THE

TRANSACTIONS

OF

THE LINNEAN SOCIETY

OF

LONDON.

VOLUME XXII.

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1856 – M.DCCC.LIX.

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PART THE FIRST.

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M.DCCC.LVI.

CONTENTS.

PART I.—1856.

TRANSACTIONS

OF

THE LINNEAN SOCIETY.

I. *On the Structure and Affinities of* Balanophoreæ.

By Joseph Dalton Hooker, *Esq., M.D., F.R.S., F.L.S., &c.*

Read February 6th, February 20th and June 19th, 1855.

THE materials from which this Essay has been drawn up, have been accumulating on my hands for a considerable period. They consist principally of—1. A very complete set of the American species, especially of the *Helosideæ*, formed at the desire of Sir William Hooker, in New Grenada, Jamaica, and Trinidad, in 1846 and 1847, by Mr. William Purdie, at that time collector for the Royal Gardens at Kew. He gathered nine species, including several new genera, and preserved many specimens of most, both dried and in spirits. 2. I am indebted to Prof. Liebmann of Copenhagen for the species collected by him in Mexico, together with drawings of them; a translation of his paper on *Thonningia* and *Helosis mexicana*, read before the Society of Scandinavian Naturalists at Christiania; and the loan of the original specimens of *Thonningia*, from the herbaria of Vahl and Schumacher. 3. Mr. Miers has placed at my disposal his Brazilian specimens of *Langsdorffia hypogæa* and *Helosis guyanensis*, from Rio and the La Plata district, together with his sketches of them made on the spot. 4. Sir Robert Schomburgk has given me his drawings of the same genera, made in Guiana; and I have also received from other travellers numerous specimens of them. 5. For the South African genera *Sarcophyte* and *Mystropetalon* I am indebted to Dr. Harvey, who, during his residence at the Cape, communicated beautiful specimens of them to Sir William Hooker. 6. Of the Indian *Balanophoreæ* I have very extensive suites of specimens indeed; having had, in the Himalaya and Khasia mountains, the opportunity of studying several species in many stages of growth. I have also examined most of the specimens collected by Mr. Griffith himself, from which he described the species for the Society's Transactions; and I have received the Peninsular and Ceylon *B. indica* from Wight, Gardner, and Thwaites. 7. Sir William Hooker has procured the Javanese species from Mr. Thomas Lobb, Prof. de Vriese of Leyden, and others. 8. For specimens of the original species of *Balanophora* (*B. fungosa* of Forster), I am indebted to Mr. M'Gillivray, who found it on the N.E. coast of

Australia, during the voyage of H.M.S. "Rattlesnake;" and I have also received it from Tanna (the place of its original discovery by Forster), where it was collected by Mr. Hinds, during the visit of H.M.S. "Sulphur" to that island:—these I have compared with Forster's original specimens in the British Museum. 9. For other species I have been indebted to various sources, including the herbarium of the British Museum, which contains the original specimen of *Lophophytum mirabile**.

The total number of species thus brought together is about twenty-eight, of which I have examined both sexes of twenty-six.

I have not considered it necessary to give a detailed list of the authorities who have written upon this Order, nor a history of the successive additions that have been made to our knowledge of it; these subjects having been minutely and well detailed by Richard, Griffith, and Endlicher; and a *résumé* of them by Dr. Lindley will be found in his valuable 'Vegetable Kingdom.' I may however mention that, in their several ways, the original Essay of the great Linnæus upon *Cynomorium*, in the fourth volume of the 'Amœnitates Academicæ,'—the admirable one of Richard on *Cynomorium*, *Helosis*, and *Langsdorffia*, in the 'Mémoires du Muséum,'—Gœppert's very valuable remarks on the anatomy of the Javanese species, in the 'Nova Acta,'—Mr. Griffith's observations in the 19th and 20th volumes of our Society's Transactions,—Schott and Endlicher's paper in the 'Meletemata,' and Weddell's paper in the fourteenth volume of Ser. 3. of 'Ann. Sci. Nat.,' are by far the most important. A very complete summary of other authors will be found in Unger's paper upon parasites in the Annals of the Vienna Museum; since which period, however, Gœppert's, Griffith's and Weddell's papers have appeared, as also Junghuhn's in the 'Nova Acta,' all of which are accompanied by valuable plates.

1. *Parasitism and Structure of the Rhizome.*

I shall employ the term rhizome for the principal axis of *Balanophoreæ*: it was

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* Since the above was read before the Linnean Society I have examined several other collections, of which the most important are—10. The original specimens of *Langsdorffia* and *Helosis*, collected by Von Martius, and preserved at Munich; 11. those of *Scybalium* (which are to this day unique), in the Vienna Herbarium; 12. the valuable collection in the Jardin des Plantes at Paris. I have also to record my great obligations to my friend M. Weddell of Paris, who has already contributed so much to our knowledge of the plants of this Order, and through his good offices to the Museum of the Jardin, for specimens of *Lophophytum* in several stages of growth, of *Ombrophytum peruvianum*, of *Corynæa Weddellii*, and of *Langsdorffia rubiginosa*; all collected by Weddell in Bolivia, Peru and Brazil; for drawings of these made on the spot by himself; for dissections of *Sarcophyte sanguinea*, showing the central embryo which he discovered and figured, and for others of *Langsdorffia hypogæa* with the fruit fully formed, and which confirm Liebmann's drawings and descriptions of the fruit of that genus.

The result of the materials thus added has been to strengthen the views I have adopted of the structure and affinities of the Order, to enable me to classify *Sarcophyte* with *Monostyli*, and to reduce the subgenus *Lepidophytum*, which I had proposed, to the previously imperfectly known *Lophophytum*, with which I had doubtfully associated it.

I have also to express my obligations to our ingenious and accomplished foreign member M. Hofmeister of Leipsic, for showing me his drawings of the impregnated ovule of *Cynomorium*, with the pollen-tube in the foramen of the ovule: this, which is the most important discovery in favour of my view of the normal condition of the nucleus of the ovule and function of impregnation in the embryonate species, is also a most remarkable instance of skilful dissection. I am encouraged to hope that M. Hofmeister will take up the subject of the embryogeny of the *Balanophoreæ*, and need hardly add, that from his unrivalled skill as a phytotomist, and extensive acquirements in embryogeny, the subject will receive the fullest illustration at his hands.—December 4th, 1855.

suggested doubtfully by Richard, who however adopted those of "radix," "tuber," and "caulis:" it is the "axis" of Griffith; "rhizome" and "caudex" of Gœppert; "basilar receptacle" of Junghuhn, &c. In mode of origin and development it sufficiently accords with the definition of a rhizome, as usually employed in descriptive botany. In speaking of the root, I wish always to be understood as referring to that organ of the plant upon which the parasite grows.

The simplest and at the same time most frequent form assumed by the rhizome of *Balanophoreæ*, is that of a simple or branched tuber, sessile on the root from which the plant derives its nourishment, and giving off one or more flower-bearing peduncles. In the earliest stage at which I have examined any of the species, the young plant appears as a cellular mass, nidulating in the bark of the root (but partially exposed), with whose cellular tissue its own is in organic adhesion, though easily distinguishable. It offers at first no trace of a vascular system, nor any distinction of parts; but before it has reached the cambium layer of the bark, and before its upper extremity has attained any considerable size, an opaque line of white cellular tissue, different from the rest, may be found in the centre of the mass or beneath each of its lobes, in which vascular tissue makes its appearance. Shortly afterwards, the wood of the root upon which the parasite grows appears to become affected; its annual layers are displaced, and at a still later period vascular bundles, enclosed in a cellular sheath, are found in the axis of the rhizome, and are continuous with those already formed in it. For illustrations of these stages of development see Plates IV. & VI.

Some genera do not present the appearance of any vascular bundles communicating with those of the root-stock; but their own vascular bundles may be traced descending to the line of union between the root and the parasite, where they become closely applied to the vascular system of the former, without, however, forming any interlacement or organic union. Of this, *Lophophytum* and perhaps *Scybalium* are examples.

The fully formed rhizomes are roughly divisible into the simple, or merely forked or lobed, and those which are cylindrical, elongated horizontally and branched; forms which, though exceedingly dissimilar, and associated with very important anatomical details, are not accompanied by such modifications of the floral organs as would afford sectional characters in the Order; as a comparison of *Helosis* with its very near allies, *Scybalium*, &c., proves. The elongated rhizomes of some species form attachments by their ramifications to the various roots they encounter; and such never have foliaceous appendages, except at the bases of the peduncles or flowering branches. The amorphous or simple rhizomes again are often provided with scales (as in *Cynomorium*, *Lophophytum*, and *Sphærorhizon*), or with cellular papillæ (as some species of *Balanophora*). These papillæ consist of simple or divided extruded masses of cellular tissue traversed by a furrow; they are very numerous and cruciate in *B. dioica*, and are probably intimately connected with the aëration or respiration of the plant; they present nothing remarkable in structure, and resemble the rimæ with swollen lips on the spongy bark of some *Menispermeæ*, *Vitis*, and many other plants*.

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* Junghuhn says (Nova Acta, xviii. Suppl. p. 223) that *B. globosa* is a species which he never found bearing these papillæ, except when it grew on the same root with *B. elongata*, when, like that species, it was always provided with them.

The rhizomes in many species attain a considerable age; but it is difficult to ascertain their duration after they have commenced flowering. *Helosis* seems to be capable of indefinite increase; the individual patches of the plant flowering at all or most seasons of the year, and the old branches of the rhizome dying as new ones are formed. In *Phyllocoryne* also, the large many-lobed rhizome seems perennial, and to flower at various seasons. In *Rhopalocnemis* and several species of *Balanophora*, it appears to me as if the rhizome continues to increase for several years; and then, after throwing up many peduncles in one season, to die the following autumn. Others however, as *B. involucrata*, which causes great knots to form on the roots of trees, either live many years and flower perennially, or else a perennial succession of young plants germinate upon the swollen root; a mode of increase suggested by the germinating specimen represented in Plate VI. fig. 8. In *Lophophytum* each tuber-like rhizome gives off only one or two peduncles, and the root on which it grows forms a shallow cup round its base; which I have found to be of many years' growth. *Cynomorium* appears to be decidedly annual, but I have not examined a sufficient number of specimens with the attachment preserved, to decide this point. *Langsdorffia* has certainly a perennial branching rhizome, and *Sarcophyte* a perennial tuberous one. Most of the *Balanophoræ* have lobed or branched rhizomes, which perhaps die after flowering.

In no case is the vegetation of the rhizome very rapid, in comparison with that of many plants; and especially of *Fungi*, with which some authors have compared them. On the contrary, I believe that the growth of all the parts is very slow; and with regard to *Rhopalocnemis* and *Balanophora* especially, I have had many opportunities of observing that the peduncle did not flower for several weeks after its protrusion from the rhizome.

The modes of attachment above indicated suggest another division of *Balanophoreæ*, namely, into—1. those in which the vascular tissue of the parasite is continuous with that of the root; 2. those in which the attachment is by means of the cellular system only; and 3. those in which bundles of vessels from the root terminate definitely in the parasite, a short distance from the point of attachment; the vascular systems of the two plants forming no evident confluence.

Of the first of these classes *Balanophora* and *Rhopalocnemis* are the best examples, from the great development of their vascular systems (which in some species present woody zones, a cortical system, and medullary rays), and from the fact that in many instances bundles of vessels appear to run in unbroken continuity from the woody system of the root to the very flowers of the parasite.

In the species of this first group, the appearance of the parasite having derived all its vascular tissue from the root has given rise to the hypothesis, that the whole production is an abnormal development from the root of the plant on which it grows:—thus Junghuhn quotes Trattinick (Linnæa, iii. p. 194) as saying of *Sarcophyte*, "hasce parasitas degenerationes plantarum specificas, sine seminum aditu creatas, modo spontaneo genitas;" and adds (Nov. Act. Acad. xviii. Suppl. p. 205), "Mihi Balanophorarum vegetatio fungosa est, originaria. Succi arborum, e quarum radicibus vivis sanisque *Balanophoræ* progerminant, nimis copiosi, cursu consueto perturbati, morphosin arboris redundantis, ut ita dicam, RETROGRADAM provocant, atque (directione vegetationis mutata) in novam et matricis naturæ alienam prolem consumuntur * * *." These theories have been well combated by Gœppert, who adduces the fact of the same species of *Balanophora* growing indifferently on various plants of very different natural families, as being quite opposed to them; to which may be added, that they have an independently developed vascular system of their own, which only in some species blends with that of the root; and that they are propagated by seeds.

Griffith does not seem to have traced the vascular bundles of the root into the peduncle of the parasite; for in his valuable paper on *Balanophora* (Linn. Soc. Trans. xx. p. 96), he describes them all as rising from the root into the rhizome, and terminating abruptly in the axis, towards its periphery: this well describes the appearance of those bundles which form the main body of the parasite; and they may be seen in the vertical section given in Plate IV. fig. 20, radiating in a fan-like manner from the root, and terminating in broad truncate masses towards the circumference of the rhizome. In a transverse section again (fig. 19) of a young, symmetrically formed, unbranched rhizome, with one peduncle, the vascular bundles will be found to be much more regularly disposed round a cellular axis, and separated by broad rays of cellular tissue.

