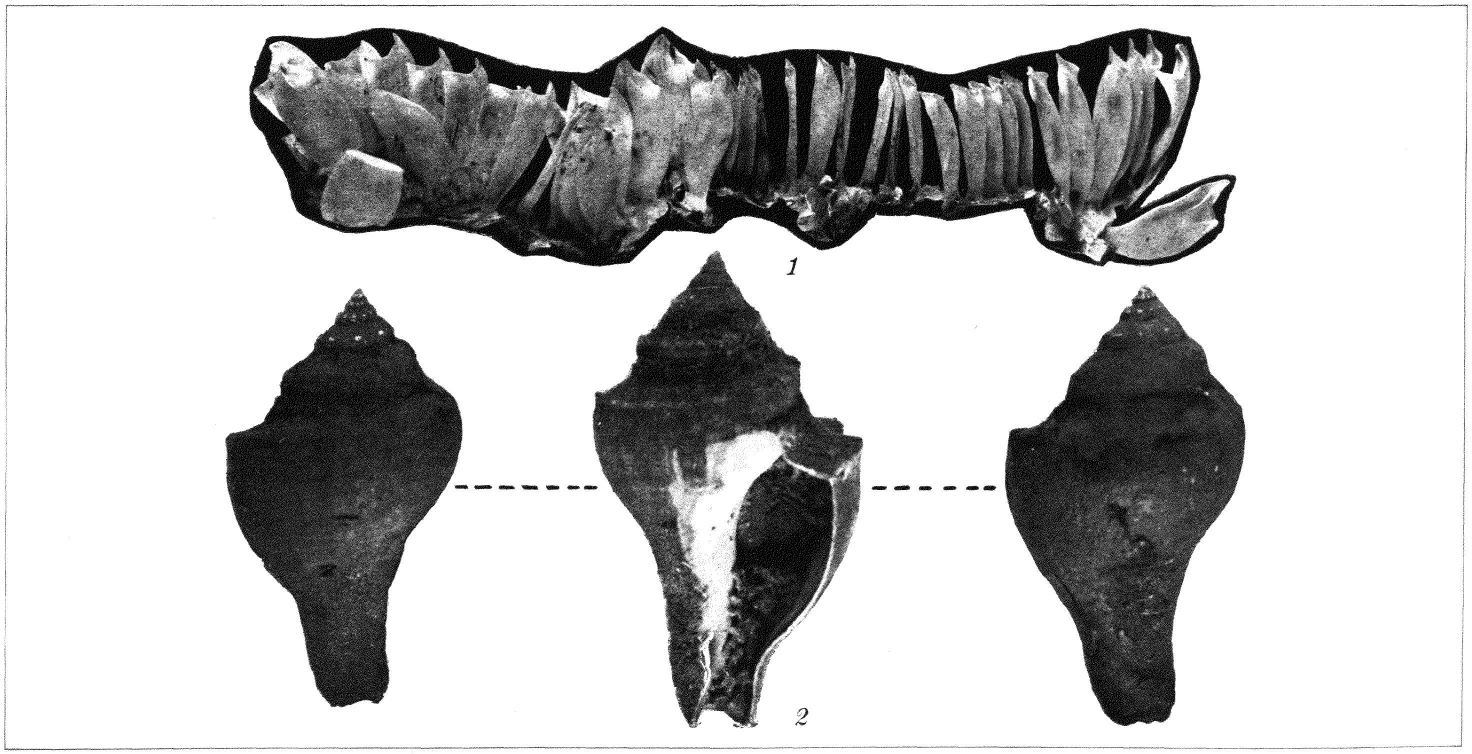


PLATE 3.

1 2 3

PLATE 4.

NEW GLASS-EYE MUTATION, A SEX-LINKED CHARACTER IN DROSOPHILA

By LEOPOLDO S. CLEMENTE and GREGORIO ONG

Of the Department of Zoölogy, University of the Philippines, Manila

ONE PLATE

Müller in 1918, as cited by Bridges and Morgan,(1) found a mutation in *Drosophila* in the stock "sable-duplicate garnet" with colorless eyes having a smooth surface which he called "glass." In 1919 Mohr, cited by the above authors, rediscovered exactly the same mutation, also in the "sable-duplicate garnet" stock. This glass-eye mutation is characterized by a loss of the separate character of the facets, which form a continuous smooth glassy surface. The eyes are very much reduced, only one half the size of the normal eyes. The reduction in size of the eye is mainly in the anteroposterior direction and it is most pronounced at the bottom and top of the eye, giving it a diamond shape in general appearance. The superficial layer of the eye is generally colorless, or, when the color is present, it is of a diffuse straw-colored tinge, while its deeper portions are more heavily pigmented. The color of the eye is different in the two sexes, being darker in males than in females. In the case of the female the color of the deeper layer is often reduced to a mere tinge similar to that of the poorly pigmented superficial layer, while in the case of the male the color of the deeper layer is usually vermillion or orange.

Genetic data obtained by Müller and by Mohr clearly show that their glass mutation is an autosomal third chromosome mutation and is recessive to normal eye. Its locus is at 63.1, or the section between "hairless" which is located at locus 69.5, and "spineless" which is located at locus 58.5. This glass mutation is normal in viability and productivity.

In this paper, however, a "new glass-eye" mutation was found among the offspring resulting from crossing two mutants obtained from the Philippine wild *Drosophila*, resembling in many ways the glass mutant discovered by Müller and by Mohr, but of entirely different genetic behavior. This "new glass-eye" mutation is a sex-linked character instead of being autosomal as is the case of the mutation found by Müller and by Mohr.

The authors are indebted to Mr. Jose V. Yap-Chiongco, who helped them carry on the genetic tests, and to Mr. Rafael Dayaw, who has kindly drawn the colored illustrations.

MATERIALS AND METHODS

The "new glass-eye" mutation reported in this paper was found in the cross involving eyeless and orange-eyed mutants with moruloid facets, which at the same time is a carrier of purple in an epistatic condition to orange. The eyeless mutant was discovered by the senior author(2) June 22, 1926, in the Manila bandless *Drosophila,* and until now is still breeding true to type in our laboratory. The eyeless fly possesses a very much reduced head, due to the total or partial disappearance of the ommatidia of the compound eyes. The simple eyes or ocelli are also absent. Occasionally there are found, among the eyeless stock, flies with a minute eye on the left side, some with a minute eye on the right side, and a very few with two small eyes on one side and only one small eye on the other side. According to unpublished data of Clemente and Nemenzo,(3) these eye variations of the eyeless stock are not hereditary, because selection experiments of different eye variations failed to produce positive results.

Eyeless flies are also carriers of the red-color factor, as shown by the fact that whenever flies with little eyes appear, the eyes are red. Moreover, when eyeless flies are mated to nonred-eyed flies, such as purple-eyed, the offspring are always red-eyed. Eyeless is a mutation of the fourth chromosome and is independent of orange, morula, and purple.

The orange-eyed fly with moruloid facets was discovered by Mr. Francisco Nemenzo in the purple-eyed stock in August, 1929, and until now is still breeding true to type. This mutation is characterized by eyes that are slightly reduced in size as compared with normal, and of orange color. The orange shade varies somewhat with age, being lighter in young flies and darker in old ones. The orange color is uniformly distributed throughout the eyes with the same intensity at the peripheral region as well as at the center. The facets upon microscopic examination are found to be irregular in shape, size, and arrangement, similar to the "morula eye" mutant of Altenburg and Müller, the "rough eye" mutant of Müller, and the "roughoid eye" mutant of Strong, as cited by Bridges and

Morgan.(1) The minute hairs or microtrichia which are found on the surface of the eyes are also present, as in normal flies. The orange-eyed fly, in addition to carrying morula, also carries purple in a hypostatic condition. Unpublished work of Clemente and Nemenzo(4) indicates that orange and morula are autosomal linked characters, probably of the third chromosome, and are recessive to the red-eye and normal facets respectively, while purple is a second chromosome mutation which is recessive to its red allelomorph.

The usual method of rearing and breeding the flies commonly employed in our laboratory was used. The flies were kept throughout the experiment inside the frigidaire at a more or less constant temperature of 25° C., because at much higher temperature the flies do not breed very well.

HISTORY OF THE "NEW GLASS-EYE" MUTATION

The first "new glass-eyed" fly was observed by the junior author February 6, 1931, among the offspring of the cross involving eyeless and orange-eyed stocks with morula facets. From the first up to the thirteenth individual of this new eye mutation only males were found. This fact gives us a clue that this "new glass eye" is probably a sex-linked character and not autosomal as in the case of the glass eye of Müller and of Mohr.

The mating from which this "new glass-eye" mutation resulted was between female eyeless and male orange-eyed flies. This mating produced only red-eyed F_1 flies with normal facets. Upon mass mating the F_1 flies the following F_2 phenotypes were produced: Red-eyed with normal facets; orange-eyed with moruloid facets; purple-eyed with normal facets; purple-eyed with moruloid facets; and eyeless.

The F_2 orange-eyed flies were again back-crossed to red-eyed stock with normal facets, and this mating produced only red-eyed flies with normal facets. Upon mass mating the red-eyed flies of this backcross, offspring of the following phenotypes were produced: Red-eyed with normal facets; purple-eyed with normal facets; purple-eyed with moruloid facets; orange-eyed with moruloid facets, eyeless, and some "new glass-eyed" flies as the mutation. Glass eye is considered a mutation because it is not expected as one of the segregates in the cross, for it is very different from the parents or immediate ancestors. Moreover, the characters involved in the cross are autosomal, whereas the "new glass-eye" mutation is sex-linked. The occurrence of mutation in crosses is not new, for similar cases have been observed by other investigators; such as the "spread wing" of Dexter, a third chromosome mutant as cited by Morgan and Bridges(5) which was found in a cross between "beaded" and "vestigial" mutants.

The following record is an account of the appearance of the first thirteen glass-eyed flies, all males, as they were found from day to day. It also shows the total number of flies among which they were found, together with the record of their matings, offspring when present, and their deaths. Certain data with regard to the flies, such as vigor and intensity of eye color, were also recorded.

First mutant, a male, found February 6, 1931, among 30 flies. Mated to 8 orange female sibs. Died on the third day after mating. Left no offspring.

Second mutant, a male, found February 16, 1931, among 78 flies. Mated to several purple female sibs. Died on the third day. Left no offspring.