Gœppert and Unger both consider that there is a double vascular system in the parasite; the one given off by the root on which it grows, and the other confined exclusively to the peduncle and its appendages, though passing downwards through the axis of the rhizome to within a very short distance of the base of the parasite, and there terminating abruptly.

The result of my own observations on live plants of *Rhopalocnemis* (and which were verified by Dr. Thomson), is that the vascular bundles of the peduncle are so intimately united with those of the rhizome towards the base of the latter, that they are organically one and the same tissue. In illustration of this I will refer to Plate IV. fig. 22, as being taken from one of the simplest and most symmetrical forms presented by a *Balanophora*: in this the letter *a* indicates the union of the vascular bundles of the peduncle and rhizome. Of *Rhopalocnemis* and *Balanophora dioica* I macerated many specimens in all stages of growth, some being in ripe fruit, when the vascular bundles have most consistence; and I never failed in dissecting them out in continuous masses from the bases of the apparent root-branches in the rhizome to the capitulum itself.

The vascular branches that connect the root with the rhizome of the parasite, are altogether analogous to those found in the exostoses of DeCandolle on the roots of various Leguminous plants; and especially such as have been pointed out to me by Prof. Henslow as being frequent on the roots of Laburnum*.

The root itself of the plant on which *B. fungosa* grows, has no pith (Plate VIII. fig. 15); but the branches which it appears to send into the parasite, enclose a pith (figs. 10 & 11 *a*), and the wedges of wood of which these branches are composed become broken up at a distance from the base of the rhizome (fig. 11 *bb*); the branches terminate in cylindrical masses of cellular tissue, enclosing a few imperfect spiral or barred vessels in their axis.

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* These latter are coralloid masses, consisting of a cortical and woody system, the latter provided with obscure medullary rays: as their distance from the root is increased, their branches become simpler in structure, being merely cellular cylinders with a vascular axis or core, the latter consisting of a little pleurenchyma and very imperfectly developed annular and other vessels.

Two forms of attachment are found amongst the genera with branched and much-elongated rhizomes. In *Helosis* the rhizome forms a tuber at each point of its attachment to the various roots it meets with in its subterranean course, and a few vascular bundles from the root are rarely sent into it at these points; but these do not appear to communicate directly with the previously existing vascular tissue of the rhizome, nor to become blended with it: possibly, however, they may have been given off by it, or have been independently formed in the rhizome; a point which can only be determined by examining the nature of the attachment at its first formation, and which I shall hereafter discuss. In *Langsdorffia* the branch of the rhizome corrodes the bark of the roots it encounters; the first contact in the case of *L. rubiginosa* being by means of woolly hairs. Both the rhizome and the root generally swell considerably, but often do not, and the root sends long vascular branches, apparently covered with the cellular bark of the root, right and left into the axis of the rhizome; with whose vascular system, however, I have never found them to form an organic adhesion (see Plate II. figs. 10, 12, 13, 16, 17). In this genus two or more species of dicotyledonous plants sometimes send their roots into one tuber of an old rhizome, each penetrating at several points.

In the Annals of the Vienna Museum (ii. 53), I find *Balanophoreæ* arranged by Unger under three of the divisions, into which all parasites are separated by that author according to the nature of their parasitism; they are the following:—1. Parasites which form a rhizome by which they adhere to the roots of plants, and from which the flower-buds rise. Example, *Scybalium*. 2. Parasites which exercise a powerful specific action upon the root, causing it to send vascular bundles into the rhizome, which hence becomes an organ intermediate in nature between the stock and the parasite. Examples, *Balanophora*, *Sarcophyte*, *Cynomorium*, *Lophophytum*? *Ombrophytum*? 3. Parasites which form a rhizome intimately attached by its vascular tissue to the root. Examples, *Helosis*, *Langsdorffia*.

It appears to me that the above are rather distinctions of words than of facts; and that in so far as they are correct, any one of the three definitions is more or less applicable to all the species: for all form rhizomes, all owe their adhesion to their power of exerting a specific action upon the roots from which they derive their nourishment, and except in the case of *Lophophytum* (and perhaps of *Ombrophytum*, which I assume to have the same mode of parasitism as *Lophophytum*), all more or less present the appearance of the vascular bundles of the root being enclosed in the cellular tissue of the parasite. Further, if my observations are correct, both *Helosis* and *Langsdorffia* should be transferred to the first class; for there is certainly no distinct union of their vascular bundles with those of the root, nor do their rhizomes appear to send any bundles towards the root; on the contrary, the appearance is perfectly distinct of the root sending its branches into the rhizome. *Langsdorffia* indeed is described both by Richard and (apparently following him) Martius, as sending forth root-fibres from its rhizome; but I not only fail to discover these on any of the very numerous specimens I have examined, but I find this appearance to be produced by fibres being given off from the roots of the plant on which the parasite grows, which fibres become included within the rhizome (Plate II. fig. 11).

The differences therefore that prevail amongst the modes of parasitism of *Balanophoreæ*, are of degree only: the power of erosion and of forming an organic adhesion is the main point; that of inducing such a diseased action on the root as gives the appearance of the latter forming growths within the rhizome is a secondary one, and varies in amount; from *Lophophytum*, in which it seems to be none, to *Rhopalocnemis*, in which the bulk of the vessels in the rhizome are confluent with those of the root. As a general rule, the older the root attacked by the parasite, the fewer are the branches which it appears to send into the parasite; and as all my specimens of *Lophophytum* are on very much older and larger roots than are those of any other species, and indeed on wood of many years' growth, it is quite possible that in the case of its attacking younger and feebler roots it may develope the same power.

Under this view, the propriety of considering the rhizome of *Balanophora* and its congeners to be an intermediate body, as suggested by Unger, seems, as Gœppert has pointed out, to be erroneous; indeed, there are stronger objections to it than have hitherto been urged, derived from the development of that body.

I am unable to confirm Gœppert's observations on one extremely difficult point, namely the presence of the two wholly independent and unconnected systems of vascular tissue. This author maintains, 1. that no free vascular bundles originate in the rhizome previous to the formation of flower-buds, but that the root gives off bundles to the rhizome, within which they ascend, prolonging, increasing in diameter, and branching, with the corresponding development of the cellular system of the rhizome. 2. That on the formation of the peduncles (floral organs), free and independent vascular bundles are developed in them, which ascend as the peduncles elongate, and also descend into the rhizome, occupying a position between the vascular bundles of the latter, with which they do not unite. 3. That these independent vascular systems present anatomical characters by which they may constantly be recognized, at any rate in the individual species. These positions I shall examine consecutively, premising that it is with considerable diffidence that I venture to dissent from the conclusions of this eminent author, since though I possess the advantage of having repeated my observations, both on living and dead plants of several species, I cannot regard these as entitled to more consideration than M. Gœppert's known skill and accuracy*.

1. With regard to M. Gœppert's first observation, it must be remembered that he never had the opportunity of examining very young specimens, the importance of which desideratum he fully admits. In the section in Plate VI. figs. 7 & 8, which represents the independent formation of vascular tissue in a germinated *Balanophora involucrata* (and in other similar cases), I find in the axis of the rhizome pale transparent lines consisting of elongated cells, which contain no wax or cytoblasts, surrounding rudimentary vascular bundles. I have never examined a very young specimen in which these bundles were found to have descended to the vascular system of the root, but I infer that they do so, and, becoming incorporated with the vascular bundles of the root, present the appearance

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* The difficulty of investigating these points is further far greater in living than in dead specimens: this is owing to the rapid sphacelation of the parts when cut, and the quantity of viscid Balanophorine (the term applied by Gœppert to the peculiar waxy secretion of *Balanophora*) contained in their cellular tissue, which prevents dissection with any approach to nicety: impediments so great, that I have no hesitation in saying, that in many cases better results may be obtained from specimens preserved in acid or spirits, than from living ones.

of having ascended from it, instead of having descended to it. This union once established, the difficulty of regarding the vascular bundles as originating in the parasite and drawing their nourishment from the root, appears to me less than that of regarding them as dependent both for origin and increase upon a reversed and diseased action of the root. The great theoretical objection to this view is, that the anatomical characters of the vascular bundles of the parasite precisely resemble those of the root, and that in some species they are even found to arrange themselves in the forms of woody plates and medullary rays, enclosing a pith axis, and to be surrounded by a cortical layer (Plate VIII. figs. 10, 11 *a*). It must however be borne in mind, that there is no law more universal in the vegetable kingdom than that vascular tissue is developed according to the requirements of the plant, both as to abundance and kind; and that the formation of a perfect organic cohesion between the walls of the individual cells of the cellular systems of the parasite and root, is in no respect less anomalous than the similar perfect and intimate organic cohesion between their respective vascular systems. As the rhizome increases, the organic cellular cohesion extends with the increased surfaces of the parasite and root, by the merismatic subdivision of the cells of both; and the vascular system increases by the development of pleurenchyma, ducts, &c. from those nucleated cells which are found in the positions in which vessels are required.

In a case of parasitism like that of *Balanophora*, which involves perfect organic cohesion between the individual cells of different plants, it must obviously in many instances be impossible to draw the line between the tissues of the parasite and those of the root on which it grows. With regard to the cellular tissues, however, there is generally no difficulty; for, that of the *Balanophora* containing organic compounds (wax), the line of union is evident; but it is different with the vascular systems, which consist in both cases of tubes of indefinite length, containing no solid organized contents, and presenting an extreme simplicity of form. Again, granting (as we must) that in *Lophophytum* (and in *Scybalium*, according to Unger's observations) the vascular tissue of the rhizome never descends to that of the root, and hence cannot form an organic cohesion with the latter, we must assume an independent origin for it in these genera, at any rate; the application of which to Gœppert's views involves the necessity of concluding that there are two fundamentally distinct principles of development amongst very closely allied species; namely, that the germinating plant of some does form independent vascular bundles (in common with all Phænogamic plants), but that that of others does not. To me it appears more in accordance with the known laws of development, to suppose that the origin of the vascular system is the same in both, but that its after-development is modified in different cases.

In *Langsdorffia*, where the rhizome has certainly a highly developed vascular tissue of its own, and where the root also appears to send branches into the rhizome, although I have never found the vascular system of the latter to unite with that of the root, I cannot but admit that such a union may exist, for the difficulty of dissecting the mixed brittle, woody, and flaccid tissues of this plant is very great.

The last argument which I shall bring forward in favour of considering the vascular system of the rhizome as in its origin proper to the parasite, is derived from the fact of free vascular bundles being formed in the flower-buds or nascent peduncles; which is conceded by Gœppert and all observers, and which is easily demonstrated. Hence, besides the difficulty of reconciling the theory of two origins for the vascular tissue in one plant to any known law, we must also break through the well-established law, that the formation of buds is a repetition of the process of germination.

2. M. Gœppert accurately describes the vascular bundles of the inflorescence as originating in the buds whilst still enclosed within the rhizome; but whereas he figures and describes them as having free terminations, I find them to become confluent with the vascular bundles of the rhizome. To any one versed in the dissection of vegetable tissues it can be no wonder that this is a point almost incapable of demonstrative proof in the solid, opaque tubers of *Balanophoreæ*, which generally turn of a deep brown when first cut, and become black in spirits; whose tissues cannot be torn; and in which the vascular bundles of the peduncle are so delicate, and run in such sinuous courses, that it is impossible so to bisect a plant that these bundles shall be traced continuously from the inflorescence to the base of the rhizome: I have, however, repeatedly found that the appearance of a free termination to the bundles is produced by cutting them obliquely across. A long maceration of the parts, and a careful picking away of the cellular tissues, are the only means I have found available for proving their confluence by direct observation; but at the same time I must confess that, whilst carrying on these dissections in various species of *Balanophora*, and in *Rhopalocnemis*, I have repeatedly changed my opinion, and indeed have on some occasions been almost convinced of the truth of the contrary view to that I have finally adopted, so deceptive are appearances.

In the tuberous *Helosideæ*, and in *Cynomorium* and *Sarcophyte*, the bundles of the rhizome are so unsymmetrically arranged, so much smaller in diameter, and so much more tortuous, that I have hitherto been unable to trace this confluence in them; whereas in both species of *Helosis*, and in *Langsdorffia*, which present the most perfect development of a cylindrical rhizome, the origin of the vessels of the peduncle in those of the rhizome is perfectly evident, and requires little skill in dissection to demonstrate.

3. With regard to the anatomical differences stated by M. Gœppert to exist between the vessels forming the vascular system of the rhizome and of the peduncle, they certainly do not exist in all the species. This is however quite consistent with Gœppert's analysis being perfectly accurate, for it is to be expected both that the vessels of the perennial rhizome should differ from those of the annual peduncle, and that from the form and direction of development of these organs being essentially different (the one chiefly increasing in breadth and the other in length), their vessels would be different also. In *Balanophora* the cellular sheath enclosing the vascular bundles is the same in the rhizome and peduncle (except that the individual utricles are longer in the latter); in both cases the cells are colourless, void of solid contents, and with few dots or markings on their walls; thus always contrasting strongly in appearance with the adjacent parenchyma, which abounds in wax. (See Plates IV., VI. &c.)

In the fully-formed flowering specimen of *B. involucrata* (Plate IV. fig. 1), I find no greater differences between the vessels in the rhizome and those in the peduncle than might be expected in organs so dissimilar in age and proportions. Plate IV. fig. 14. is a transverse, and 15. a vertical section of a vascular bundle from below the capitulum, composed of elongated cells which are more opaque towards the centre of the bundle; lower down in the peduncle they present the same appearance as is represented in figs. 26 and 27, which show vessels from the apices of the bundles in the rhizome. In fig. 22 some vessels of the rhizome, and on the left the base of one of those of the peduncle, are seen: at this part of their course both are regularly banded; which is better seen in figs. 23 and 24, where they are more highly magnified. Every intermediate form of vessel may be found between those represented at figs. 15 and 27; and occasionally in both organs the form of cellular tissue, seen at fig. 25, is found; which appears to be another modification, intermediate between the vascular and cellular, and which, in fig. 23, is placed outside the barred vessels.

In older specimens of *B. involucrata* much larger cylindrical vessels are found in the rhizome, mixed with hexagonal tubes with barred or otherwise marked sides, and bundles of pleurenchyma, which also occur in the peduncle, but in a much less perfectly developed state.

I find considerable uniformity in the microscopical character of the vessels amongst different specimens of *B. dioica*, although these have grown on widely different genera of plants (and the same remark applies to *Rhopalocnemis*); and I do not in any case find a more highly developed tissue in the peduncle than in the rhizome. On a comparison of my dissections of young specimens of *B. involucrata* with Gœppert's of old ones of *B. elongata*, the differences between them are perfectly reconcilable. Gœppert figures barred cylindrical vessels of cellular tissue as occurring only in the peduncle, and larger vessels with short transverse bars as occurring only in the rhizome; this I also find to be the case in old specimens; but in younger ones the barred cylindrical vessels are abundant in the rhizome, and comparatively rare in the peduncle; from which it may be inferred, that the said vessels are an imperfectly developed tissue.

In full-grown specimens of *B. fungosa* (Plate VIII. fig. 12), the same forms, relations, and modifications of vascular tissue prevail to a considerable extent; and the same may be said of other species which I have examined, though less in detail; whence I conclude that the anatomical differences between the vessels of the rhizome and those of the peduncle are dependent on position and degree of development.

The rhizome of the most perfect species of *Balanophoreæ* is decidedly exogenous. If a transverse section of the elongated one of *Helosis mexicana* be taken, the mass will be found to be composed of cellular tissue, enclosing (in the specimen given at Plate XV. fig. 14) a vascular system consisting of seven wedges, which surround a narrow cylindrical axis. Each of these wedges is (on a transverse section) narrow and oblong, and consists of many rows of annulate or transversely barred cylindrical or angular ducts, which occupy the position of the pleurenchyma of ordinary exogenous plants; outside of these is a reniform mass of stout, elongated liber-cells, into whose concave faces the outer ends of the wedges are thrust. Beyond the vascular system is a very thick spongy cellular mass continued to the circumference, where the cells are smaller and denser: this cellular tissue is everywhere interrupted by small masses of thick-walled sclerogen-cells, round which the cells of parenchyma radiate, and which, in a transverse section, resemble scattered liber-bundles. Surrounding the axis is a seven-lobed zone of stout sclerogen-tubes, the lobes of which project outwards as the bases of the medullary rays; and between these lobes lie the axial ends of the vascular wedges. The following is a summary of these characters:—1. The axis is occupied by hexagonal cells, which become vertically elongated and woody (*see* 2.) towards the vascular wedges, and then radially elongated in the medullary rays, and pass insensibly into the membranous hexagonal tissue of the cortical portion: these cells contain grains of starch, and chlorophyll in abundance. 2. The woody tubes forming the outer zone of the axis (which is in many respects analogous to a medullary sheath) consist of long and strong cylindrical pleurenchyma, with much-elongated angular sclerogen-cells: these are all extremely hard, and their walls are perforated by innumerable canals. In old specimens the pith passes gradually into these tissues; its utricles becoming first cubical, with thick dotted or perforated walls; then becoming tubes elongated vertically; which are succeeded by tubes with blunt ends and narrow cavities. 3. The wood consists wholly of scalariform vessels which are cylindrical in young rhizomes, but polygonal with transversely barred or gashed walls in older ones; intermixed in every instance with smaller, more irregular and variously marked or perforated cells and tubes. 4. The liber-bundles consist of large, stout-walled, woody, hexagonal tubes, of great density; their walls everywhere perforated by canals. 5. The isolated sclerogen-cells in the cortical portion in no respect but shortness differ from liber.

Both in arrangement and in anatomical characters this description of the rhizome resembles in most particulars that of the stems of many *Menispermeæ*; and a more close examination bears out this resemblance.

In a transverse section of the peduncle of *Helosis mexicana* (Plate XV. fig. 12), eight symmetrically disposed vascular bundles are seen, and outside of these a few smaller irregularly scattered ones: and, as in *Balanophora*, the anatomical structure of the vessels composing these differs from that of the rhizome only in degree. The bundles consist of a sheath of elongated cellular tissue, enclosing a few fusiform vessels, some scalariform, others with spiral bands or transverse bars, with a few woody tubes and sclerogen-cells; and these may be traced up to the scales of the capitulum, to which scales much stronger bundles are given off than to the flowers.

In the rhizome of *Helosis guyanensis* (Plate XVI. fig. 30) I find—1. The whole pith formed of the same woody vessels as surround the pith of *H. mexicana*; and this both in New Grenada, Trinidad, and Rio de Janeiro specimens; these pass into a muriform tissue of woody tabular cells, which occupy the broad medullary rays, and of polyhedral cells still with very thick walls, in the circumference of the rhizome. 2. The wood is seen in a transverse section to be formed of seven lanceolate wedges of soft, white, scalariform, or spirally unrollable tubes. 3. A very large reniform mass of liber-cells or short tubes is placed outside each wood-bundle, and in contact with it. This does not seem to increase annually, but other and equally large liber-bundles form a zone exterior to these, and alternate with them; as in many *Menispermeæ*. 4. Isolated masses of sclerogen-cells and long liber-vessels are scattered throughout the parenchyma of the periphery.

The peduncle of *Helosis guyanensis* presents innumerable bundles of vascular tissue, composed of sclerogen-cells, spirally marked and scalariform vessels, and a few woody tubes, generally occupying definite relative positions. In a specimen of *H. guyanensis* from

Columbia the medullary system is much more utricular, lax, and membranous; but there are so many modifications of all these tissues in different specimens of the same species and parts of the same specimen, that it would be useless to multiply descriptions of them.

In all the other *Helosideæ* the same vessels are very conspicuous; but owing to the form of the rhizome they are confused in arrangement and variable in amount, frequently presenting no system whatever.

Langsdorffia presents the same exogenous arrangement in its rhizome as *Helosis*, but its axis (pith) is formed wholly of long wood-tubes (Plate II. figs. 5 & 6): its tissues are more particularly described under the remarks on the genus itself; where also its resemblance to the Indian *Balanophoreæ* in its waxy cell-contents is noticed.

Cynomorium has a rhizome which I have never seen to branch, though luxuriant specimens probably do so. The fusiform axis at the base of the peduncle, which is probably not the rhizome, but only the base of the peduncle, presents in a transverse section many small, unsymmetrically disposed vascular fascicles: each of these is composed of—1. towards the axis a bundle of delicate, white, cylindrical and angular, barred or scalariform vessels, or long polygonal cells with variously marked faces:—2. externally to this is a rather broad mass of vertically elongated oblong cells, of equal length; with blunt superimposed extremities, which all meet at the same height; giving this tissue a transversely marked appearance.

The tissues of *Sarcophyte* and *Mystropetalon* present nothing remarkable.

Cellular tissue.—This has been extremely well described in the Java species, by Gœppert, of whose remarks the figures of *B. involucrata* (Plate IV. figs. 7, 8, &c.) are illustrative. The walls of the cells are almost invariably dotted; in some cases owing to pores, and in others to deposits of wax and chlorophyll. Very frequently (and always in young specimens) each cell presents a conspicuous cytoblast, firmly adherent to a discoid spot. At Plate IV. fig. 11. are seen some of the waxy contents of the cells, in the shape of spherical or rounded nuclei of various sizes; full of utricles, which appear to burst, and scatter their granular contents within the cell, which is seen ruptured in fig. 13.

The wax of *Langsdorffia* and *Balanophora* is replaced in most of the other genera by starch-grains: these are especially abundant in *Sarcophyte*, *Cynomorium* and *Lophophytum*, which are in consequence eaten, as are other species occasionally*. The fluids of most of the species are colourless or pale yellow; those of the Indian *Balanophoræ* are quite white, and often very viscid.

I have never observed the appearance of the red cortical layer of the bark of the root, which Gœppert describes as ascending with and surrounding the vascular bundles of the rhizome in *Balanophora*, and which, he adds, contains tannin: it is, however, very conspicuous in *Langsdorffia*, and probably developed more or less in many other species. I have not found the raphides which he describes in the Javanese *B. alutacea*.

Unger calls the elongated parenchyma-cells with cytoblasts, "pseudo-pleurenchyma," and notices their similarity to vessels that occur in *Filices*; and he hence alludes to an affinity between *Balanophoreæ* and Acrogens. Gœppert also, considering that the cellular

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* A chemical analysis of this wax is given by Gœppert, who calls it Balanophorine, and observes that it resembles the wax of *Ceroxylon andicola*.

tissues of *Balanophoreæ* are more uniform throughout the whole plant than in any other vegetables in which so abundant and high a development of cytoblasts occurs, is inclined to refer all Rhizanths to one class, which he would place amongst Acrogens, and near *Filices*. I need scarcely say that these feeble analogies do not appear to me to be of the smallest systematic value; so long as they are unsupported by definite characters, and that any such affinity is negatived by every other point in their structure and development.

The cuticle of *Balanophoreæ* never presents stomata, but is very simple in its structure, and formed of small cells, sometimes however of large vesicular ones, either isolated or in groups; as in *B. involucrata* (Plate IV. figs. 7 & 16): in other specimens clusters of bladdery cells form warts on the rhizome (fig. 16), which are arranged in lobed masses in *B. elongata* and others.

Hairs rarely occur on plants of this Order, though they are abundant on *Langsdorffia tomentosa*, and found on the flowering stem of *Thonningia*: in both genera they are unbranched, cylindrical, rather blunt tubes, with swollen and often bulbous bases, and more or less rough surfaces, and have thin walls and a large continuous empty cavity.

Sclerogen-cells, or *clostera*, abound in most of the species, and always present very thick, woody, perforated walls: they are especially conspicuous in the rhizome of *Langsdorffia*, in the cortical layer of that of *Lophophytum*, and in the leaf-scales of the latter plant, in which they pass into the form of tubular vessels.

Foliar organs.—No species is wholly deprived of these, though in some they are almost absent, and in others represented by scales on various parts of the plant; rarely on the rhizome, and most frequently on the capitulum, where they form more or less perfect bracts. There is, however, no obvious law for their development. In *Cynomorium* and *Lophophytum* they occur on all parts, from the rhizome to the apex of the capitulum. In *Langsdorffia*, *Thonningia*, *Balanophora*, *Scybalium*, and *Mystropetalon*, they are more or less highly developed on the peduncle, and very much reduced on the capitulum: in *Phyllocoryne*, they clothe both the peduncle and capitulum: in *Sphærorhizon*, they occur only at the base of the peduncle, on it, and on the capitulum: in *Helosis guyanensis* they cover the capitulum, but on the peduncle and at its base are reduced to a few small scales; whilst in *H. mexicana*, *Rhopalocnemis*, and *Corynæa*, they are almost confined to the former organ.

It hence appears that their chief development is upwards; the most rudimentary forms occurring on the rhizome at the base of the peduncle, where they compose the bud-scales; the most perfect on the capitulum, where they appear as bracts.

The bud-scales are numerous and imbricating in *Sphærorhizon*, and probably also in *Scybalium*; valvate in *Langsdorffia* and *Helosis guyanensis*; reduced to a volva or ring in *Balanophora* and *Rhopalocnemis*; and absolutely wanting in *Corynæa*. In most of the species the foliar organs are alternate; but in several *Balanophoræ*, in *Langsdorffia*, and *Helosis guyanensis*, those of the peduncle are whorled, and together form a cup; while they are reduced to an obsolete ring in *Helosis mexicana*.

Inflorescence.—The flowers are arranged in a uni- or bi-sexual spherical, oblong, cylindrical, or ovoid capitulum, in all the genera except in those of *Lophophyteæ* and in *Sar-*

cophyte, in which they occur in compound spikes or panicles. However simple these capitula appear, they are invariably found to be compound if examined at an early period of growth, when the bracts or scales imbricate completely over them, and cover definite masses of flowers, representing branches of the inflorescence. *Sarcophyte* presents the most perfect inflorescence, and the only one with a fully branched panicle; it has general bracts on the main axis below each ramification, but no partial ones. *Lophophytum* presents the next degree of perfection in inflorescence: each bract is a very highly developed peltate organ, subtending a cylindrical branch of the main axis, which is covered with flowers:—a modification of this arrangement is found in all the *Helosideæ*, and in *Cynomorium*, where the bracts are peltate and imbricate in a young state, and either peltate and attached by their margins, or scattered, in the older state.