Third mutant, a male, found February 20, 1931, among 35 flies. Mated to 4 morula female sibs. Died on the following day. Left no offspring.

Fourth mutant, a male, found February 25, 1931, among 15 flies. Small, dark-eyed, and weak. Mated to some morula female sibs. Died on the fifth day. Left no offspring.

Fifth mutant, a male, found March 3, 1931, among 23 flies. Small, dark-eyed, and weak. Died soon after it was found.

Sixth mutant, a male, found March 6, 1931, among 48 flies. Small, with light-colored eyes, and weak. Mated to morula female sibs. Died on the third day. Left no offspring.

Seventh mutant, a male, found March 6, 1931, among 16 flies. Dark-eyed, strong, vigorous, and could fly around. Mated to several morula female sibs. Eggs were laid but failed to hatch. Died on the eighth day.

Eighth mutant, a male, found March 7, 1931, among 25 flies. Dark-eyed and weak. Mated to morula female sibs. Died on second day. Left no offspring.

Ninth mutant, a male, found March 9, 1931, among 17 flies. Dark-eyed and weak. Mated to morula females. Died on the third day.

Tenth, eleventh, and twelfth mutants, all males, found March 10, 1931, among 38 flies. Two dark-eyed and one light-eyed. All weak, died the same day they were found.

Thirteenth mutant, a male, found March 11, 1931, among 8 flies. Dark-eyed, big, strong, and vigorous. Mated to several morula female sibs. Eggs laid March 17, 1936, from which the following were produced: 29 Red-eyed, 7 purple-eyed, and 2 dark glass-eyed females.

DESCRIPTION OF THE "NEW GLASS-EYE" MUTATION

This new mutation was called "glass eye" because of the shiny surface of the eyes of the flies affected. The glassy appearance is especially well manifested whenever bright light falls on the surface of the eyes. The eyes are very much reduced in size, to about one-half that of normal. The reduction is greatest on the anterior and posterior borders, thus making the eyes appear spindle-shaped (Plate 1). There is a wide periphery of colorless area surrounding the eye as a result of the reduction in size.

There are three shades of eye color among the glass-eyed mutants. They are light, medium, and dark, but the most frequent is the dark (Plate 1). The color in all these shades is uniformly distributed all over the eyes, unlike the glass eye of Müller and of Mohr in which the color is unevenly distributed. The different shades cannot be due to difference in age of the flies, for all of the three shades were found even among the newly emerged flies. Neither is the color different in the two sexes as is true of the glass eye of Müller and of Mohr. The difference in intensity of the color of glass eye is perhaps due to the interaction of genetic factors, such as orange eye, purple eye, and red eye, which are present in the mutating stock. Our unrecorded breeding observations seem to indicate that the dark glass eye can produce all the three color shades; the medium glass eye can produce both medium glass and light; whereas the light glass eye can produce only light.

When seen under the microscope, the eyes are found to be devoid of hairs on the surface, and instead of having facets of hexagonal partitions as in normal eyes, they form a continuous single shiny mass very similar to glass. In other words, the eyes are hairless and facetless, similar to the ocelli or simple eyes of insects. Whether or not the ommatidia have also lost their separate character is not known, for no serial sections of the eyes have been made. There is no doubt but that the absence of both the hair and facets are responsible for giving the glassy or shiny appearance to the eyes.

The glass-eyed flies are weak, rather small in size, and, as a rule, short-lived. They are not as active nor prolific as the normal flies. They do not fly around actively as do normal flies, and usually die a few days after emerging from the pupal cases. In most instances they live only for three days. Breeding data seem to indicate that many of them die before they reach the adult stage.

GENETIC BEHAVIOR OF THE "NEW GLASS-EYE" MUTATION

Mating of the new glass-eyed males and females.—Several matings of glass-eyed males and females were made primarily for the purpose of producing a pure breeding stock of this new eye mutation. To our surprise, no offspring was produced in all our matings, and thus we failed in our attempt to produce the pure stock of glass-eyed flies. Thus the only way to carry on this new eye mutation was to mate the glass-eyed males to normal females which are either homozygous normal or are carriers of the glass mutation, because pure glass-eyed females were found to be sterile.

Mating of the new glass-eyed flies to normal.—In our attempt to study the genetic behavior of this new eye mutation, crosses were made between glass-eyed females and normal males as well as their reciprocal crosses. Again, to our surprise, whenever glass-eyed females were mated to normal males the mating was sterile, but whenever the glass-eyed males were mated to normal females the mating was always fertile. It seems that this new glass-eye gene causes sterility whenever it is found in a double dose as in the glass-eyed female, and that whenever it is found only in a single dose as in the glass-eyed male, the effect is not enough to cause sterility. This finding is similar to that of Mohr as cited by Bridges and Morgan(1) in the case of the third chromosome mutant "varnished," and of that of Morgan and Bridges(5) in the case of the sex-linked "rudimentary wings." According to Morgan and Bridges the reason for these perfectly fertile males and perfectly sterile females is that the germ cells cease to develop in the early growth stage of the eggs while the spermatozoa undergo normal development. Whether or not this explanation of Morgan and Bridges holds true in our case is not known.

Mating of glass-eyed males to normal-eyed females.—The mating of glass-eyed males to normal-eyed females was first resorted to primarily because of the sterility among the glass-eyed females, and secondarily because the only glass-eyed mutants available at the beginning were males. Inasmuch as the glass-eyed males are weak, several males were mated to a number of normal females. This type of mating was used because it gave better results than when only one glass-eyed male was used at a time. If glass eye is really a sex-linked recessive gene, this mating of glass-eyed males, *g*—, to normal females, *GG,* should produce normal males of the genotype *G*— and normal females of the genotype *Gg*. This expected result was obtained, as can be seen in Table 1. There are 125 females and 117 males, which are all normal-eyed like the wild parent. The expected 1 : 1 ratio of males to females was also realized, with but a slight deviation. The sex-linked recessive nature of this new glass-eye mutant is further demonstrated in the following mating, when the F_1 of this cross were mated together en masse to produce the F_2 generation.

TABLE 1.—*Glass-eyed male* × *normal-eyed female.*

Results.	Normal-eyed.	
	Female.	Male.
Number obtained	125	117
Number expected	121	121
Deviation	+4	—4
Expected ratio	1	1

Mating of the F_1 *flies en masse.*—Table 2 shows the result of the mating of the F_1 en masse to produce the F_2. Theoretically, according to the sex-linked inheritance, there should be expected in this mating between normal females of the genotype *Gg* and normal males of the genotype *G*— offspring in the proportion of 2 normal females of the genotypes *GG* and *Gg*: 1 normal male of the genotype *G*—: 0 glass-eyed females: 1 glass-eyed male of the genotype *g*—. This expectation was realized, as there were obtained 151 normal-eyed females, 102 normal-eyed males, 0 glass-eyed females, and 25 glass-eyed males. The absence of glass-eyed females and the presence of glass-eyed males in the F_2 is a clear indication that glass eye is a sex-linked character and is recessive to normal eye. The fewness of F_2 male glass-eyed individuals in proportion to the numerous normal-eyed males and females as can be seen by their minus deviation may be explained by the general weakness and poor viability of the glass-eyed individuals, as was observed at the very beginning.

TABLE 2.—F_1 *normal-eyed male* × F_1 *normal-eyed female.*

Results.	Normal-eyed.		Glass-eyed.	
	Female.	Male.	Female.	Male.
Number obtained	151	102	0	25
Number expected	139	69.5	0	69.5
Deviation	+12	+32.5	0	—44.5
Expected ratio	2	1	0	1

Back-crossing the F_1 normal-eyed females to glass-eyed males.—Table 3 shows the result of the back-crossing of the F_1 normal-eyed females of the genotype *Gg* to glass-eyed males of the genotype *g*—. As is expected according to sex-linked interpretation of glass eye, there should be normal-eyed females of the genotype *Gg;* glass-eyed females of the genotype *gg;* normal males of the genotype *G*—; and glass-eyed males of the genotype *g*— in equal numbers. This expectation was realized, as there were produced 75 normal-eyed females, 74 normal-eyed males, 23 glass-eyed females, and 20 glass-eyed males. There are again a relatively small number of glass-eyed individuals in both sexes where equality in number with the normal is expected, thus indicating once more the poor viability of the flies possessing the glass-eye gene.

TABLE 3.—*Glass-eyed male* × F_1 *normal-eyed female.*

Results.	Normal-eyed.		Glass-eyed.	
	Female.	Male.	Female.	Male.
Number obtained	75	74	23	20
Number expected	48	48	48	48
Deviation	+27	+26	—25	—28
Expected ratio	1	1	1	1

Mating of glass-eyed males to F_2 normal-eyed females.—The results of mating the F_2 normal females to glass-eyed males are shown in Table 4. Theoretically, as stated before, there are two genotypes in equal number among the F_2 normal females; one is homozygous normal, *GG,* while the other is heterozygous normal, *Gg.* Upon mass mating a number of these F_2 females to a number of glass males, *g*—, we expect a 3 : 1 ratio in both sexes between normal-eyed and glass-eyed flies, respectively. This theoretical result was obtained, as can be seen in Table 4. There were produced 90 normal-eyed females of the genotype *Gg*, 86 normal-eyed males of the genotype *G*—, 20 glass-eyed females of the genotype *gg*, and 28 glass-eyed males of the genotype *g*—. Again, there is a slight minus deviation in the glass-eyed females, due to their poor viability.

TABLE 4.—*Glass-eyed male* × F_2 *normal-eyed female.*

Results.	Normal-eyed.		Glass-eyed.	
	Female.	Male.	Female.	Male.
Number obtained	90	86	20	28
Number expected	84	84	28	28
Deviation	+6	+2	—8	0
Expected ratio	3	3	1	1

Mass-mating of F_2 normal-eyed males and females.—As was stated above, there are two genotypes of equal number among the F_2 normal females, *GG* and *Gg*. On the other hand, there is but one genotype of F_2 normal males, *G*—. Upon mass-mating of the F_2 normal males and females there would be expected, according to the sex-linked inheritance of glass eye, a ratio of 4 normal females : 3 normal males : 0 glass-eyed females : 1 glass-eyed male. This expectation (Table 5) was realized, although again there is a minus deviation among the glass-eyed males due to their general weakness. There were obtained 131 normal females of the genotypes *GG* and *Gg*, 92 normal males of the genotype *G*—, 0 glass females, and 23 glass-eyed males of the genotype *g*—. The total absence of glass-eyed females and the presence of glass-eyed males in this mating is again a clear indication that glass eye is a sex-linked character and is recessive to normal eye.