In *Ombrophytum* the flowers are whorled round the pedicel of a very complete peltate bract, and in most *Balanophoræ* the female flowers are similarly arranged round a very rudimentary clavate one. In *Thonningia* and *Langsdorffia* the female flowers have no bracts whatever, and the male flowers very rudimentary ones. *Mystropetalon*, the most highly developed genus in many other respects, has a trifid bract under each flower, and no general bracts on the capitulum.

Articulated filaments occur abundantly over the whole surface of the capitula of most of the *Helosideæ*, and are probably rudimentary female flowers: their similarity to the paraphyses of *Musci* has been dwelt upon by Griffith, who (with some other authors) attaches great systematic value to this resemblance. These anomalous organs will be described under the respective species: analogous ones may be seen in the capitulum of *Langsdorffia*, and between the male flowers of some *Balanophoræ*. For further structural particulars respecting the inflorescence, the individual genera must be consulted.

The periods of inflorescence present some remarkable anomalies in *Balanophoræ*, and especially in the *Helosideæ* with bisexual capitula; a curious phenomenon, first observed by Richard (fully described by him under *H. guyanensis*), which necessitates the agency of dichogamy, or the fertilization of the ovaria of one capitulum or plant by the males of another.

Some genera are constantly diœcious; as *Langsdorffia*, *Thonningia*, *Rhopalocnemis*, *Sarcophyte*, *Lophophytum*, and some *Balanophoræ*; though in *B. dioica*, which is one of the most constantly so of that genus, I have occasionally found male capitula on the same rhizomes with female ones. The inflorescence is bisexual or monœcious, with the male flowers below, in some *Balanophoræ*: the male flowers are above in *Lophophytum* and *Mystropetalon*, and the two sexes are irregularly mixed in *Helosideæ* and *Cynomorium*, which latter occasionally presents also hermaphrodite flowers.

Flowers.—These present many gradations of perfection, both in the male and female. They are most fully developed in *Mystropetalon*, and the least so in the female of *Balanophora* and the male of *Lophophytum*.

The perianth, when present, is almost invariably dimorphous, and most perfect in the male flowers: in those of *Lophophytum* it is wholly wanting, or reduced to two opposite mamillæ alternating with the stamina; in *Thonningia* it consists of three minute scales which at no period cover the stamens; in *Cynomorium* it appears as six linear or clavate scales; in *Rhopalocnemis* it is tubular; in *Sphærorhizon* and *Corynæa* it is tubular below and campanulate above; in *Helosis*, *Scybalium*, and *Sarcophyte* it is tubular below, with three valvate segments; in *Balanophora* solid below, with three to eight valvate segments; in *Mystropetalon* it is irregular and oblique, of one free and two combined pieces, all valvate, and forming a tube below. The æstivation of the perianth is invariably valvate.

In the female flowers of all the genera but *Cynomorium*, the perianth differs very widely indeed from that of the male; as much so as in any Natural Order of plants. It is generally far less highly developed than the male, though more so in *Lophophyteæ* and *Thonningia*. It is assumed to be more or less adherent with the ovary in all the genera, but is perhaps totally suppressed in *Balanophora*, which presents the simplest possible form of female flower. In *Sarcophyte* the ovaries are immersed in a fleshy perianth, and all cohere into a solid capitulum. All the *Distyli* have two confluent ovaria, forming a one- or rarely two-celled pistil, and crowned by a two-lipped perianth; except in the case of *Lophophyteæ*, in which the limb is truncate or suppressed. In *Cynomorium* the six pieces of the perianth adhere to the ovary at irregular heights, being rarely wholly superior or wholly inferior. *Thonningia* and *Langsdorffia* have slender tubular perianths, which are solid below, and bear at their very base a small ovule, which is sunk in the fleshy capitulum: in the latter of these genera the female perianth much resembles the male, and its mouth is sometimes swollen and obscurely three-lobed. The female flower of *Mystropetalon* departs widely from the general type of the Order: the spherical ovary is seated on an oblate disc, and crowned by a small, campanulate, three-lobed, deciduous perianth, which may either be considered as the articulate free limb of the adherent calyx, or as a corolla. Analogy with *Halorageæ*, *Rubiaceæ*, *Compositæ*, &c., suggests the latter explanation, which however is opposed to the fact of there being no double perianth in the male flowers of this genus, or in any other plant of the Order.

Stamina.—The diversity of form so conspicuous in the perianth of different genera of *Balanophoreæ* is shared by the male organs, which agree in no point save the production of pollen. In *Lophophyteæ* the stamen is of the normal form, but only two in each flower, and without any other perianth than two mamillæ: the stamens have a very short filament and a long linear anther. In *Cynomorium* the stamen is solitary and of the usual form, but surrounded by a perianth, and subtended by a rudimentary style: in hermaphrodite flowers it is epigynous, and the filament is stout, attached to the anther by a very small point, and the anther is introrse. *Mystropetalon* presents the next modification, having three free stamens, each opposite a division of the perianth, and being similar to that of *Cynomorium*, but with an extrorse anther. *Sarcophyte* has three free stamens, opposite the valves of the perianth; they have fleshy filaments and adnate subspherical capitate anthers, full of polliniferous cavities. In all the remaining genera, viz. those of *Helosideæ*, *Thonningia*, *Langsdorffia*, and *Balanophora*, the stamens are opposite the lobes of the perianth; they are usually three in number, but vary in this respect; and are more or less confluent, both by their filaments and anthers. The dehiscence varies extremely, as does the number of cells. In all the species of *Balanophora*, *Langsdorffia*, and *Thonningia*, the anthers burst extrorsely, and have two or more loculi, which are confluent or anfractuose in some species of *Balanophora*: in all the *Helosideæ* they burst introrsely, and also by their apices, which decay away, and thus allow the pollen to escape.

The tissues of the anthers present little peculiarity; that of the connective is simply cellular, without any of the spiral vessels or beautiful modifications of banded or annulate cells, so conspicuous in the endothecium of many plants. It is frequently lined with a pulpy mass of mucilaginous filaments of excessive tenuity, which appears to be the remains of the tissue amongst which the pollen-cells were elaborated.

The pollen of various species has been carefully described by Gœppert, Griffith, and others, and presents nothing remarkable: it is generally spherical, often 3-lobed or 3-nucleate; in *Mystropetalon* it is polygonal. The surface of the extine is occasionally minutely granulated. Impregnation is probably mainly effected by insect agency, and at night; for during the day there is a singular want of insect life in the still, humid forests frequented by the species of *Balanophora*. I have, however, failed in many attempts to trace insect action; and a small *Acarus* feeding on the pollen of the monœcious *B. involucrata* is the only one I have found to be concerned in the operation, and that no doubt quite accidentally. The necessity of cross impregnation is manifest in the *Helosideæ*, as indicated by Richard, and elsewhere explained in this Essay (under the genus). The fact of insects forming a nidus in the fleshy plants of this Order, has been used as an argument in favour of insect action assisting in impregnation; but the same might be applied to any fleshy fungus or fruit.

Ovaries.—These vary in number, from one in the *Monostyli* and *Sarcophyte*, to two in the *Distyli*; and, according to Endlicher, to sometimes three in *Helosis* and *Scybalium*. When there are more than one, they are congenitally coherent, enclosed within the adherent perianth, and all the cavities but one are suppressed (being rarely present, according to Endlicher and Schott, in some flowers of *Helosis* and *Scybalium*), whilst the styles invariably remain, and are equal, and symmetrically disposed (right and left to the axis) at the summit of the perfectly symmetrical one-celled ovary. In those species which have a perianth, it may be traced surrounding the ovary, if examined before the latter begins to swell, and at all periods in some species; in most, however, the walls of the ovary become indurated, and blend insensibly with the adherent perianth, whose limb however generally remains, as the two-lipped calyx of the *Distyli*: in the *Lophophyteæ* it is truncate and suppressed; and in *Cynomorium*, *Mystropetalon*, and *Sarcophyte*, its structure has been already explained. Amongst the *Monostyli* the ovary is always one-celled; and in *Langsdorffia* and *Thonningia* it is enclosed in a very evident perianth. In *Balanophora* there are not even rudimentary traces of a perianth.

The style varies considerably in the Order. In *Balanophora*, *Langsdorffia*, and *Thonningia*, it is reduced to its simplest form, namely a cellular column composed of a very few oblong cells surrounding a soft, pulpy, stigmatic tissue; the latter does not form a distinct stigma, and the termination of the style scarcely differs from any other part of that organ. The pollen appears to take effect anywhere towards the apex of the style, and I have found pollen-tubes in the axis of the style. In the *Distyli* the style is usually capitate, and rather more perfect than in the *Monostyli*, terminating in a few larger, often globular cells. After impregnation, the walls of these cells, when very highly magnified, appear minutely wrinkled on the surface. The long single style of *Mystropetalon* terminates in a clavate or capitate, and evidently 3-lobed stigma. *Sarcophyte* has a sessile, broad, discoid stigma. The style of *Cynomorium* is more complex than in any other species, and terminates in a 2-lobed stigma; it is provided with two vascular cords and a central groove occupied by stigmatic tissue:—a detailed account of it will be found in the remarks upon *C. coccineum.*

In all the above-mentioned plants the cellular tissue of the ovary is very loose, consisting of oblong utricles, usually furnished with cytoblasts, and without any vascular tissue in its walls (except in the style of *Cynomorium*): there is, however, a manifest approach to vascular tissue in the woody cells of the superior perianth of *Thonningia*, and perhaps also of *Langsdorffia.*

Ovule.—This is invariably solitary, and pendulous from the summit of the cavity of the ovary. In both *Monostyli* and *Distyli* its insertion is so near the very centre of the cavity, that I cannot detect any deviation in its position from the axis of the ovary; nor in the *Distyli* do I find it to be placed nearer to one of the styles than to the other.

The earliest appearance of the ovule of *Balanophora* is as a solitary cell, protruded from the wall of the ovary: its subsequent stages I have followed to some extent in *B. involucrata*, though, owing to the rapid sphacelation of the cellular tissue of the ovary immediately after opening it, and the extreme minuteness of all the parts, the analysis is one of great delicacy, and proportionately liable to error.

Plate V. figs. 11 & 12. represent an opened ovary of *B. involucrata*, showing a very young ovule, consisting of a delicate hyaline sac suspended almost immediately below the insertion of the style, and containing two free spherical cells, each full of fluid and covered with opaque spots, which are probably cytoblasts. I found it impossible to detach the ovule, or to view it, except *in situ*, and by transmitted light. The formation of cells proceeds with great rapidity within the sac, but I was unable to trace their evolution. The resemblance between the cells thus developed, and those in the embryo-sac of ordinary ovules, is obvious, and it suggests the possibility of the ovule being reduced to an embryo-sac. I could obtain no clue to the period at which impregnation is effected, nor to the particular action of the pollen-tubes, which I never found within the cavity of the ovary or ovule*: nor could I trace on any part of the surface of the ovule, any indication of a chalaza, raphe, or foramen, at which impregnation is probably effected. After the ovule has swelled, so as to fill the cavity of the ovary, it adheres by means of its membranous coat to the walls of the ovary; at which time it consists of a dense opaque mass of cohering hexagonal cells.

The ovule, as thus described, does not materially differ from that of *Viscum*, as described in Decaisne's admirable memoir on that plant (Mémoires de l'Académie de Bruxelles), except in being more simple; the ovule of *Viscum* consisting of an embryo-sac covered by a delicate cellular membrane (the tercine of Mirbel), and the greater portion of the substance of its nucleus being undeveloped. Regarding *Balanophora* as presenting the most reduced form of ovule, *Loranthaceæ* are a step higher, and from these the passage is direct to the naked nuclei of *Santalaceæ* and their allies, of *Corneæ*, *Caprifoliaceæ*, *Rubiaceæ*, *Umbelli-*

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* But which M. Hofmeister has observed in the ovule itself of *Cynomorium*.

feræ, and some others; and from these, through the single-coated ovules of *Menispermeæ,* many *Monocotyledones,* and other Orders, to the double-coated ovule of most Phænogams, and lastly to the three ovular integuments of *Gnetum.*

This rudimentary ovule can by no means be compared to the archegonium of a moss; nor does the reduction of the ovule to its simplest form argue any alliance between *Balanophoreæ* and *Cryptogamic* plants. The affinity which Griffith endeavoured to establish, is in this respect founded upon erroneous views of the origin and development of the ovule of *Balanophora,* with which he was not acquainted; and the development of this reduces the grounds of the argument to a casual external resemblance, or rude analogy, between two organs which are not homologous, and have no similarity of origin, structure, or function.

I very much regret my having been unable to trace the development of the ovule in any of the three embryonate and albuminous genera, *Sarcophyte, Mystropetalon,* and *Cynomorium*; and can only suggest that in them the albumen is endospermic, or developed within the embryo-sac, and not in the substance of the nucleus. The position of the radicle in *Mystropetalon* being close to the hilum of the seed, suggests the probability of the ovule being anatropous, and hence somewhat more complex than its congeners; whilst the lateral position of the embryo of *Cynomorium* is consistent with an obliquely pendulous ovule. Until, however, we become acquainted with the process of impregnation or the development of the ovule or the albumen, we have no materials for forming an opinion on the real nature either of the ovule or the seed. I have repeatedly dissected half-grown ovules of *Cynomorium* preserved in spirits, but never found a trace of any coats to the ovule, which always appeared as a membranous sac, full of cells as in *Balanophora,* and amongst which cells one is free, and from it the embryo is developed.

M. Weddell (Ann. Sc. Nat. sér. 3. v. 14) has also considered the ovule to be an embryo-sac, but he makes this opinion depend upon views of the nature of the ovary, style, stigma, and perianth, so different from my own, as to render our accordance upon this individual point purely accidental. I shall return to this subject after describing the seed.

Seed.—There are two types of seed in this order; the embryonate, and what has been called by various authors the exembryonate, and which has been described as consisting of a homogeneous or sporuliferous mass. The only known embryonate genera are *Cynomorium, Sarcophyte,* and *Mystropetalon.*

The seed is always pendulous from the summit of the cavity of the pericarp. The excessively thin testa contracts an intimate but not organic adhesion with the walls of the generally crustaceous endocarp, and is always so closely applied to the surface of the seed that it cannot be detached. This structure is very frequent in various Orders of Exogens, as in *Gunnera,* whilst there is a manifest tendency to it in *Araliaceæ, Boldoa* (a South American genus of *Monimiaceæ*), and other plants. In the exalbuminous species the substance of the seed is uniformly cellular; the cells, which are loose in the ovule, and fill the cavity of the pericarp previous to the swelling of the seed, become densely packed, probably from the cavity being limited in size, and its walls indurated before the seed has arrived at its full growth. When ripe, the seeds of most are densely corneous, especially towards the periphery. The comparison of the seed to a loose cellular mass, so frequently made by authors, probably in all cases arises from their having only examined immature specimens.

The individual cells of the homogeneous embryo are angular, with very thick transparent walls, and small cavities filled with a few chlorophyll-granules. I have never found starch in the embryo of any species; the contents of their cells being browned by iodine. Oil abounds in the exalbuminous species, and in the embryos of *Cynomorium* and *Mystropetalon*.

Hitherto the true nature of the exalbuminous, so-called exembryonate seed of *Balanophoræ* has eluded all research; nor till its germination has been traced*, is it probable that this point will be satisfactorily cleared up. In the mean time it may involve less of hypothesis to assume that the embryo is a homogeneous mass, in so far as any evident distinction of cotyledons and radicle is concerned, than to regard it as an albumen in which the embryo has not yet been discovered. Much may be said on both sides of this question; for instance, analogy with *Cynomorium*, in which the embryo is oily and the albumen not so, is in favour of the seed of *Balanophora* being considered to be embryo; on the other hand, if the cellular ovule of *Balanophora* so perfectly resembles the embryo of *Cynomorium*, it appears reasonable to conclude that the albumen of *Cynomorium* is endospermic, and developed in the same delicate sac with the embryo itself; against which view there appears no theoretical objection†.

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* Impressed with the great importance of this point, I endeavoured, when in India, but uniformly in vain, to induce the seeds of *Balanophora* and *Rhopalocnemis* to germinate.

† Amongst the many Natural Orders whose homogeneous seeds or embryos present more or less analogy with those of *Balanophoreæ*, none have so close a similarity as those of *Triurideæ*. I have examined a species of this Order in a living state in the Khasia Mountains (East Bengal): its ovule (which has not hitherto been described) is manifestly anatropous, and consists of one integument and nucleus; offering one out of many proofs that the structure and position of the ovule in no degree influence the after-development of the embryo: in other words, that the development of the embryo, so far as its form and structure are concerned, is in a great measure irrespective of the presence or absence of envelopes to the embryonary sac.

Mr. Miers, in his valuable and elaborate paper on *Triurideæ* (Linn. Soc. Trans. xxi. p. 51) considers that it is consistent with the simplicity of the structure of other parts of the plants belonging to that family, "to expect a nucleus equally simple in its nature, formed merely of an aggregation of cytoblasts, which, under favourably-exciting circumstances, are endowed with the faculty of self-development." The true nucleus of the ovule in *Triurideæ* is however in no way different in structure or position from that of ordinary Phænogamic plants, from which it follows that although the embryo appears amorphous, its radicular extremity must be a determinate point with relation to the seed, and that in germination that end will elongate, and perform the function of the roots. The term "Protoblastus," therefore, as indicating an embryo that germinates from no determinate point, cannot under this view be adopted for that of *Triurideæ*, though, if it were proved that the germination of *Balanophoræ* (the structure of whose ovules does not reveal the position of the radicle) were from an indeterminate point, it might be more applicable to them. In both *Cynomorium* and *Mystropetalon* however, the radicular end of the embryo is very evident, and as there can be no doubt that the embryos of most or all *Balanophoreæ* germinate whilst still within the pericarp, it may be inferred that the radicle will protrude from a given ruptured point of the latter, and not indifferently through any part of its walls. Under these circumstances, I hesitate to adopt a term, which, in the present state of the inquiry, and as far as regards this order, implies, not that the germinating point is indeterminate, but that this, and the whole process of germination, are absolutely unknown.

With regard to other embryos which would come under the definition of a Protoblastus, that of *Orchideæ* evidently germinates from a given point; and Caspari's beautiful observations on *Orobanche* show that the same is the case in that genus. Blume describes the embryo of *Amorphophallus* as throwing out plumulary leaves from several points at once, which probably indicates a development of several much-reduced internodes crowded together, Richard (Mém. du Muséum, viii. p. 429), and latterly Lindley (Veg. Kingd. p. 85), have assumed the seed to be embryonate in all *Balanophoreæ*; arguing from that of *Cynomorium*, which both well understood; and I at one time adopted the same opinion, being much influenced by the fact that in certain plants with densely fleshy albumens, formed of large coherent cells, the embryo scarcely exceeds one such cell in bulk, and often eludes a very careful search; as that of *Mystropetalon* escaped Harvey, Griffith, and others. Yielding, however, to the mass of evidence in favour of the absence of any visible embryo within the seed of *Balanophora* and of all the *Distyli*, I am now inclined to agree with Griffith (Linn. Trans. xx. p. 93) in considering the embryo as a homogeneous mass, or "indivisus albuminiformis."

Endlicher (Meletemata, p. 9; and Gen. Pl. p. 73) describes the seed as a nucleus, "nucleo e tela cellulosa, massa sporacea farcta, conglobato," and adds that the testa is coriaceous, hard or subosseous, evidently mistaking the endocarp for a testa. Blume (En. Pl. Jav. i. p. 87) seems to have taken a similar view of the contents of the seed. Junghuhn, an ingenious and acute observer, says (Act. Acad. xviii. Suppl. p. 205), "Semina nulla adsunt; quod (supra) ovaria salutavi, vix nisi analoga sunt germinum plantarum perfectarum quæ nunquam maturescunt, sed more fungorum putredine pereunt." Trattinick also (Linnæa, iii. p. 194) says, under *Sarcophyte*, "that these plants are not developed from seeds, but are specific degenerations of the plants on which they grow."

Gœppert (Nov. Act. *l. c.* p. 257) considers that *Balanophoræ* grow from seeds, and describes these as "nuda exembryonata;" and Nees von Esenbeck (Nov. Act. *l. c.* p. 225) calls them acotyledones of a high class.

Liebmann (Proceedings of Assembly of Scandinavian Naturalists at Christiania) says of the seed of *Langsdorffia hypogæa*, that it is intermediate in character between a cryptogamic spore and a naked seed.

Martius (Nov. Gen. et Sp. iii. p. 186) regards the seed as an embryo, and states that he has seen small fibres given off from its basilar end, like rootlets; an observation not hitherto confirmed.

I have reserved to the last the discussion of M. Weddell's views, because they differ from those of other authors, and are based upon a comparison of an extensive range of organs, which cannot be considered separately; they are published in a paper read before the Société Philomatique of Paris, and more at length in the 'Annales des Sciences Naturelles' (sér. 3. xiv. p. 166): they especially refer to the relationship between *Balanophoreæ* and *Rafflesiaceæ*, and may be thus summed up:—

1. "The so-called fruit of *Balanophoreæ* is constructed on the same plan as the seed of *Rafflesiaceæ*; the so-called styles, which are almost always observable on that organ before its maturity, are appendages of one of the essential parts of the ovule. The fruit of *Balanophoreæ* must hence be regarded as a naked seed."

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but all belonging to one axis. In Griffith's admirable paper on *Ambrosinia* (Linn. Trans. xx.), an extremely anomalous embryo is reduced to the ordinary type by a careful study of development and germination, and it is shown that though its parts are undistinguishable at first sight, each has its functions defined. It is remarkable that Griffith has not alluded to the strong resemblance between the embryo of *Ambrosinia* and the bulbils formed on the deformed inflorescence of several species of its near ally, *Remusatia*.

2. "The so-called flower of *Rafflesiaceæ* may be regarded as an inflorescence; the pericarp of the fruit is a receptacle, of which the folds form the placentæ."

It is not my intention to discuss the second of these propositions*, and I therefore confine myself to the first. In his descriptions M. Weddell states that the female reproductive organ of *Balanophora* is the nucleus of an ovule, and that of *Cynomorium*, *Helosis*, *Ombrophytum*, and *Sarcophyte*, a nucleus surrounded by a peculiar envelope, which is not a perianth, but is formed from the axis, and is to a certain extent analogous to the integuments (pericarp) of ordinary seeds: he was led to this conclusion by a comparison of the fruit of *Balanophora* with the seed of *Rafflesia*; and adds, that there is no more fundamental difference between the pericarp with its anfractuous cavity, of *Rafflesia* or *Hydnora*, and the convex or peltate receptacles of *Balanophora* or *Ombrophytum*, than there is between the receptacle of a fig and that of a mulberry.

In support of these views, Weddell contrasts the fruits of *Rafflesia* and *Balanophora*, and of *Hydnora* and *Sarcophyte*; but the comparison being maintained by the employment of the same terms for organs that do not appear to me to be homologous, the similarity becomes one of words, and not of facts. The term "styliform processes," for what other authors consider the styles of the ovary, and which analogy suggests to be such, appears to be the most anomalous; and by describing them as almost always present in *Balanophora*, it is implied that they are sometimes absent, which I have never found to be the case.

In commenting upon Griffith's theory that there is an analogy between the pistil of *Balanophora* and the pistillidium of *Musci*, Weddell points out that Griffith is in error in describing the styles as perforate, and adds in a note, "On reaching the periphery of the capitulum, this styliform process becomes eroded at the apex, when its internal cavity communicates with the external air: consequently the styliform process, being bathed in a mucous fluid that surrounds the capitulum, is exposed to the action of the fovilla of the pollen, which is mingled with that fluid, and fecundation is thus effected." In proof of this it is added, that in some diœcious species of the Order, which do not secrete this fluid, the ovules remain sterile; such at least being the case with *Langsdorffia* and *Helosis*.

Weddell is right with regard to the imperforation of the style, for at no period do I find an open canal in the style either of the American or Indian species; but neither do I find any erosion, or other arrangement of the organs by which I can conceive an erosion to be effected. The only fluid exudation I have seen on *Balanophoreæ* was a limpid watery one, on old capitula of *Rhopalocnemis*, after they had been removed from the ground; and this is a diœcious species, which was then in ripe fruit.

Lastly, the structure of the hermaphrodite flowers of *Cynomorium* (which M. Weddell was not acquainted with) is conclusive against the pistil being regarded as a naked ovule.

Affinities of BALANOPHOREÆ.

Polymorphism and an extreme simplicity in every organ are the prominent features of

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* No explanation of the staminal apparatus in *Rafflesia* is given that is at all consistent with this view; and this therefore, as well as the presence of a discoid stigma, is adverse to the theory. Also, it is not shown how, if the seeds of *Rafflesia* are truly naked, the pollen is applied to the nuclei.

this Order, when surveyed in a structural point of view; and were value to be attached to the fact of every organ appearing in a most degraded state in one or more of the species, *Balanophoreæ* would rank low in the system of Phænogamic plants. If however we disregard imperfection, and inquire what organs are wanting in the Order, we shall find that, with the exception of terrestrial roots, all are present which are necessary to justify their being placed amongst Phænogamic plants.

The arguments which have been used to exclude *Balanophoreæ* from Phænogams, all appear to have originated on the one hand in mistaking feeble analogies between the forms of organs that are not homologous, for affinities; and on the other, in overlooking a multitude of positive characters. These arguments may be summed up as being:—

1. An erroneous view of the nature of the seeds, by Endlicher, Martius, Blume, and others, who describe them as a sporuliferous mass; a term which, even were it applicable, has no meaning.

2. An erroneous view of their origin being in a diseased state of the plants they grow upon; adopted by Junghuhn and Trattinick.

3. A supposed similarity in appearance to *Fungi**, and an erroneous idea that their appearance is meteoric, and their growth rapid; a theory advocated by Endlicher, who (Meletemata, p. 5) says of the horizontal rhizome of *Helosis* and *Langsdorffia*, "mycelio Fungorum quam maxime analogum."

4. The resemblance between the articulated filaments on the capitula of the *Helosideæ*, and the paraphyses of *Musci*; and between the pistilla of *Balanophora*, and the pistillidia of *Musci*; strongly advocated by Griffith and Lindley.