TABLE 5.—*Mass mating of F_2 normal-eyed male and female.*

Results.	Normal-eyed.		Glass-eyed.	
	Female.	Male.	Female.	Male.
Number obtained	131	92	0	23
Number expected	123	92.25	0	30.75
Deviation	+8	—.25	0	—7.75
Expected ratio	4	3	0	1

SUMMARY AND CONCLUSIONS

1. A new mutation in *Drosophila* was found in which the flies affected possess facetless, hairless, smooth, shiny, and glass-like eyes.

2. The glass eyes are reduced in size, with the anterior and posterior borders being greatly reduced, while the dorsoventral portions are slightly reduced.

3. Three color shades of glass eye were found, which can be classified into dark, medium, and light. This difference in eye shade may be due to genetic factors, inasmuch as the dark shade can produce all the three colors; the medium can produce only medium and light shades, while the light color breeds true.

4. Genetic tests have conclusively proven that this new glass-eye mutation is sex-linked and recessive to normal eye, and not autosomal as was the glass eye of Müller and of Mohr.

5. Glass-eyed females were found sterile while glass-eyed males were found fertile. This may be due to the double glass-eye genes in females and the single glass-eye gene in males.

6. Glass-eyed flies are generally weak, short-lived, and not prolific. They live only a few days after emergence from the pupal cases. Their number is usually less than expected, because of their general weakness.

BIBLIOGRAPHY

1. BRIDGES, C. B., and T. H. MORGAN. The third chromosome group of mutant characters of Drosophila melanogaster. Carnegie Inst. of Wash. Publication No. 327 (August, 1923).
2. CLEMENTE, L. S. Mutation studies on Philippine wild Drosophila. Philip. Journ. Sci. 47 (1932) 221.
3. CLEMENTE, L. S., and F. NEMENZO. Selection of the different eye variations among the eyeless stock in Drosophila. Unpublished.
4. CLEMENTE, L. S., and F. NEMENZO. New eye mutations in Philippine wild Drosophila. Unpublished.
5. MORGAN, T. H., and C. B. BRIDGES. Sex-linked inheritance in Drosophila. Carnegie Inst. of Wash. Publication No. 237 (1916).

ILLUSTRATION

PLATE 1

FIG. 1. Light glass-eyed fly.
2. Medium glass-eyed fly.
3. Dark glass-eyed fly.

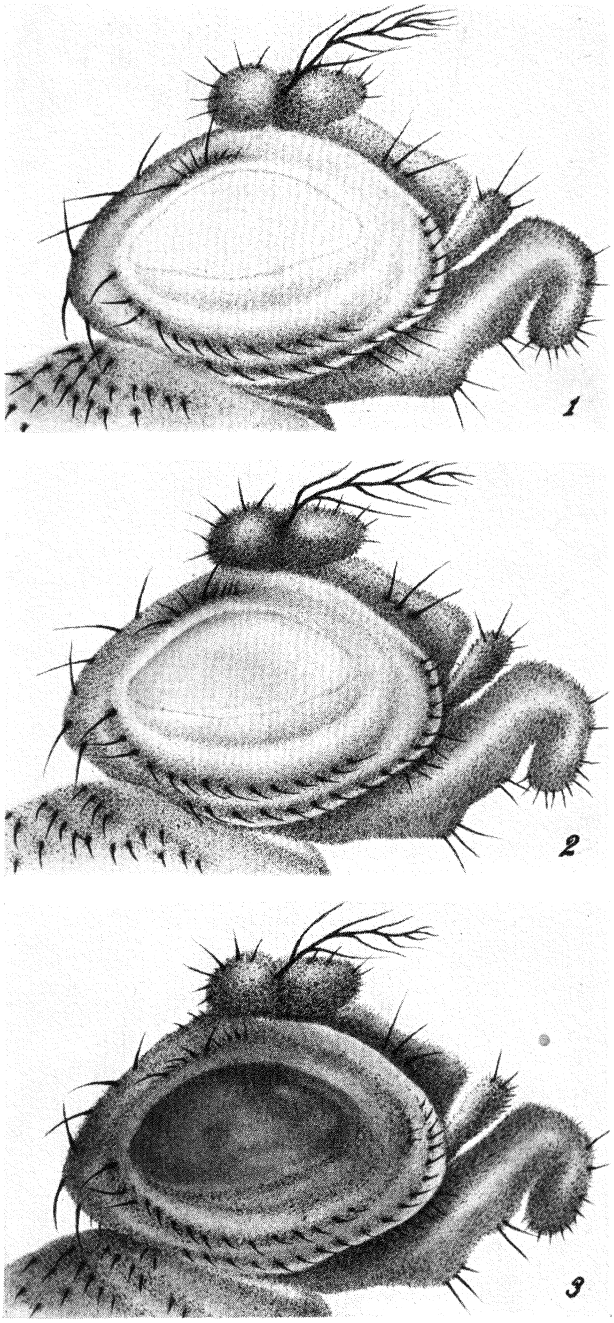


PLATE 1.

NOTES ON THE ALGAL FLORA OF NEW ZEALAND, II

FRESH-WATER ALGÆ FROM NAPIER

By B. W. SKVORTZOW
Of Harbin, Manchoukuo

ONE PLATE

The present paper on fresh-water algæ has resulted from the examination of algal material received from Mr. Ian C. Edmundson, of Napier, New Zealand, who collected it from an aquarium. The sample consists of greenish masses of immense growth of *Scenedesmus brasiliensis* Bohlin, among which I have noted 4 species of Flagellatæ and 28 species of Diatomaceæ.

The following features may be pointed out in connection with the diatom flora of this sample. (*a*) About 50 per cent of all diatoms here recorded are new to New Zealand; (*b*) almost all the diatoms are fresh-water species, except *Diploneis Smithii* Breb. and *Rhopalodia gibberula* (Ehr.) O. Müll. var. *Van Heurckii* O. Müll., common in brackish water; (*c*) *Cyclotella Meneghiniana* Kütz. var. *Novae Zealandiae* var. nov., *Diploneis subovalis* Cleve fo. *Novae Zealandiae* fo. nov., and *Rhopalodia Novae Zealandiae* Hustedt var. *ventricosa* var. nov. are proposed as new. The types of the two latter diatoms have been described by P. T. Cleve and Fr. Hustedt as endemic for New Zealand.

All algæ collected by Mr. I. C. Edmundson are here described and illustrated by me. The diagrams were made with E. Leitz Apochromat 2 mm and Compens Okular 4 in my laboratory in Harbin.

FLAGELLATÆ

TRACHELOMONAS VOLVOCINA Ehr. Plate 1, fig. 28.

Trachelomonas volvocina Ehr., G. DEFLANDRE, Monogr. Genre Trachelomonas Ehr. (1926) 55, fig. 1 *a*, *b*.

Shell spherical, reddish brown, smooth. Chromatophores distinct and green. Diameter of shell, 0.01 to 0.011 mm; neck, 0.0017 mm broad. Common. Reported from fresh water.

TRACHELOMONAS HISPIDA (Perty) Stein var. SUBARMATA Schröder. Plate 1, fig. 32.

Trachelomonas hispida (Perty) Stein var. *subarmata* Schröder, SKVORTZOW, New Phytologist (5) 24 (1925) 300, fig. 2; LEMMERMANN, E. Eugleniae (1913) 149, 150, fig. 572.

Shell dark brown, oval, with broad-rounded ends, covered with sharp-pointed spines, 0.017 mm long, 0.013 mm broad. Aperture for flagella 0.0017 mm broad, without a tubelike neck. Chromatophores numerous. Common.

TRACHELOMONAS OBLONGA Lemm. Plate 1, fig. 29.

Trachelomonas oblonga Lemm., G. DEFLANDRE, Monogr. Genre Trachelomonas (1926) 69, figs. 121, 124.

Shell elliptic-globose, minute, brown, smooth. Chromatophores several. Shell 0.0119 mm long, 0.01 mm broad. Aperture for flagella about 0.0015 mm broad. Infrequent.

TRACHELOMONAS HAMILTONIANA sp. nov. Plate 1, figs. 30 and 31.

Lorica oblonga ubique rotundata. Collo nullo. Membrana fusca crassa, scrobiculato-punctata. Chloroplastis numerosis, disciformibus. Longis 0.017 mm; latis 0.013; ore 0.0017 latis. Habit in aquis dulcis stagnalis prope Napier, N. Z. Legit I. C. Edmundson.

Shell oval or elliptical, with rounded ends. Membrane fine-scrobiculate, brown. Aperture for flagella without a tubelike neck, 0.0017 mm broad. Chlorophores numerous. Shell 0.017 mm long, 0.013 mm broad. Infrequent. Forms with scrobiculate membrane are easily identified from *Trachelomanes abrupta* Swirenko by the form of the shells. Named in honor of Mr. A. Hamilton, Wellington, New Zealand, a naturalist and an enthusiastic collector.

CHLOROPHYCEÆ

SCENEDESMUS BRASILIENSIS Bohlin. Plate 1, fig. 19.

Scenedesmus brasiliensis BOHLIN, Jos. Brunnthaler, Protococcales (1915) 165, fig. 222.

Cœnobia flat, of 2 to 4 cells arranged in a single linear series. Cells ovoid-ellipsoid, with a distinct longitudinal ridge extending from the pole on each side of the cell. Poles with 2 or 3 small teeth. Cells 0.011 to 0.014 mm long, 0.0034 to 0.0042 mm broad. Four-celled cœnobia 0.017 to 0.02 mm long. Abundant. Reported from Europe and America.

DIATOMACEÆ

CYCLOTELLA MENEGHINIANA Kütz. var. NOVAE ZEALANDIAE var. nov. Plate 1, fig. 38.

Valvis circularis, 0.0085 mm in diametris. Striis robustris ad centrum percurrentes. Centrum minor et hyalina. Habit in aquis dulcis stagnalis prope Napier, N. Z. Legit I. C. Edmundson.

Valve flat-circular, with distinct outer area a band ¾ the radius in width, strongly marked with closely set radiating costæ, 0.012 to 0.014 mm. Circular central area hyaline. Diameter 0.0085 mm. Differs from the type in the smaller size, the sparse striæ, and the presence of a little hyaline center. Rare.