5. The resemblance of the cellular and vascular tissues in some of their characters to some of those of *Filices*; as indicated by Unger and Gœppert.

6. A very peculiar view of the nature and relations of the parts of the female flower, entertained by Weddell; who hence considers *Balanophoreæ* (together with *Rafflesiaceæ*) to approach nearer to *Gymnosperms* than to any other group of plants.

It would be fruitless to discuss these opinions at length; for it cannot be doubted that, had the authors who advocate them been sufficiently furnished with specimens and facts, they would never have been entertained. On the other hand, it is not easy to account for the little importance attached by so many good botanists to the positive evidence afforded by the presence of sexes, the perfection of the essential organs of the male flower in all the species, the total dissimilarity in structure and function between the female organs of all the species and those of Cryptogams, and their identity of structure in all essential points with those of other Phænogams.

With regard to the union of *Balanophoreæ* with *Rafflesiaceæ*, into one great class of Phænogams, equivalent to *Monocotyledones* or *Dicotyledones*, the arguments brought against it by Brown and Griffith are conclusive. Not only have these Orders no characters of systematic value in common, either physiological or structural, except parasitism, but they present positive evidence of widely different affinities; which in the case of *Rafflesiaceæ* have long been recognized. Thus, Linnæus himself referred *Cytinus* to *Asarum*; and Brown, Brongniart, and Griffith have all placed *Rafflesiaceæ* in close

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* I may mention here that the species I have examined never became putrescent.

proximity to *Aristolochiæ*, an Order with which *Balanophoreæ* have not the slightest affinity. The arguments employed by Blume, Endlicher, Lindley, &c., for combining these Orders into one group, are also employed for removing both from Phænogams; the strongest reason for allying them being, not that they present characters in common, but that neither of them is considered to be allied to any other known Order of Phænogams.

Of the authors who consider *Balanophoreæ* to be Phænogamic, the majority refer them to *Monocotyledones*; Richard, and others following him, placing them in the neighbourhood of *Aroideæ*.

Griffith places them in *Dicotyledones*, and suggests their being the homogeneous embryonate group of *Urticeæ*; to which the structure of the *Distyli* is quite opposed: nor indeed does he endeavour to support this hypothesis by any arguments, but merely throws it out as a suggestion.

In my opinion, the arrangement of the vascular bundles in the rhizomes of *Helosis* and *Langsdorffia* is sufficient evidence of these plants being exogenous; for these, as I have elsewhere shown, are altogether exogenous, differ little from the stems of *Menispermeæ* and other anomalous, but still undoubted, Dicotyledons, and resemble no known Endogen in structure or arrangement.

In endeavouring to determine the affinities of *Balanophoreæ*, I shall disregard the negative characters, as those may be termed which are founded on the imperfection of organs; and I shall take the most perfectly developed species, as the best expositors of the typical structure of the Order. In so doing, I believe I am obeying a maxim supported by an attentive study of the natural system; for there are few Natural Orders, however perfect, that do not present structurally incomplete genera or species, many of which in point of development of their organs might rank below many *Balanophoreæ* and some Cryptogams; but which, nevertheless, are not departures from the type of their Order, but simply less developed forms of it.

Balanophoreæ have an adherent perianth in all the genera where this organ is developed, and an epigynous stamen in *Cynomorium*, the only species in which hermaphrodite flowers occur. These characters indicate a position amongst the epigynous *Calycifloræ*; a group which, though far from being well limited as a natural class, is in our present state of knowledge one of considerable value, as comprehending many nearly allied natural families. Amongst them, the most direct relation of *Balanophoreæ* is certainly with *Halorageæ*, and especially *Gunnera*; with which it presents many important characters in common, especially the valvate perianth and stamens opposite its lobes, and near which I would place it in the linear series.

A detailed comparison of the individual organs of a family so eminently polymorphous, with those of its allies, can alone establish its affinities: the more conspicuous of them are:—

1. Between *Cynomorium* and *Hippuris*, in the one epigynous stamen, on an ovarium consisting of one carpel with a solitary pendulous ovule and simple style.

2. Between the *Distyli* and *Halorageæ* a relation is established through the Australian genus *Loudonia*, which is a very peculiar form of the latter Order, having four styles, and

only one cell to an ovarium containing one or two pendulous ovules. This tendency to suppression of the ovaria, combined with the constant presence of their styles, and the styles of the suppressed ovaries being in all respects similar to that of the developed ovary, and equally perfect, is a very peculiar character, frequent in the *Halorageæ*, though not absolutely confined to them: it is very conspicuous in *Gunnera*. The greater tendency to imperfection in the female than in the male flowers of *Halorageæ*, is also a marked feature shared by *Balanophoreæ*.

3. Between *Gunnera* and *Lophophytum* the affinity is so close that the female flowers of these genera might be mistaken for one another; and the male flowers of *Lophophytum* in their two stamens, linear anthers and basal short filaments, are absolutely identical with those of several species of *Gunnera*: in the subgenus *Misandra* especially, the male flower often consists of two small sessile calyx-lobes, with two alternating stamens.

4. If the female inflorescence of *Gunnera* and *Lophophytum* be compared, the affinity may be very easily pursued: in each, short conical branches of the flower-head project laterally from a stout axis, and are subtended by a large bract, and studded with a dense mass of flowers, which consist of an adherent perianth, no trace of rudimentary stamens, two styles, and a one-celled ovary, with a pendulous ovule, whose integument, in ripening, contracts an adhesion to the inner wall of the cavity.

5 The tendency to a dimerous or tetramerous arrangement of the parts of the flower, so conspicuous in all *Halorageæ*, and in *Gunnera*, is common to the *Helosideæ* and *Lophophyteæ*.

Griffith has suggested an affinity between *Mystropetalon* and *Loranthaceæ*, founded on the form of the male perianth, and the opposition of the stamens to its lobes; but this is not borne out by the female flowers, which must be considered of the highest importance in establishing affinities. Griffith further was ignorant of the true structure of the seed of *Mystropetalon*, and supposed that the genus had no relationship with *Balanophoreæ*. After much consideration, however, I have included that genus in this Order, for reasons appended to some notes upon its structure; and in which view I am likewise following that taken by Mr. Brown (Linn. Soc. Trans. xix. p. 233, in note).

I have not dwelt upon the character afforded by the extreme dissimilarity of the sexes of *Balanophoreæ*, and which is also conspicuous in *Gunnera* and *Halorageæ*; because it is common to many other Orders, and indeed is perhaps a very constant accompaniment of reduction in structure, or of a normally imperfect development of the floral whorls.

Amongst the objections that may be urged against associating *Balanophoreæ* with the epigynous *Calycifloræ*, the strongest will probably be considered to be derived from the habit, and the imperfection of the foliar organs: with regard to the former, it appears wholly valueless, as will be proved by a cursory inspection of many Orders; and of these none are so conspicuous as *Halorageæ*, which, for its extent, is one of the most polymorphous in the vegetable kingdom, and further, one consisting for the most part of reduced forms of *Onagrarieæ*.

The extreme simplicity of the structure of the seed and ovule is another point of some importance, and may be used as an argument against the alliance I have proposed; but there is a manifest tendency to such imperfection in the epigynous *Calycifloræ*, especially amongst *Corneæ*, *Loranthaceæ*, and several other Orders in which the ovule is reduced to a nucleus. The homogeneous embryo is (as indicated by Brown and Griffith) a form of that organ which, if taken alone, appears to be of little value in a systematic point of view; for it occurs in various genera belonging to natural families which have, typically, highly developed embryos; and this argument is further weakened by the fact of *Cynomorium*, *Sarcophyte* and *Mystropetalon* having very obvious embryos immersed in albumen.

To parasitism, as a character of systematic value, I need scarcely allude; its invalidity being universally conceded.

As an Order, *Balanophoreæ* may in one sense be considered a strictly limited one, not passing directly into any other, except perhaps through *Gunnera* into *Halorageæ*; and forming a sufficiently natural assemblage of species, though, owing to causes I have repeatedly dwelt upon, not easy of exact definition. Putting aside any consideration of its relationship with other Orders, and regarding it *per se*, it is not easy to say whether it should abstractedly be considered as ranking high, or the contrary. Assuming that the conventional definition of perfection in use amongst zoologists is applicable to the vegetable kingdom, and which argues that a high degree of specification of organs and morphological differentiation of them for the performance of the highest functions, indicates a high rank, *Balanophoreæ* may in some respects be considered to hold a very high one. Thus:—

1. The monœcious and generally diœcious flowers show that either a whole plant, or a considerable portion of it, is specialized for each sex.

2. The great difference between the perianths of the sexes indicates a very high degree of morphological differentiation for each special function or sex.

3. The deviation of the parts composing the perianth of all the species from the common leaf-type indicates great differentiation.

4. The cohesion of the parts of the perianth in the male flower is a further deviation from that theoretical simplicity which assumes the leaves composing the floral whorls to be developed free from one another.

5. The cohesion of the anthers and filaments in most of the species is a further instance of specialization of the same nature.

6. The adhesion of the perianth of the female flower to the ovary shows its special adaptation as a protecting organ to be carried to the highest degree.

7. If it is safe to assume that either of the two perfectly equal and similar styles of the group *Distyli* is capable of conveying pollen-tubes to the solitary ovule, we have here a very remarkable case of specialization; for these two styles undoubtedly belonged originally to as many ovaries, though finally specialized for the use of one only.

As however is the case in all theoretical inquiries which are not based upon fixed principles, so in this as to the comparative rank of *Balanophoreæ*, there is much to be said on both sides. The reduced axis, the imperfect vascular system, the absence of leaves in many of the species, and their reduction to scales without stomata in the remainder, together with the invariable absence of a corolla, and of integuments to the ovule, are all evidences of a very low development. Whatever difference of opinion there may be as to the position of *Halorageæ,* of which I regard them to be reduced forms, it cannot be disputed that amongst Phænogams there are few groups so uniformly incomplete as regards the normal complement of organs, or the arrested development of those organs which are present. The value of this consideration is however much diminished by the fact, that there are no limits to the suppression of organs in the individual genera of Orders which are, nevertheless, typically highly developed.

In a systematic point of view, the value of these suppressions in the Vegetable Kingdom diminishes to a great extent in ascending from the root towards the ovary: thus, the absence of a root of the ordinary structure, and the adaptation of the lower portion of the stem to a parasitic attachment, occur in six or seven natural families of Exogens which are normally terrestrial, and perhaps in many more. A total absence of leaves, or a reduction of them to minute scales, occurs in many natural families. A reduction of the whole plant to a leafless, single- or few-flowered stem, is found in many parasites, and in *Orchideæ, Burmanniaceæ, Ericeæ, Scrophularinæ, Triurideæ, Rafflesiaceæ, Gentianeæ,* and other families which have no mutual affinities; whilst the reduction of the inflorescence to a single flower, and the parts of the latter to its essential organs, is too frequent to need specification. That of the embryo to a homogeneous mass is found in various genera, as indicated by Brown and Griffith: the reduction of the ovule to an embryo-sac is however, in the present state of our knowledge, almost peculiar to *Balanophoreæ.*

As regards the including the *Monostyli* and *Distyli* under one Natural Order, these are so manifestly different, that it is a theoretical question how far, were there more genera of each, or had they a widely different geographical distribution, they would by common consent have been united into one natural family: and the same argument might indeed be applied with equal force to the removing *Mystropetalon* and even *Cynomorium.*

It is difficult to indicate any particular genus of *Balanophoreæ* which can be considered typical of the Order, though *Cynomorium* may be taken as such for the *Monostyli,* and *Helosis* for the *Distyli. Mystropetalon,* though in many respects the most perfect genus of the Order, cannot in any degree be considered typical of it; for it departs far more widely from the prevalent structure of its allies than any other genus does. Our ideas of what is or is not typical, are, however, vague and arbitrary; the ideal type being either the prevalent form of the group, or that which unites most of the peculiarities which distinguish it, or that which possesses the fullest complement of organs united in one individual, or that in which these are most complex, as well as specially adapted to the functions they perform.

Classification of BALANOPHOREÆ.

In the following arrangement of *Balanophoreæ,* I have been chiefly guided by the structure of the female flowers, which are generally found to afford the most important characters for systematic purposes.

The primary division into *Monostyli* and *Distyli* was proposed by Griffith (Linn. Soc.

Trans. xx. p. 103); who however erroneously refers *Rhopalocnemis* (*Phæocordylis*, Griff.), of which his specimens appear to have been imperfect, to the *Monostyli*. The genera of each group are all more nearly related to one another than to any of those of the other group; and such a division is therefore perfectly natural: but there are, notwithstanding, such very great differences between the members of each group, that the genera of *Monostyli* especially have all characters of far more than generic value, and may well be conceived to be types of very distinct assemblages of genera. This is not so much the case among the *Distyli*, for the two genera of *Lophophyteæ* are very nearly related, and those of the *Helosideæ* so much so, that it may be doubted how far *Corynæa*, *Scybalium*, and *Sphærorhizon* are distinct from *Helosis*.

Sarcophyte must at present be considered as in many points a doubtful member of the *Monostyli*, from my inability to discover whether the ovarium is simple or compound, at any period of growth. The absolutely sessile, discoid stigma is found neither in *Monostyli* nor *Distyli*, and in some other characters it partakes as much of one group as of the other; thus in its three stamens it agrees with *Balanophora* and all the *Helosideæ*, but it differs from them in its stamens being free, and in its anomalous anthers (which however suggest an affinity with *B. polyandra*). In its branched inflorescence it resembles *Lophophyteæ*, but differs totally in the structure of the male flowers.

For characters of secondary importance, I have availed myself of the male flowers, and especially of the number and form of the stamens and their cohesion. A remarkable analogy between two of the sections into which each primary group is divided, is established by these organs; the *Lophophyteæ* (of *Distyli*) having free stamens of the ordinary type of Phænogamic plants, and being hence analogous to *Cynomorium* and *Mystropetalon* (among *Monostyli*), while all the other genera have anomalous anthers.

In framing the genera, characters of the third degree of importance have been employed; such as the presence or absence of the perianth, and its structure; aided occasionally by the stamina, the cohesion of the flowers, the nature of the inflorescence, and lastly, the habit; this term implying in these plants not merely differences in the outline of organs, but also in their development and mode of evolution.

Besides Griffith's arrangement of *Balanophoreæ*, that of Endlicher (Meletemata, p. 4) is the only one of any importance hitherto proposed. His division is founded on the stamens being free or combined: this however not only assumes the position and arrangement of the stamina to be of more importance than those of the ovaria, but brings together genera which have otherwise little in common.

Geographical Distribution, and Variation.

The greater number of *Balanophoreæ* belong to the tropical and subtropical mountains of Asia and South America, where they probably occur in nearly equal proportions. In both hemispheres certain species ascend to 10,000 feet; comparatively few being found in low tropical forests, almost the only ones being *Balanophora fungosa* in the eastern, *Helosis guyanensis* in the western hemisphere, and *Thonningia* in Africa. A considerable number are extra-tropical; as *Cynomorium*, which attains lat. 41° N. in Europe; the two *Mystropetala* and *Sarcophyte*, which inhabit South Africa; *Helosis guyanensis*, which extends to the La Plata district; and the North Indian species of *Balanophora* and *Rhopalocnemis*.

The genus *Balanophora* is confined to India, and the Malay and western Polynesian islands: it extends from the N.W. Himalaya at Simla throughout that mountain-range to the eastward, thence to the Khasia Mountains, Burma, and the Malay Peninsula, Sumatra, Java, the N.E. coast of New Holland, as far east as the New Hebrides; it is also found in the Indian Peninsula, Ceylon, and the Philippine Islands, and no doubt occurs in Borneo and New Guinea. The *Helosideæ*, with the exception of the Indian *Rhopalocnemis*, are confined to the American continent and islands, where they extend from Jamaica and Mexico to the Pampas. Of the *Langsdorffiæ*, two species are American, and one (*Thonningia*) is found on the west coast of tropical Africa. The *Lophophyteæ*, as far as is known, all inhabit tropical South America, and are chiefly confined to South Brazil, Peru, and New Grenada.

The individual species of this Order have often exceedingly wide ranges, though some are extremely local. The most conspicuous examples of extensive distribution are: *Cynomorium coccineum*, which ranges from the Canary Islands to the mouths of the Nile, viz. through 3000 miles of longitude; *Rhopalocnemis* is found in lat. 27° N. in East Nepal and Sikkim, in the Khasia Mountains of East Bengal, and in Java, under the Equator, places no less than 3000 miles apart; *Balanophora dioica*, which has probably a still wider range; and *B. fungosa*, which is found both in East Australia and Tanna, places separated by 1500 miles of ocean. In the new world, *Langsdorffia hypogæa* has been found in the province of Oaxaca in Mexico, lat. 18° N., by Prof. Liebmann, in the mountains of New Grenada by Mr. Purdie, at Rio de Janeiro by many collectors, and in the Pampas by Mr. Miers (lat. 34° S.); having thus a range of 52 degrees of latitude, and 4000 miles in a straight line.

I do not find that the widely distributed species vary much according to the distance they spread; specimens from the most distant localities often being absolutely identical; and all being very constant to one form: on the other hand, some of the most local species as well as some of the most widely spread are excessively variable. As a general rule, the most imperfect forms vary most in general characters, especially *Balanophora*, the individual species of which differ in the size of their parts, in the form of their scales, their rhizome and their capitula, in the capitula being unisexual or bisexual, and in the size, form and number of the parts of the flower. *Helosideæ* again vary extremely in size and habit, but much less in the capitulum. *Langsdorffiæ* are rather variable, and *Cynomorium* is conspicuously so.

Balanophorearum Tabula Synoptica.

Div. I. Monostyli (Griff.). *Stylus* 1.

§ I. *Stamina* libera. *Semen* embryone et albumine instructum.

A. Mystropeteleæ.

Gen. I. Mystropetalon (Harv.). *Perianthium* fl. ♂ 3-partitum, 2-labiatum, segmentis valvatis, 2 anticis connatis; fl. ♀ epigynum, campanulatum, 3-lobum. *Stamina* 3, segmentis perianthii opposita, iisque inserta; antheris extrorsis. *Embryo* hilo proximus.—Pedunculus *solitarius, squamosus.* Capitulum *oblongum, bisexuale*; floribus ♀ *inferioribus,* ♂ *3-bracteatis.*

1. *M. Polemanni,* Harv.; bracteâ anticâ spathulatâ, perianthio ♀ tubuloso.
Hab. Africâ Australi.

2. *M. Thomii* (Harv.); bracteâ anticâ latè oblongâ, perianthio ♀ subgloboso.
Hab. Africâ Australi.

B. Cynomorieæ.

Gen. II. Cynomorium (Mich.). *Perianthium* utriusque sexus 6-phyllum. *Stamen* 1, in fl. ⚥ epigynum; filamentum in fl. ♂ basi stylo deformato suffultum; antherâ introrsâ. *Embryo* lateralis, hilo remotus.—Pedunculus *solitarius, squamosus.* Capitulum *cylindricum.* Flores *unisexuales, rarius bisexuales,* ♂ *et* ♀ *immixti*; bracteis *sparsis remotis.*

1. *C. coccineum* (Mich.).
Hab. Regione Mediterraneâ, et Insulis Fortunatis.

C. Sarcophyteæ.

Gen. III. Sarcophyte (Sparrm.). *Flores* dioici, ♂ paniculati; perianthii lobis 3, valvatis. *Stamina* 3, antheris multilocularibus, liberis. *Fl.* ♀ in capitulis globosis arctè cohærentes. *Stigma* discoideum, sessile.—Rhizoma *simplex, lobatum.* Pedunculus *nudus, ramis inflorescentiæ primariis basi bracteatis.*

1. *S. sanguinea* (Sparrm.).
Hab. Africâ Australi.

§ II. *Stamina* connata. *Semen* homogeneum?

D. Langsdorffieæ (Endl.). *Perianthium* fl. ♀ tubulosum.

Gen. IV. Langsdorffia (Mart.). *Staminum* columna cava. *Perianthii* fl. ♂ lobi 3, valvati, præfloratione genitalia includentes. *Antheræ* breves.—Rhizoma *horizontale, ramosum.* Pedunculi *terminales, squamis imbricatis tecti.* Capitula *unisexualia.*

1. *L. hypogæa* (Rich.); rhizomate glaberrimo v. glabrato.
Hab. Americâ tropicâ.

2. *L. rubiginosa* (Wedd. MSS.); rhizomate tomentoso v. lanato.
Hab. Brasiliâ et Guianâ.

Gen. V. Thonningia (Vahl). *Staminum* columna solida, infra medium squamis 2-6 aucta. *Antheræ* lineares.—Habitus *et* vegetatio *Langsdorffiæ.*

1. *T. sanguinea* (Vahl).
Hab. Africâ tropicâ occidentali.

E. Balanophoreæ. *Perianthium* fl. ♀ 0.

Gen. VI. BALANOPHORA (Forst.). *Perianthium* fl. ♂ 3–6-phyllum. *Antheræ* extrorsæ. Fl. ♀ pistilla bracteolis clavatis immixta v. pedicellis bractearum inserta.—Rhizoma *tuberosum v. ramosum.* Pedunculi *nudi v. squamosi.* Capitula *unisexualia v. bisexualia.* Flores *unisexuales.*

α. Pedunculi squamis in cupulam v. involucrum connatis.

1. *B. involucrata* (n. sp.).

Hab. Himalayâ temperatâ.

β. Pedunculi squamis alternis v. imbricatis; antheris 3–6 2-locularibus.

2. *B. dioica* (Brown); capitulis unisexualibus cylindricis, rhizomate tuberoso lobato pustulis lobulatis instructo.

Hab. Sylvis montosis subtropicis Indiæ borealis, Bengaliæ et Birmæ.

3. *B. elongata* (Blume); capitulis unisexualibus subcylindricis, rhizomate elongato ramoso ramis cylindricis pustulis lobulatis instructis.

Hab. Montibus temperatis Javæ et Peninsulæ Indiæ orientalis.

4. *B. Indica* (Wall.); capitulis unisexualibus, ♀ obovoideis globosisve, pedunculis elongatis, rhizomate tuberoso lobato.—(An *B. globosæ* var.?)

Hab. Sylvis montosis subtropicis Peninsulæ Indiæ orientalis et Ceyloniæ.

5. *B. globosa* (Jungh.); capitulis unisexualibus, ♀ globosis, pedunculis brevibus, rhizomate tuberoso lobato.—(An *B. abbreviata*, Blume?)

Hab. Sylvis temperatis Javæ.

6. *B. fungosa* (Forst.); capitulis bisexualibus ovoideis subglobosisve, rhizomate tuberoso lobato granulato.

Hab. Orâ orientali Australiæ tropicæ, et Ins. Novæ Hebrides dictis.

7. *B. alutacea* (Jungh.); capitulis bisexualibus cylindricis, rhizomate lobato lævi, pedunculi squamis paucis vaginantibus.

Hab. Sylvis tropicis Javæ et Ins. Philippinis.

γ. Pedunculi squamis alternis v. imbricatis; antheris multilocularibus.

8. *B. polyandra* (Griff.).

Hab. Sylvis montosis subtropicis Himalayæ orientalis et Khasiæ.

Div. II. DISTYLI (Griff.). *Styli* 2.

F. Lophophyteæ (Endl.). *Stamina* libera.

Gen. VII. LOPHOPHYTUM (Schott & Endl.). *Flores* secus ramulos pedunculi mamillæformes apice obtusos congesti, mamillis basi bracteis deciduis suffulti.—Rhizoma *crassum, supernè squamis imbricatis tectum.* Pedunculus *basi nudus.*

1. *L. mirabile* (Schott & Endl.); paleis cum floribus immixtis v. 0; stylis 2 elongatis breviusculisve.

Hab. Brasiliâ.

2. *L. Bolivianum* (Wedd.); paleis inter flores 0, stylis 0 (an delapsis?).

Hab. Cordillerâ Boliviæ.

3. *L. Weddellii* (n. sp.); floribus dioicis, paleis inter flores 0.

Hab. Cordillerâ Novæ Granadæ.

Gen. VIII. OMBROPHYTUM (Pœpp. & Endl.). *Flores* secus pedicellos bractearum peltatarum congesti.—Vegetatio *et* habitus *Lophophyti, sed squamæ nullæ.* Pedunculus *basi volva v. annulo circumdatus.*

1. *O. Peruvianum* (Pœpp. & Endl.).

Hab. Cordillerâ Boliviæ et Peruviæ.

G. Helosideæ (Endl.). *Stamina* connata.

Gen. IX. Scybalium (Schott & Endl.). *Rhizoma* tuberosum, lobatum. *Flores* pedunculis distinctis squamis imbricatis tectis monoici. *Capitula* convexa v. planiuscula. *Perianthium* ♂ 3-lobum.

1. *S. fungiforme* (Schott & Endl.).
Hab. Brasiliâ.

Gen. X. Sphærorhizon (n. g.). *Rhizoma* tuberosum, indivisum. *Pedunculus* solitarius, squamis deciduis tectus. *Capitula* sphærica v. oblonga. *Perianthium* ♂ 3-lobum.

1. *S. curvatum* (n. sp.).
Hab. Novâ Granadâ.

Gen. XI. Phyllocoryne (n. g.). *Rhizoma* lobatum v. ramosum. *Pedunculi* plurimi squamis persistentibus subhexastichè imbricatis tectum. *Capitula* cylindracea v. oblonga. *Perianthium* ♂ 3-lobum.

1. *P. Jamaicensis* (Cynomorium Jamaicense, *Sw.*).
Hab. Ins. Jamaicâ.

Gen. XII. Rhopalocnemis (Jungh.). *Rhizoma* tuberosum, simplex v. lobatum. *Pedunculi* pauci v. solitarii, basi annulo v. volvâ instructi. *Capitulum* oblongo-cylindraceum. *Perianthium* ♂ tubulosum.

1. *R. phalloides* (Jungh.).
Hab. Sylvis montosis Himalayæ temperatæ orientalis, Khasiæ, et ins. Javæ.

Gen. XIII. Corynæa (n. g.). *Rhizoma* tuberosum, simplex v. lobatum. *Pedunculi* solitarii v. pauci, basi annulo v. volvâ obscurâ instructi. *Capitula* sphærica v. oblongo-cylindracea. *Perianthium* ♂ campanulatum.