MERIDION CIRCULARE Agardh. Plate 1, fig. 25.

Meridion circulare Agardh, FR. HUSTEDT, Bacillar. (1930) 130, 131, fig. 118.

Valve clavate. Apex broad-rounded, tapering to elongate, subacute ends. Length, 0.0476 mm; breadth, 0.0003. Rare. Common in mountain streams. Reported from New Zealand.

MERIDION CIRCULARE Agardh var. CONSTRICTA (Ralfs) Van Heurck. Plate 1, fig. 18.

Meridion circulare Agardh var. *constricta* (Ralfs) Van Heurck, FR. HUSTEDT, Bacillar. (1930) 131, fig. 119.

Valve subclavate, needle-shaped, with capitate elongate apex and attenuate end. Length, 0.044 mm; breadth, 0.0058. Infrequent. Common in running water.

SYNEDRA ULNA (Nitzsch) Ehr. Plate 1, figs. 6, 7, and 39.

Synedra ulna (Nitzsch) Ehr., FR. HUSTEDT, Bacillar. (1930) 159*b*; A. SCHMIDT, Atlas Diatom. (1914) pl. 301, figs. 1–26.

Valve linear, with parallel margins and subrostrate rounded ends. Length, 0.162 mm; breadth, 0.0058 to 0.0085. Striæ 8 in 0.01 mm. Common; almost in fragments. Reported from New Zealand.

COCCONEIS PLACENTULA Ehr. Plate 1, fig. 4.

Cocconeis placentula Ehr., FR. HUSTEDT, Bacillar. (1930) 189, 190, fig. 260.

Valve broad-elliptic, with rounded ends. Length, 0.017 mm; breadth, 0.0085. Striæ about 28 in 0.01 mm. Infrequent. Reported from New Zealand.

ACHNANTHES COARCTATA Breb. Plate 1, fig. 37.

Achnanthes coarctata Breb., FR. HUSTEDT, Bacillar. (1930) 210, fig. 308*a*.

Valve linear-elliptic, slightly constricted in the middle, with subrostrate rounded ends. Length, 0.022 mm; breadth, 0.0068. Striæ radiate, punctate, 15 in 0.01 mm, forming from lower part of valve a distinct broad fascia. Infrequent. Known from fresh water and moist earth. Reported from New Zealand.

DIPLONEIS SMITHII Breb.? Plate 1, fig. 23.

Diploneis Smithii Breb., FR. HUSTEDT, Bacillar. (1930) 253, fig. 402.

Valve elliptic, ovate, with slightly attenuate and rounded ends. Length, 0.0272 mm; breadth, 0.017. Median line straight. Central nodule of median size; furrows narrow. Transverse rows of alveoli radiate. Costæ with double rows of alveoli, 7 in 0.01 mm. Infrequent. A brackish-water species. New Zealand.

DIPLONEIS SUBOVALIS Cleve fo. NOVAE ZEALANDIAE fo. nov. Plate 1, fig. 27.

Valvis ovalis, prae forma typica latior, lateribus modice arcuatis, polis vastis, rotundatis. Alveolae 5 vel 6 in 0.01 mm, poris duabis. Valvis longis 0.0306 mm; latis 0.017. Habit in aquis dulcis stagnalis prope Napier, N. Z. Legit I. C. Edmundson.

Differs from the type in its valves being more ovate, subrhomboid, and its more distinct costæ. The type is known from Paeroa, New Zealand.

DIPLONEIS PUELLA (Schumann) Cleve forma. Plate 1, fig. 26.

Diploneis puella (Schumann) Cleve, FR. HUSTEDT, Bacillar. (1930) 250, fig. 394.

Valve elliptic, with rounded ends. Length, 0.0238 mm; breadth, 0.015. Costæ robust, 10 or 11 in 0.01 mm, very indistinctly striate. Infrequent. Differs from the type in its more robust costæ. Reported from fresh and brackish water. New to New Zealand.

NAVICULA CRYPTOCEPHALA Kütz. Plate 1, fig. 15.

Navicula cryptocephala Kütz., FR. HUSTEDT, Bacillar. (1930) 295, fig. 495.

Valve lanceolate, with attenuate ends. Length, 0.027 mm; breadth, 0.0068. Striæ slightly radiate, 17 or 18 in 0.01 mm. Infrequent. Reported from New Zealand.

NAVICULA PUPULA Kütz. var. CAPITATA Hust. forma. Plate 1, fig. 22.

Navicula pupula Kütz. var. *capitata* Hust., FR. HUSTEDT, Bacillar. (1930) 281, fig. 467c.

Valve linear-elliptic, with enlarged margin and attenuate broad ends. Length, 0.0136 mm; breadth, 0.0068. Striæ radiate, about 20 in 0.01 mm. Differs from the type in its smaller size. New to New Zealand.

NAVICULA CUSPIDATA Kütz. var. AMBIGUA (Ehr.) Cleve. Plate 1, fig. 8.

Navicula cuspidata Kütz. var. *ambigua* (Ehr.) Cleve, FR. HUSTEDT, Bacillar. (1930) 268, fig. 434.

Valve elliptic-elongate, with subcapitate, rounded ends. Length, 0.064 mm; breadth 0.018. Striæ parallel, 15 in 0.01 mm. Infrequent. Reported from New Zealand.

PINNULARIA VIRIDIS (Nitzsch.) Ehr. var. RUPESTRIS (Hantz.) Cleve? Plate 1, fig. 34.

Pinnularia viridis (Nitzsch) Ehr. var. *rupestris* (Hantzsch.) Cleve, A. SCHMIDT, Atlas Diatom. (1876) pl. 46, figs. 38–44.

Valve elliptic, with slightly attenuate and rounded ends. Length, 0.0442 mm; breadth, 0.012. Striæ slightly divergent at the middle and convergent at the ends, 11 or 12 in 0.01 mm. Longitudinal bands indistinct. Rare. New to New Zealand.

PINNULARIA MICROSTAURON (Ehr.) Cleve. Plate 1, fig. 21.

Pinnularia microstauron (Ehr.) Cleve, FR. HUSTEDT, Bacillar. (1930) 320, fig. 582.

Valve linear-elliptic, with almost straight margin and slightly subrostrate ends. Length, 0.0442 mm; breadth, 0.009. Striæ divergent in the middle and convergent at the ends, 12 in 0.01 mm. Infrequent. New to New Zealand.

GOMPHONEMA SUBCLAVATUM Grun. Plate 1, fig. 40.

Gomphonema subclavatum Grun., A. SCHMIDT, Atlas Diatom. (1902) pl. 237, fig. 34.

Valve subclavate, elliptical. Apex broader than attenuate end. Length, 0.0255 mm; breadth, 0.0051. Striæ robust, slightly radiate, 12 in 0.01 mm, with distinct isolated puncta. Infrequent. Reported from New Zealand.

GOMPHONEMA SUBCLAVATUM Grun. var. MONTANA Schum. Plate 1, fig. 13.

Gomphonema subclavatum Grun. var. *montana* Schum.? A. SCHMIDT, Atlas Diatom. (1902) pl. 238, figs. 1–3.

Valve minute, clavate, slightly biconstricted, with short-apiculate apex and narrow basis. Length, 0.022 mm; breadth, 0.0051. Striæ subradiate, 15 or 16 in 0.01 mm. Infrequent. New to New Zealand.

GOMPHONEMA PARVULUM (Kütz.) Grun. Plate 1, fig. 2, 11, and 12.

Gomphonema parvulum (Kütz.) Grun., FR. HUSTEDT, Bacillar. (1930) 372, 373, fig. 713*a*.

Valve subclavate, elliptical, tapering from the middle to the acute ends. Length, 0.0085 to 0.017 mm; breadth, 0.0051 to

0.0068. Striæ slightly radiate, 15 to 18 in 0.01 mm. Very common. Reported from New Zealand.

GOMPHONEMA PARVULUM (Kütz.) Grun. var. EXILISSIMA Grun. Plate 1, figs. 1 and 10.

Gomphonema parvulum (Kütz.) Grun. var. *exilissima* Grun., VAN HEURCK, Synopsis (1880) pl. 25, fig. 12.

Valve lanceolate, slightly clavate. Length, 0.022 mm; breadth, 0.0042 to 0.005. Striæ slightly radiate, 17 or 18 in 0.01 mm. Very common. New to New Zealand.

GOMPHONEMA ANGUSTATUM (Kütz.) Rabh. Plate 1, fig. 9.

Gomphonema angustatum (Kütz.) Rabh., FR. HUSTEDT, Bacillar. (1930) 373, fig. 690.

A little diatom with robust striæ and distinct isolated puncta. Valve subclavate, with apex broader than lower part of valve. Length, 0.0204 mm; breadth, 0.0051. Striæ 8 or 9 in 0.01 mm. Infrequent. Reported from New Zealand.

GOMPHONEMA ACUMINATUM Ehr. Plate 1, fig. 14.

Gomphonema acuminatum Ehr., FR. HUSTEDT, Bacillar. (1930) 370, fig. 683.

Valve clavate, biconstricted with apiculate apex. Length, 0.037 mm; breadth, 0.011. Striæ radiate, 11 in 0.01 mm. Isolated puncta distinct. Infrequent. Reported from New Zealand.

GOMPHONEMA CONSTRICTUM Ehr. Plate 1, fig. 3.

Gomphonema constrictum Ehr., FR. HUSTEDT, Bacillar. (1930) 377, fig. 714.

Valve clavate, with subtruncate-capitate apex and less broad obtusely truncate basis. Length, 0.0204 mm; breadth, 0.085. Striæ 12 in 0.01 mm. Infrequent. Reported from New Zealand.

EPITHEMIA SOREX Kütz. Plate 1, fig. 5.

Epithemia sorex Kütz., A. SCHMIDT, Atlas Diatom. (1904) pl. 252, figs. 22–28.

Valve lunate, with concave ventral and arcuate dorsal margins. Ends recurved and capitate. Length, 0.0306 mm; breadth, 0.0085. Common. Reported from New Zealand.

RHOPALODIA GIBBERULA (Ehr.) O. Müll. var. VAN HEURCKII O. Müll. Plate 1, fig. 24.

Rhopalodia gibberula (Ehr.) O. Müll. var. *Van Heurckii* O. Müll., A. SCHMIDT, Atlas Diatom. (1905) pl. 255, figs. 113–116.

Valve semilanceolate, with straight ventral and arcuate dorsal margins. Ends oblique and acute. Length, 0.0289 mm; breadth, 0.0068. Costæ 4, striæ 15 in 0.01 mm. Not common. Reported from brackish water. New to New Zealand.

RHOPALODIA NOVAE ZEALANDIAE Hustedt var. VENTRICOSA var. nov. Plate 1, fig. 35.

Valvis sublanceolatis, ventre directis, dorso convexis et arcuatis. Polis utrimque obliquis acutis et rotundatis. Strialis transversis delicatissime, 12 in 0.01 mm. Longis valvis 0.0476 mm; latis 0.0204. Habit in aquis dulcis stagnalis prope Napier, N. Z. Legit I. C. Edmundson.

Valve semilanceolate, with arcuate dorsal side, broader than type. Length, 0.0476 mm; breadth, 0.0204. Striæ 12 in 0.01 mm. Infrequent. The type is known from New Zealand.

HANTSCHIA AMPHIOXYS (Ehr.) Grun. Plate 1, figs. 17 and 20.

Hantzschia amphioxys (Ehr.) Grun., FR. HUSTEDT, Bacillar. (1930) 394, fig. 747.

Valve length, 0.0289 to 0.034 mm; breadth 0.0068. Costæ 6, striæ 15 to 18 in 0.01 mm. Several valves have been observed. Common. Reported from New Zealand.

NITZSCHIA THERMALIS Kütz. var. INTERMEDIA Grun. Plate 1, fig. 16.

Nitzchia thermalis Kütz. var. *intermedia* Grun., VAN HEURCK, Synopsis (1880) pl. 59, figs. 17–19.

Valve slightly concave in the middle. Length, 0.073 mm; breadth, 0.005. Ends oblique and attenuate. Costæ 10 to 12, striæ about 35 in 0.01 mm. Not common. New to New Zealand.

NITZSCHIA PALEA (Kütz.) W. Smith. Plate 1, fig. 36.

Nitzschia palea (Kütz.) W. Smith, FR. HUSTEDT, Bacillar. (1930) 416, fig. 801.

Valve linear, with parallel margins and attenuate, subacute ends. Length, 0.034 mm; breadth, 0.0028. Costæ 13 to 15 in 0.01 mm. Striæ indistinct. Rare. Reported from New Zealand.

SURIRELLA ANGUSTATA Kütz. var. CONSTRICTA Hustedt. Plate 1, fig. 33.

Surirella angusta Kütz. var. *constricta* Hustedt, FR. HUSTEDT, Bacillar. (1930) 435.

Valve elliptic, slightly constricted in the middle. Ends attenuate and rounded. Length, 0.0272 mm; breadth, 0.0072. Costæ 7 in 0.01 mm. Rare. New to New Zealand.

LITERATURE CITED

1. BRUNNTHALER, JOS. Protococcales. Jena (1915).
2. DEFLANDRE, G. Monographie du Genre Trachelomonas Ehr. (1926).
3. HUSTEDT, FR. Bacillariophyta. Jena (1930).
4. LEMMERMANN, E. Eugleniae. Jena (1913).
5. SCHMIDT, A. Atlas Diatomaceenkunde. Leipzig (1875–1931).
6. SKVORTZOW, B. W. On Trachelomonas hispida (perty) Stein and its varieties. New Phytologist (5) 24 (1925).
7. 'VAN HEURCK, Synopsis des Diatomees belgiques. Anvers (1880–1885).

ILLUSTRATION

PLATE 1

FIG. 1. *Gomphonema parvulum* (Kütz.) Grun. var. *exilissima* Grun.
2. *Gomphonema parvulum* (Kütz.) Grun.
3. *Gomphonema constrictum* Ehr.
4. *Cocconeis placentula* Ehr.
5. *Epithemia sorex* Kütz.

FIGS. 6 and 7. *Synedra ulna* (Nitz.) Ehr.
8. *Navicula cuspidata* Kütz. var. *ambigua* (Ehr.) Cleve.
9. *Gomphonema angustatum* (Kütz.) Rabh.
10. *Gomphonema parvulum* (Kütz.) Grun. var. *exilissima* Grun.

FIGS. 11 and 12. *Gomphonema parvulum* (Kütz.) Grun.
13. *Gomphonema subclavatum* Grun. var. *montana* Grun.?
14. *Gomphonema acuminatum* Ehr.
15. *Navicula cryptocephala* Kütz.
16. *Nitzschia thermalis* Kütz. var. *intermedia* Grun.
17. *Hantzschia amphioxys* (Ehr.) Grun.
18. *Meridion circulare* Agardh var. *constricta* (Ralfs) Van Heur.
19. *Scenedesmus brasiliensis* Bohlin.
20. *Hantzschia amphioxys* (Ehr.) Grun.
21. *Pinnularia microstauron* (Ehr.) Cleve.
22. *Navicula pupula* Kütz. var. *capitata* Hust. forma.
23. *Diploneis Smithii* Breb.?
24. *Rhopalodia gibberula* (Ehr.) O. Müll. var. *Van Heurckii* O. Müll.
25. *Meridion circulare* Agardh.
26. *Diploneis puella* (Schum.) Cleve forma.
27. *Diploneis subovalis* Cleve fo. *Novae Zealandiae* fo. nov.
28. *Trachelomonas volvocina* Ehr.
29. *Trachelomonas oblonga* Lemm.

FIGS. 30 and 31. *Trachelomonas Hamiltoniana* sp. nov.
32. *Trachelomonas hispida* (Perty) Stein var. *subarmata* Schröder.
33. *Surirella angustata* Kütz. var. *constricta* Hust.
34. *Pinnularia viridis* (Nitzsch) Ehr. var. *rupestris* (Hanzsch.) Cleve?
35. *Rhopalodia Novae Zealandiae* Hust. var. *ventricosa* var. nov.
36. *Nitzschia palea* (Kütz.) W. Smith.
37. *Achnanthes coarctata* Breb.
38. *Cyclotella Meneghiniana* Kütz. var. *Novae Zealandiae* var. nov.
39. *Synedra ulna* (Nitzsch) Ehr.
40. *Gomphonema subclavatum* Grun.

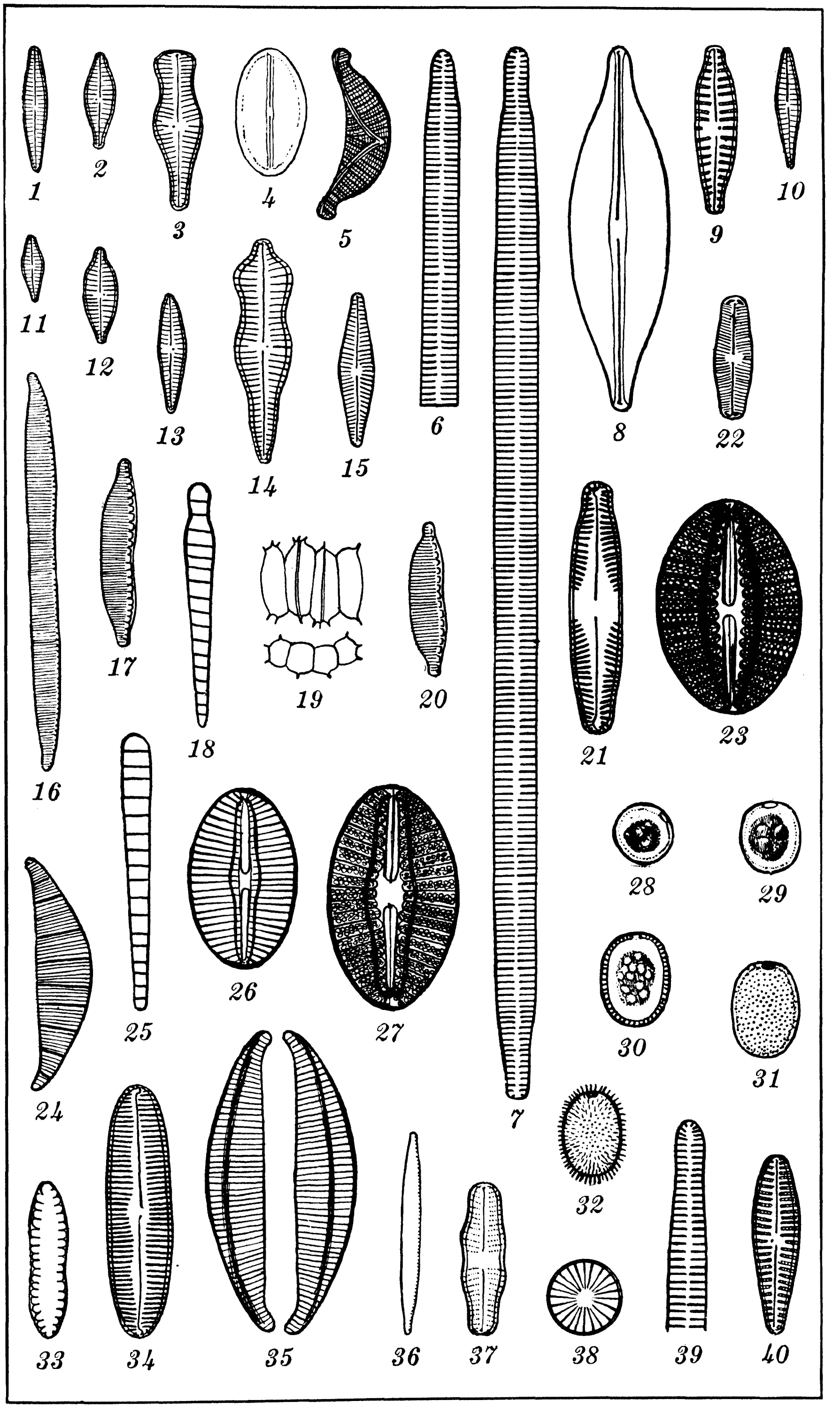

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40

PLATE 1.

SCOLYTIDÆ AND PLATYPODIDÆ: FAUNA PHILIPPINENSIS, V

By KARL E. SCHEDL

Of the Zoologisches Institut der Forstlichen Hochschule, Münden Hannover, Germany

TWO TEXT FIGURES

Through the courtesy of Dr. L. B. Uichanco, professor of entomology at the College of Agriculture, and Mr. A. de Mesa, assistant professor of forest entomology at the School of Forestry, and a forester, Bureau of Forestry, all in Laguna Province, Luzon, I was given the opportunity of examining their collections of Scolytidæ and Platypodidæ made in the Philippine Islands. The genera and species found in these collections are given below.

Genus CROSSOTARSUS Chapuis.

CROSSOTARSUS LECONTEI Chapuis.

LUZON, Laguna Province, Maquiling, February 1, 1934 (*L. Amon*), on *Cedrela odorata* L., July 29, 1931 (*L. Amon*), on *Diplodiscus paniculatus* Turcz., March 27, 1924 (*A. de Mesa*) on *Madhuca betis* (Blanco) Merrill, November 22, 1929 (*A. de Mesa*); Los Baños, February 29, 1915 (*D. R. Tuason*). MINDANAO, Zamboanga Province, Naganaga, March 23, 1930 (*A. de Mesa*) on *Pentacme contorta* (Vidal) Merr. et Rolfe, March 23, 1930 (*De Mesa and Tamayo*) on *Celtis philippensis* Blanco. MINDORO, Puerto Galera, Kalayaan, altitude 1,000 feet, April 23, 1935 (*S. M. Cendaña*).

CROSSOTARSUS FRACTUS Sampson.

LUZON, Laguna Province, Los Baños, August 17, 1922 (*S. M. Cendaña*) March, 1935 (*H. Varian*) on *Swietenia mahogani* Jacq.; Mount Maquiling, March 27, 1924 (*A. de Mesa*) on *Madhuca betis* (Blanco) Merrill.

CROSSOTARSUS OCTOCOSTATUS Schedl.

LUZON, Laguna Province, Los Baños, August 17, 1922 (*S. M. Cendaña*), November 16, 1929 (*D. Soriano*) on *Albizzia acle* (Blanco) Merrill; Mount Maquiling, altitude 110 meters, March 27, 1924 (*A. de Mesa*) on *Madhuca betis* (Blanco) Merrill.

CROSSOTARSUS BIFURCUS sp. nov.

Male.—Reddish brown, 3.5 millimeters long, 3.4 times as long as wide. This species, remarkable in the development of the declivity, has to be placed in a new group of the *Crossotarsi*, together with *C. octocostatus* Schedl and *C. derosus* Schedl, the main characters of which are: Lateral processes of apical margin of elytra similar to those in *Crossotarsi subdepressi*, but with alternate interspaces carinate towards declivity and ceasing as recessed pointed spines above declivital convexity. The group should be called *Crossotarsi alternante-depressi.*

Front flat, shiny, densely punctate along epistomal margin and towards articulations of antennæ, opaque and shallowly areolate above, medially with a short impressed striga, rounded towards vertex. Pronotum longer than wide (11 : 9), widest at posterior angles of femoral grooves, brightly shiny, sparsely beset with fine punctures, somewhat more densely so along base; median sulcus extremely fine, surrounded by a large cordiform patch of densely placed fine but deep punctures. Elytra wider than (10.2 : 9) and nearly twice as long as pronotum, shiny, widest at commencement of declivity, sides straight, feebly divergent, declivity commencing in posterior third, shortly convex; base carinate, disc with first four striæ sulcate near base, impressed behind, strial punctures indistinct, interspaces at first narrowly carinate, then convex and with scattered minute punctures; interspaces 2 and 4 widened towards and projecting as straight pointed spines over declivital convexity, interspaces 1, 3, and 5 narrowed and ceasing at commencement of latter, interspaces 6 and 7 united behind to form a lateral ridge which ceases short above sutural angle in a short downwards directed spine; declivital face opaque, finely rugulose, with indications of impressed rows, especially above, apical margin drawn out into two long downward-directed lobes which are pointed at their tips, thus producing a deep semicircular emargination at suture.

Female.—In size and proportions similar to male, front feebly depressed, shiny area narrower, median impressed strigæ longer. Pronotum stouter, punctures near apical margin coarse and dense, posterior angles of femoral grooves not so strongly developed. Elytra with base less carinate, interspaces 3 and 5 strongly elevated near base and covered with transverse rugæ, the others convex, all flattening out toward middle, striæ moderately impressed, remotely punctured, punctures large;

declivity convex, with a perpendicular flattened face below; striæ not visible on convexity, finely rugose, covered (especially on the perpendicular face) with short yellow pubescence.

Types in the collection of the Division of Forest Studies and Research, Bureau of Forestry, and in my own collection.

MINDANAO, Lanao Province, Kolambugan, November 20, 1929 (*A. de Mesa*) on *Parashorea malaanonan* (Blanco) Merrill; Kolambugan, Mangosinoro, October 20, 1929 (*A. de Mesa*): Zamboanga Province, Naganaga, October 9, 1930 (*A. de Mesa*), on *Dipterocarpus grandiflorus* Blanco; Lumarao, February 25, 1930 (*A. de Mesa*), on *Parashorea malaanonan* (Blanco) Merrill: Occidental Misamis Province, Misamis, February 25, 1930 (*A. de Mesa*), on *Shorea mindanensis* Foxworthy: Surigao Province, May 15, 1935 (*H. Varian*), on *Shorea negrosensis* Foxworthy.

Genus PLATYPUS Herbst

PLATYPUS SOLIDUS Walker.

LUZON, Laguna Province, Mount Maquiling (*H. F. Varian*), on *Peltophorum inerme* (Roxb.) Llanos, altitude 110 meters, March 27, 1924 (*A. de Mesa*), on *Madhuca betis* (Blanco) Merrill, January 3, 1934 (*L. Amon*), on *Sideroxylon mecranthum* Merrill, December 26, 1934 (*L. Amon*), on *Macaranga bicolor* Muel.-Arg.; Los Baños, October 10, 1920 (*S. M. Cendaña*).

PLATYPUS EXCEDENS Chapuis.

LUZON, Laguna Province, Los Baños, December 20, 1929 (*R. Buhay*) on *Dysoxylum decandrum* (Blanco) Merrill; Mount Maquiling (*A. de Mesa*), on *Dipterocarpus grandiflorus* Blanco, April 14, 1933 (*L. Amon*), on *Alangium longiflorum* Merrill.

PLATYPUS LEPIDUS Chapuis.

LUZON, Laguna Province, Los Baños, 50 meters, April 2, 1934 (*L. B. Uichanco*); Mindoro Province, San Jose, April 11, 1923 (*L. B. Uichanco*).

PLATYPUS TURBATUS Chapuis.

LUZON, Laguna Province, Los Baños, February 12, 1918 (*C. S. Banks*); Mount Maquiling, altitude 110 meters, March 24, 1924 (*C. Rabaya*) on *Cassia javanica* Linn., altitude 200 meters, December 27, 1935 (*V. J. Madrid*).

PLATYPUS HYBRIDUS Schedl.

MINDANAO, Misamis Province, Misamis, November 22, 1929 (*A. de Mesa*), on *Diospyros pilosanthera* Blanco.

PLATYPUS SPECTABILIS Schedl.

MINDANAO, Zamboanga Province, Lumarao, February 24, 1930 (*A. de Mesa*), on *Dipterocarpus grandiflorus* Blanco.

Genus DACTYLOPALPUS Chapuis

DACTYLOPALPUS TRANSVERSUS Chapuis.

LUZON, Laguna Province, Mount Maquiling, March 17, 1932 (*A. G. Bautista*), on *Myristica philippensis* Lam.

Genus DIAMERUS Erichson

DIAMERUS MERINJAKI Sampson.

LUZON, Laguna Province, Mount Maquiling, altitude 200 meters, December 27, 1935 (*V. J. Madrid*).

The male, which has hitherto been undescribed, has the front planoconvex, with two slight depressions, one between the articulations of the antennæ, the other between the upper half of the eyes.

Genus SPHÆROTRYPES Blandford

SPHÆROTRYPES QUADRITUBERCULATUS Sampson.

LUZON, Laguna Province, Mount Maquiling, February 20, 1934 (*L. Amon*), on *Parashorea plicata* Brandis, January 20, 1934 (*L. Amon*), on *Pentacme contorta* (Vidal) Merrill et Rolfe.

Genus HYLESINUS Fabricius

HYLESINUS JAVANUS Eggers.

LUZON, Laguna Province, Mount Maquiling, March 30, 1932 (*Bautista*), on bark of *Ficus* sp.

Genus PHLŒSINUS Chapuis

PHLŒSINUS VAGANS Sampson.

MINDANAO, Zamboanga Province, Margosatubig, November, 1930 (*A. de Mesa*), on *Myristica philippensis* Lam.

PHLŒSINUS CRIBRATUS Blandford.

MINDANAO, Zamboanga Province, Naganaga, April 22, 1930 (*A. de Mesa*), lot No. 698, on *Myristica philippensis* Lam.

Genus CRYPHALUS Erichson

CRYPHALUS INDICUS Eichhoff.

LUZON, Laguna Province, Mount Maquiling, March 30, 1932 (*H. Varian*), on bark of *Ficus* sp.

CRYPHALUS HAGEDORNI Eggers.

LUZON, Laguna Province, Los Baños, February 25, 1918 (*A. G. Toquero*).

CRYPHALUS MINIMUS Eggers.

LUZON, Laguna Province, Mount Maquiling, January 30, 1921 (*M. A. Mariano*), on *Eugenia* sp.

Specimens that fit the description very well show sexual differences not mentioned by Eggers. The male has the apex of the pronotum more narrowly rounded, the asperities finer, and the asperate area not so sharply defined as the female. The elytral declivity is decidedly more strongly convex.

CRYPHALUS CAPUCINUS sp. nov. Text fig. 1.

Male.—Yellowish brown, 2.1 millimeters long, 2.2 times as long as wide. Dissection of one specimen shows that the series consists of males only. Pronotum similar to that of *C. indicus* Eichhoff, but the number of apical asperities and the general shape quite different. I could find no specimen that could be the female sex.

Front planoconvex, densely punctulate, with a faint longitudinal carina.

Pronotum wider than long, base distinctly bisinuate, moderately convex, summit behind middle densely finely punctate, with very small scattered asperities except on a rather broad and long area above anterior extension and on posterolateral corners; posterolateral angles not rounded, sides broadly arcuate, rather strongly extended apically, apex armed with two large and two smaller toothlike asperities; pubescence extremely short and intermixed with scattered long yellow hairs. Scutellum hardly noticeable. Elytra but little wider than and 1.7 times as long as pronotum, sides parallel in basal half, then gradually narrowed, broadly rounded behind, declivity commencing in middle, gradually convex; disc faintly striate-punctate, strial punctures very small, closely placed, striæ feebly impressed, more strongly so towards and on declivity, interspaces very densely, irregularly punctured, pubescence double, one set of hairs short, inclined, and yellow, the other long, erect, dark brown.

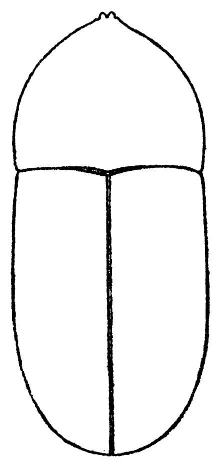


FIG. 1. *Cryphalus capucinus* sp. nov.; outline of male.

Types in the collection of the Division of Forest Studies and Research, Bureau of Forestry, and in my own collection.

LUZON, Laguna Province, Mount Maquiling, November, 1931 (*A. de Mesa*), lot No. 835, on *Cassia javanica* Linn.

Genus IPS DeGeer

IPS BICAUDATUS Egger.

MINDANAO, Zamboanga Province, Naganaga, March 22, 1930 (*De Mesa, Reyes, and Tamesis*), lot No. 656, on *Vatica mangachapoi* Blanco.

Genus XYLEBORICUS Eggers

XYLEBORICUS IMITATOR Eggers.

LUZON, Laguna Province, Mount Maquiling, March 18, 1924 (*A. de Mesa*) on *Canarium multipinnatum* Llanos.

Genus XYLEBORUS Eichhoff

XYLEBORUS HYBRIDUS Eggers.

LUZON, Laguna Province, Los Baños, December 20, 1929 (*R. Buhay*) on *Dysoxylum decandrum* (Blanco) Merrill.

XYLEBORUS QUADRATICOLLIS Eggers.

LUZON, Laguna Province, Mount Maquiling, August 21, 1932 (*V. J. Madrid*).

XYLEBORUS NEPOS Eggers.

LUZON, Laguna Province, Los Baños, December 17, 1929 (*R. Buhay*), November 26, 1929 (*V. Parras*), on *Dysoxylum decandrum* (Blanco) Merrill.

XYLEBORUS CRASSITARSUS Schedl.

LUZON, Laguna Province, Mount Maquiling, altitude 200 meters, February 5, 1924 (*C. Rabaya*), on *Allaeanthus luzonicus* (Blanco) F. Vill.

XYLEBORUS DIVERSICOLOR Eggers.

LUZON, Laguna Province, Mount Maquiling, March 16, 1924 (*A. de Mesa*), on *Canarium multipinnatum* Llanos.

XYLEBORUS EXIGUUS Walker.

LUZON, Laguna Province, Mount Maquiling, January 15, 1935 (*H. F. Varian*), on *Swietenia mahogani* Jacq.

XYLEBORUS INDICUS Eichhoff.

LUZON, Laguna Province, Los Baños, December 26, 1929 (*V. Parras*), on *Dysoxylum decandrum* (Blanco) Merrill, December 2, 1929 (*R. Buhay*), on the same host.

XYLEBORUS TESTACEUS Walker.

LUZON, Laguna Province, Los Baños (*S. M. Cendaña, C. S. Banks, F. B. Santos, A. de Mesa, J. S. Versoza, M. Sulit*), December 10, 1929 (*P. San Buenaventura*) on *Artocarpus integra* (Blanco) Merrill, December 2, 1929 (*R. Buhay*), on *Dysoxylum decandrum* (Blanco) Merrill: Pangasinan Province, Mangaldan, December 18, 1935 (*S. M. Cendaña*). NEGROS, Silay-Hawaiian, November 8, 1928 (*C. T. Buligan*).

XYLEBORUS BADIUS Eichhoff.

LUZON, Laguna Province, Los Baños (*P. San Buenaventura, V. Parras, J. S. Versoza, C. S. Banks, F. B. Santos, L. B. Uichanco, A. A. Goco, R. B. Bautista*), March 12, 1929 (*R. Buhay*), on *Dysoxylum decandrum* (Blanco) Merrill.

XYLEBORUS SIMILIS Ferrari.

LUZON, Laguna Province, Los Baños, November 12, 1916 (*E. G. Collado*), August 15, 1915 (*F. W. Ashton*), November 24, 1923 (*M. A. Mariano*); Mount Maquiling, March 18, 1924 (*A. de Mesa*), on *Dillenia philippinensis* Rolfe.

XYLEBORUS OBTUSICOLLIS sp. nov. Text fig. 2.

Female.—Head and pronotum reddish brown, elytra distinctly darker (uniform in the whole series), 4.5 millimeters long, twice as long as wide. This species, which belongs in the *obtusus* group, has its closest allies in *X. bellus* Samps. and *X. obliquesectus* Eggers.

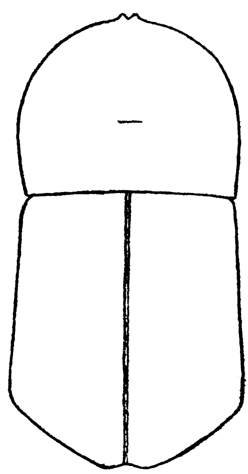


FIG. 2. *Xyleborus obtusicollis* sp. nov.; outline of femora.

XYLEBORUS OBLIQUESECTUS Eggers.

Front convex, densely shallowly punctured, medially with a low longitudinal ridge. Eyes large, long-oval, deeply emarginate in front. Pronotum wider than long, base transverse, posterolateral angles rectangular, rounded; sides subparallel behind, semicircularly arcuate in front; apex narrowly extended, armed with two large asperities; transverse at summit, short behind middle; pronotum globose, anterior area steeply convex, perpendicular below, with rather few low asperities in cephalic half, finely granulate up to summit, posterior area densely finely punctate. Scutellum not visible. Elytra at base as wide as pronotum, at commencement of declivity distinctly wider and 1.5 times as long as pronotum, sides straight but divergent towards declivity, rather obliquely rounded behind, with a shallow notch at suture, declivity obliquely truncate but without well-defined margins and commencing distinctly behind middle; disc shiny, without pubescence except at extreme base, densely irregularly punctured; declivity planoconvex, with a shallow longitudinal impression near posterolateral corners, entire face irregularly finely punctured and with dense yellow and inclined pubescence.

Types in the collection of the Division of Forest Studies and Research, Bureau of Forestry, and in my own collection.

MINDANAO, Zamboanga Province, Naganaga, March 23, 1930 (*Tamayo, A. de Mesa*), lot No. 619, on *Vatica mangachapoi* Blanco.

ILLUSTRATIONS

TEXT FIGURES

FIG. 1. *Cryphalus capucinus* sp. nov.; outline of male.
2. *Xyleborus obtusicollis* sp. nov.; outline of femora.

BOOKS

Acknowledgment of all books received by the Philippine Journal of Science will be made in this column, from which a selection will be made for review.

REVIEWS

Report on an Investigation into Maternal Mortality. Presented by the Minister of Health to Parliament by Command of His Majesty, April, 1937. London, Printed and Published by His Majesty's Stationery Office, 1937. 353 pp., maps, diagr., graphs, tables. Price, 5s. 6d.

This report, profusely illustrated with tables, graphs, maps, and diagrams, is a study made in England and Wales regarding the persistently stationary maternal mortality rate, in spite of improved medical, economic, and health conditions.

During the period 1925–1933 this stationary maternal mortality rate existed in England and Wales and 17 other countries not mentioned. The puerperal death rate is calculated on births and not on pregnancies, hence the rate is exaggerated because it includes deaths due to abortions. The puerperal death rate of England and Wales during the years 1933, 1934, and 1935, which respectively were 4.51, 4.60, and 4.10 per thousand, would correspondingly be reduced to 3.86, 3.94, and 3.51, if deaths due to abortion had been excluded. The reviewer agrees with the Report in its statement that the puerperal death rate should be calculated from the number of pregnancies and not from the number of births, as this gives an inaccurately higher maternal mortality, but does not agree with its opinion that the incidence of pregnancies cannot possibly be determined. This can be done if the compulsory registration of all abortions and miscarriages as well as all births is officially required.

As in America and other European countries, the chief causes of mortality in the 770 maternal deaths in 1934 which were the subject of investigation were, in the order of frequency: Sepsis, albuminuria and convulsions, and hæmorrhage. It is of significant interest that in Manila, at least during the period 1914–1934, hæmorrhage as a cause of puerperal mortality occupies second place in the order of frequency. Abortion caused

14 per cent of the puerperal death rate. More deaths from abortion occurred in married women but abortion was responsible for the higher maternal death rate of the unmarried.

Besides a detailed investigation on the particular circumstances attending each maternal death with a view to its preventability, the Report also cites the attempt to find the influence of certain conditions on puerperal mortality and the conclusions drawn therefrom.

The main recommendation of the Report is to place all obstetrical patients under the control of experts who will act in an advisory capacity or as consultants to medical practitioners engaged in midwifery and who should see to it that the best obstetrical skill is available to every maternity patient. Recommendations were also made for research on (*a*) the reliable prophylactic treatment of puerperal infection, (*b*) the influence of abortion on maternal morbidity and mortality and future child-bearing, and (*c*) the possible influence of dietary upon child-bearing.—H. A. S.

Maternal Deaths—The Ways to Prevention. By Iago Galdston. New York, The Commonwealth Fund, 1937. 115 pp. Price, $0.75.

This little book summarizes the maternal mortality problem in the United States and cites medical investigations and statistics gathered in New York city. Preventive measures are discussed. Many mothers will perhaps not have died in vain if the lessons taught by their tragic and untimely deaths are given effective application in the future. Among the lessons suggested by the author are adequate antepartum care, competent medical service, and well-equipped hospitals. Fifty per cent of the mortality rate can be prevented by the coöperation of medical men, social workers, and the public. Better instruction is needed by these various groups, and most emphatically by the public.

The Appendix illustrates the type of medical organization the large communities can create to improve the quality of obstetrical service rendered. This brief survey will be of interest to physicians, to health workers, and to laymen.—I. F.

To Drink or Not to Drink. By Charles H. Durfee. New York, Longmans, Green and Co., 1937. 212 pp. Price, $2.

Through this book the author has made a valuable contribution to the solution of a complex social problem caused by the unwise use of alcohol. The readers will get interesting facts concerning the influence of alcohol upon the psychology and health of human beings and society as a whole. The author is a noted psychologist, and the methods of treatment found in this book are the result of his personal experience based on an extensive psychoanalysis of the life and character of alcoholic persons coming from different walks of life.

This book gives us a clear picture of a problem drinker whose drinking becomes a habit and a social evil to him, to his home, and to society. With long years of experience inside and outside his institution the author has made extensive studies of the histories, causes, and treatment of typical cases of problem drinkers, and discusses them in detail in this book. He has shown that all the difficulties encountered among alcoholics can be conquered by means of the modern scientific methods of treatment, such as the application of psychic persuation, educational training, and constructive occupational therapy. All these methods of treatment constitute an important advance in the therapy of alcoholism. He proved by actual experience on his farm in Rhode Island the advantages of this method of therapy, and cites several cases in which complete cure was accomplished. To physicians, social workers, and laymen, this book will serve as an effective guide in fighting the social evils which arise from the abuse of alcohol.—P. J. A.

By-Effects in Salvarsan Therapy and Their Prevention with Special Reference to the Liver Function. By V. Genner. Copenhagen, Levin & Munksgaard, 1936. 358 pp. Price, $6.50.

Part I of this book contains a detailed presentation and analysis of by-effects in salvarsan therapy as they occurred in 5,526 syphilitic patients treated in the Dermatological Department of the Rigshospital, Copenhagen University, Denmark, from 1913 to 1932. Thorough discussions were made with citation of literature on the pathogenesis of the objective by-effects, such as erythema, jaundice, albuminuria, and joint complaint occurring in the salvarsan therapy on the different stages of syphilis. In Part II the author enumerates the different subjective by-effects of salvarsan therapy obtained by careful questioning as they occurred in his 316 out or dispensary patients. A great percentage of these subjective by-effects with few exceptions was checked or mitigated by injecting salvarsan in glucose solution. Two simple functional liver tests were applied on the dispensary patients with the object of determining the condition of the liver during the salvarsan therapy, before and after the occurrence of by-effects. Part III deals with other functional liver tests applied on 108 syphilitic patients under salvarsan treatment that could not be done on dispensary patients. The tests applied were: The determination of icterus index (Meulengracht), estimation of quinine resistant lipase in the blood (Rona), and Bauer's galactose tolerance test, for urobilinogen and for bile salts. From the results of these tests the author tried to reason out whether latent functional disturbances of the liver occurred under salvarsan therapy.

On the whole, the book is very valuable to those who are confronted with by-effects of salvarsan therapy.—F. G.

Selected Topics in Colloid Chemistry; With Especial Reference to Biochemical Problems. By Ross Aiken Gortner. Ithaca, New York, Cornell University Press, 1937. 169 pp., 35 figs., 38 tables. Price, $2.50.

This brief volume on "Colloid Chemistry" covers the lectures of the author when he held the George Fischer Baker Non-Resident Lectureship in Chemistry at Cornell University, 1935–1936.

The first part of the book gives the basic concepts of colloid chemistry including the fundamental properties of colloidal systems. The latter part treats of the author's explanation and viewpoints on such important subjects as have important bearing on biochemical problems, as electrokinetics, surface and interfacial phenomena, molecular orientation, and adsorption. The last and concluding chapter discusses "bound water," which the author believes is of first importance in the elucidation of living processes. The book includes 35 figures and 38 tables of data which are critically discussed.—F. L. R.

Latex in Industry. A New and Comprehensive Textbook. By Royce J. Noble. New York, The Rubber Age, 1936. 384 pp., illus. Price, $7.

This book gives in a brief but comprehensive manner the technology and chemistry of latex. It gives a condensed discussion of latex—its sources, preservation, and concentration. The latter portion of Part I covers such subjects as artificial latices, the compounding, coagulation, and vulcanization of latex, and the physical and chemical examination of latex. Part II of the treaties deals with the industrial applications of latex. Chapters XII to XVI describe the processes by which latex finds use in manufactured goods, as impregnation, spreading, dipping, molding, and electrodeposition. Paper treatment with latex, artificial leather, porous rubber and rubber thread, the manufacture of friction elements and adhesives, latex treatment of rugs, and the miscellaneous applications of latex are covered in the last part of the volume.

On the whole the present volume should be useful to workers in the field of rubber not only as a source of condensed information but also as an up-to-date reference. The wealth of the bibliography at the end of each chapter makes it a handy reference guide for those who desire to go into the literature of latex in greater detail.—F. L. R.

The Bed-Bug; its Habits and Life-History and How to Deal with It. By A. W. McKenny-Hughes. London, Printed by Order of the Trustees of the British Museum, 1937. 4th ed. 19 pp., front., illus. Price, 6d.

This pamphlet is a practical account of the bedbug, one of the most widely distributed house pests known. It takes up the external anatomy of the insects, its blood-sucking apparatus, life history, habits, mode of dissemination, relation to disease, and methods of control. Under the last item the eradication of minor and major bug infestations are discussed, and the promising results obtained with the use of heavy naphtha, a fumigant which is apparently not poisonous to human beings, are mentioned.—M. T.

An Introductory Course in Science for Colleges. I. Man and The Nature of His Physical Universe. II. Man and the Nature of His Biological World. By Frank Covert Jean, Ezra Clarence Harrah, and Fred Louis Herman. With the Editorial Collaboration of Samuel Ralph Powers. Boston, Ginn and Company, c1934. 2 vols. Price, $4.50.

Discussions on space and cosmic bodies are presented in a fascinating way in volume I of this work. The principal types of force and energy, like gravitation, heat, magnetism, electricity, and radiant energy, are treated from the point of view of pure science and their practical applications to human living through the use of machines and inventions. This volume ends with a study of the earth and its characteristics and features which make life upon it possible.

Plants, animals, synthesis and decomposition, evolution, and adaptation, genetics and heredity, and man's cultural development are discussed in volume II. Biology has changed man's ideas as to the nutritional needs of the body, the nature and extent of hormone regulation, and the means adopted by the organism to combat disease.

New discoveries and the further application of scientific principles to the needs of modern life affect fundamentally both the content of the curriculum and the methods of instruction.

The student acquires an adequate conception of the general principles of science and an appreciation of the relation of that particular science to his needs. The courses are organized from the point of view of the life needs of the general student rather than of the student who wishes to become a specialist.

The authors of this text have subscribed to the organization of generalized introductory courses in science which are presented in such a way as to help the student to orientate himself in his universe, to help to free him from superstition and prejudice, to teach him to rely upon established truth, and to appreciate the careful, logical methods employed by the scientist in arriving at trustworthy conclusions.

These two volumes are the result of four years experience in the classroom. The illustrations, questions, and references at the end of each chapter enhance the value of this book.—L. R.

INDEX

[New names and new combinations are printed in **boldface.**]

D

E

H

R

T

U

V

O

VOL. 67, NO. 4 DECEMBER, 1938

THE PHILIPPINE JOURNAL OF SCIENCE

MANILA
BUREAU OF PRINTING
1938

24117

THE PHILIPPINE JOURNAL OF SCIENCE

Published by the Bureau of Science, Department of Agriculture and Commerce

[Entered at the Post Office at Manila, P. I., as second-class matter.]

THE PHILIPPINE BUREAU OF SCIENCE

RECENT MONOGRAPHIC PUBLICATIONS

SUMMARY OF PHILIPPINE MARINE AND FRESH-WATER MOLLUSKS. By Leopoldo A. Faustino. Order No. 485. Bureau of Science Monograph 25. Paper, 384 pages. Price, $2 United States currency, postpaid.

SECOND TEN-YEAR INDEX OF THE PHILIPPINE JOURNAL OF SCIENCE, Volume 11 (1916) to Volume 28 (1925). By Winifred I. Kelly. Order No. 486. Bureau of Science Monograph 26. Paper, 381 pages. Price, $2 United States currency, postpaid.

FILTERABLE VIRUS AND RICKETTSIA DISEASES. By Earl Baldwin McKinley. Order No. 487. Bureau of Science Monograph 27. 442 pages, 70 plates, and 7 text figures. Prices, paper, $2.50; bound in full red keratol, $4, United States currency, postpaid.

A STUDY OF THE IGOROT LANGUAGE AS SPOKEN BY THE BONTOC IGOROTS. By Margaret P. Waterman. Order No. 488. Bureau of Science Monograph 28. Paper, 142 pages. Price, $0.75 United States currency, postpaid.

EXPERIMENTAL STUDIES OF DENGUE. By James Stevens Simmons, Joe H. St. John, and Francois H. K. Reynolds. Order No. 489. Bureau of Science Monograph 29. Paper, 489 pages, 3 plates, and 159 text figures. Price, $3.50 United States currency, postpaid.

PHILIPPINE LAND MAMMALS. By Edward H. Taylor. Order No. 490. Bureau of Science Monograph 30. Paper, 548 pages, 25 plates and 25 text figures. Price, $2.50 United States currency, postpaid.

THE PHILIPPINE JOURNAL OF SCIENCE

Manuscripts intended for publication in the Philippine Journal of Science should be sent to the Editor, Philippine Journal of Science, Bureau of Science, post-office box 774, Manila, P. I.

One hundred separates of each paper published in the Journal are furnished to the author without charge. Additional copies may be had at the author's expense if ordered when the manuscript is submitted for publication.

The Journal is issued twelve times a year. The subscription price is 5 dollars United States currency per year. Single numbers, 50 cents each.

Subscriptions may be sent to the Business Manager, Philippine Journal of Science, Bureau of Science, post-office box 774, or to the Publications Division, Department of Agriculture and Commerce, post-office box 613, Manila, P. I., or to any of the agents listed below.

Publications sent in exchange for the Philippine Journal of Science should be addressed: Scientific Library, Bureau of Science, post-office box 774, Manila, P. I.

AGENTS

The Macmillan Company, 60 Fifth Avenue, New York, N. Y.
Martinus Nijhoff, Lange Voorhout 9, The Hague, Holland.
G. E. Stechnert & Co., 31–33 East 10th Street, New York, N. Y.
The Maruzen Co., Ltd., 6 Nihonbasi, Tori-Nichome, Tokyo, Japan.

CONTENTS

The articles in the Philippine Journal of Science are indexed in the International Index to Periodicals, New York, N. Y.