1. *C. crassa* (n. sp.); capitulo cylindraceo.
Hab. Montibus temperatis Novæ Granadæ.
2. *C. sphærica* (n. sp.); capitulo rhizomatis fossâ sessili sphærico.
Hab. Montibus temperatis Novæ Granadæ.
3. *C. Purdiei* (n. sp.); capitulo sphærico pedunculato.
Hab. Cordillerâ Peruvianâ.

Gen. XIV. Helosis (Rich.). *Rhizoma* cylindraceum, ramosum. *Pedunculi* plurimi, nudi v. basi v. medio annulati. *Capitula* ovoidea, oblonga v. globosa. *Perianthium* ♂ 3-partitum.

1. *H. Guyanensis* (Rich.); pedunculis basi volvâ v. involucro 5–7-phyllo instructis medio nudis.
Hab. Americâ tropicâ.
2. *H. Mexicana* (Liebm.); pedunculis medio v. supra medium annulo obsoleto instructis.
Hab. Americâ tropicâ.

I. MYSTROPETALON, Harv.

(Tab. I. B.)

1. Mystropetalon Thomii, Harv. in Ann. Nat. Hist. 1839, vol. i. p. 386. t. 19; Griff. in Linn. Soc. Trans. vol. xix. p. 336.

I have little to add to the excellent descriptions of Harvey and Griffith, except with regard to the embryo, which I have found to be constantly present in the ripe fruit; it is clavate, placed at the upper part of the seed, lying quite loose in its axis, with the radicle pointed to the hilum, and close to it. The albumen-grains are oleaginous, large, loosely coherent, and enclosed in a delicate cellular membrane. I find no membrane enclosing the embryo, which is pale, transparent, and formed of minute cohering cells, and is not oleaginous. The apex of the stigma is obscurely 3-lobed: there is no very distinct stigmatic canal; but the cells of the stigma and centre of the style are soft and pulpy.

Griffith, who did not detect the embryo of this plant, considered that this albumen (which he describes doubtfully as an embryo) suggests a greater resemblance to a sporuliferous mass than is shown by any other so-called Rhizanth: it is remarkable that this observation should refer to one of the only three known plants of the Order, of which the truly albuminous nature of the great mass of the seed is indisputable; and is an example of the inexpediency of assuming an organ to be anomalous because its structure is unexplained.

The inflorescence of *Mystropetalon* differs from that of other *Balanophoreæ* in the male flowers being at the summit of the capitulum, and the female below. In the monœcious *Cynomorium* and most monœcious *Helosideæ* they are promiscuously mixed, with the males generally lowest; in monœcious *Balanophoreæ* the males are normally at the bottom of the capitulum; though I have seen traces of male flowers at the apex of a capitulum of *B. involucrata.*

Mystropetalon is certainly in all respects the most highly developed genus of the Order, both from the complexity of the floral envelopes, and from the presence of a perfect embryo, placed in the usual position of that organ in Phænogamous plants. It was referred to *Balanophoreæ* by Harvey and by Mr. Brown (Linn. Soc. Trans. xix. p. 233, in note*); and though very anomalous in its greater perfection, must remain as a section of that Order, or in close proximity to it. Griffith considered it as *sui ordinis*, but with great sagacity indicates its affinity with *Cynomorium* (a plant he had not examined), and finally described it (doubtfully) as the homogeneous-embryo form of a group of plants including *Loranthaceæ, Proteaceæ, Santalaceæ,* and other Orders comprehended in Lindley's alliance *Tubiferosæ.* Considering the very great structural and morphological differences presented by *Balanophoreæ*, it becomes impossible to exclude *Mystropetalon* from the Order; of its affinity with which there are many positive evidences, and the curious negative one of extreme dissimilarity between the perianths of the sexes. Of positive characters, the most conspicuous besides habit, are, in the male flowers, the valvate 3-partite perianth, tubular below, and enclosing a rudimentary ovarium, the stamens opposite the segments of the perianth, and the extrorse anthers; in the female flowers, the epigynous monosepalous perianth, the deciduous style, the structure of the walls of the ovary, the extreme simplicity of the ovule, and the adherent membranous coat of the seed. It departs from all the rest of the Order in its male flowers being normally above the female; in its very unequal male perianth, its frequently imperfect odd stamen, and angular pollen; in the ovarian disc, deciduous perfect female perianth, 3-lobed stigma, presence of an imperfect pistil in the male flower, and axile clavate embryo. Considering its monostylous ovary, with a tubular perianth, its nearest ally would appear to be *Langsdorffia*, between which and *Cynomorium* it will rank in a linear series.

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* The species there referred to does not appear to me to be specifically distinct from *M. Thomii.*

II. CYNOMORIUM, Mich.

(TAB. I. A.)

1. CYNOMORIUM COCCINEUM, Mich.—Ad citationes evulgatas adde, Linn. Amœn. Acad. iv. 351. t. 2; Webb, Flor. Ins. Canar. iii. 431; Weddell in Ann. Sc. Nat. sér. 3. xiv. p. 176. t. 11.

Though this curious plant has received so much illustration from many able botanists, there are still some points in its structure which are little known; and there are points in Linnæus's description in the 'Amœnitates Academicæ,' which have, I believe, escaped most subsequent observers.

The geographical range is very remarkable: it extends from the Canary Islands to the Levant; *i.e.* over fully fifty degrees, or 3000 miles of longitude. I have examined specimens from its extreme eastern and western limits; namely, from Lancerotte and from the delta of the Nile; and I have compared these with others from various intermediate localities, as Oran, Malta, Sardinia, S. Spain, and Sicily; and I have found no traces of any differences that suggest the propriety of establishing even varieties. It is also found in Etruria, lat. 41° N. (its northern limit), Lampedusa, and Tunis according to Linnæus.

Cynomorium is not singular amongst *Balanophoreæ* in this wide distribution; though it is more local and scarce than any of its congeners which occupy an equally extensive area. It is the only species known to inhabit a dry climate and soil, and is no less remarkable for delighting in the immediate neighbourhood of the sea, and growing in salinas, and often on saline plants (Linn.). Mr. Webb informs us (Hist. Ins. Canar. Bot. vol. iii. p. 431) that it is eaten in the island of Lancerotte.

In a young state the lower part of the peduncle is remarkably distinct from the upper; it is broader, fusiform, and covered with short, broad, acuminate, imbricating, spirally arranged scales (well shown in Micheli's plate), giving it a polygonal appearance: these scales are much less conspicuous in the old plant, and are probably very deciduous; whence the discrepancy that Richard remarks between his Egyptian specimens and Micheli's figure. The lower portion of this contracts suddenly at the point of union with the root-stock, and there is, I believe, a well-developed rhizome; but I have no complete specimens of it. The parasitism consists in an intimate organic adhesion between a small surface of the cellular tissue of the *Cynomorium*, and the wood of the root on which it grows; but no vascular tissue (at any rate in the old state) unites the latter with the parasite.

The vascular system (represented by Unger, Ann. Wien. Mus. ii. t. 5. f. 32) consists of many bundles irregularly scattered through the peduncle and capitulum; forming waving lines, but never crossing or resembling the endogenous type in structure or arrangement. These, in a transverse section, are seen to consist of two kinds of vessels; namely, 1. internally of a small bundle of delicate cylindrical or angular white tubes with transverse marks or bands; 2. a broader dark external tissue which in a transverse section appears cellular, and in a longitudinal one is found to consist of many series of linear, superimposed, oblong cells, regularly placed, and all terminating at the same plane, thus giving a barred appearance to the tissue; the contents of these are all highly coloured.

Besides these there are thick-walled pleurenchyma-cells. The cellular system, which forms by far the greater mass of the plant, consists of large polygonal utricles, with thin transparent walls, full of starch and chlorophyll granules.

The scales upon the upper part of the peduncle are broader than those at the base; blunt, often transversely oblong, peltately attached, and, on the capitulum, gradually assume the character of peltate bracts. In the youngest specimens I have examined (Tab. I. A. fig. 1) long before the flowers are discernible, except as lobed papillæ, the appearance of all the scales from the base to the top of the plant is remarkably uniform; they are broadly ovate, acuminate, and imbricated at the fusiform swollen base, more scattered and broader, and blunter or truncate, on the upper contracted portion of the peduncle, and again acute and densely imbricated from the base to the summit of the capitulum, the surface of which they wholly conceal. At this early period the scales are very obliquely peltate; in a vertical section each is seen to curve upwards and cover the lower part of the peltate scale immediately above it, whilst the lower part is produced into a long incurved lobe. The lower lobe presents a semi-lunar curve towards the capitulum, and arches over a mamilla of the capitulum covered with nascent flowers. The concave upper surface of the next scale below is closely applied to the dorsum of the lower lobe of that above it. A strong vascular cord enters each scale, and is united at a little distance from its base, within the body of the capitulum, with an equally stout cord from the mamilla above it. It will thus be seen that each scale forms the protecting organ to a definite mass of flowers below its point of insertion, but is connected by its vascular system with the mamilla of flowers above it; an arrangement similar to that which occurs in *Lophophytum* and some *Lycopodiaceæ*, but which can in *Cynomorium* only be discovered at a very early period.

Owing to the much more rapid growth of the capitulum than of the scales, these eventually become scattered, at the same time losing their bracteal form, and becoming broader and fleshy. These changes are precisely the same in their nature as occur in the bracteal scales of *Helosis* and its allies. The paleæ which occur abundantly amongst the flowers, and vary extremely in form, consist of rudimentary flowers, both males and females, and of perigonial leaves, removed from their flowers by unequal growth. There is a disposition in some of the floral scales of larger size than the rest, to assume the position of a bractlet under each flower, or group of flowers.

The male and female flowers appear promiscuously in succession for a considerable period: in this respect *Cynomorium* presents a remarkable contrast to *Balanophora* and *Helosis*, &c.; as in these the evolution of the sexes occurs at different times: and it is worthy of remark that this phænomenon is perhaps confined to this genus, and is therefore peculiar to the only plant of the Order which exhibits a strong tendency to hermaphroditism.

In Webb's 'Flora of the Canary Islands' (iii. 431), I have described hermaphrodite flowers of *Cynomorium*; which were pointed out to me by Mr. Brown in a drawing of Bauer's: they were originally discovered by Linnæus (Gen. Plant. ed. 5, 1754), and described by him; as indicated by Richard, who, however, failed to find them himself.

The palea of Richard, surrounding and half enveloping the stamen of the male flower, is a remarkable organ: from analogy with *Balanophora*, *Helosis*, and indeed the majority of the Order, it might be considered an imperfect perianth; whereas in the hermaphrodite flowers it is seen to be a well-developed style, the ovary of which is usually suppressed. In these flowers the stamen rises from near the summit of the ovary, above the insertion of any of the perigonial scales, and the base of the filament is lodged in a narrow vertical canal immediately opposite the concave face of the style (figs. 3, 4 & 5). I have not been able to ascertain the position of the style and stamen with reference to the axis of the plant; but, considering the simple nature of the pistil, and that the flowers are collected in groups, representing theoretically ramifications of the inflorescence, I assume that the concave face of the style is opposite to the ideal axis of each such ramification.

In the youngest state of the male (fig. 6), the floral envelopes are often symmetrically disposed. A spathulate palea subtends each flower, and within it are six perigonial scales; these are frequently perfectly regular, and form a verticil round the rudimentary ovarium and filament: the whole flower afterwards grows with great rapidity, and some of the perigonial scales are left at its base, while others are carried up on the elongating imperfect ovarium, which resembles a pedicel, and branching bundles of vessels are developed in their axes. The style at the same time elongates rapidly, but increases also in breadth upwards, so as to resemble a perigonial scale much more than the style of the female flower does; it has however no vascular tissue. In some male flowers all the perigonial scales remain symmetrically disposed round the filament and style, till the flower has attained its full development.

At the earliest period the female flowers (fig. 2) appear as compressed, pedicelled bodies, subtended by a bract similar to that of the males. The pedicel dilates, and divides into two (rarely three) linear perigonial leaves, and again contracts, forming the base of a compressed obovate ovary, on whose summit is the broad linear style, somewhat contracted immediately below the papillose stigma; and at its base are three other linear blunt perigonial leaves of equal size, which are always symmetrically disposed, two being placed right and left in the same plane as the style and the two lower perigonial leaves, and one at the dorsum of the style. Two vascular cords are seen, one on each side of the ovarium, meeting at its base in the pedicel, and again at its summit immediately at the base of the style, below which an opaque circular spot marks the cavity of the ovary; these vascular cords again separate in the style, and are free to its apex. The base of the style is contracted, and of a very dark colour at the contraction: I am not aware what this indicates. The opacity is also seen at the base of the filament in hermaphrodite flowers, and often upon all the perigonial scales, at a point exactly corresponding to the base of the style.

During the growth of the female flowers, the perigonial scales do not attain the development they do in the males, nor do they generally contain vascular bundles. They become variously displaced; some remaining on the summit of the ovary, and others being more or less basal, or adnate to its surface. In the adult female flower a small cellular protuberance may often be seen on the summit of the ovary (fig. 7), fronting the concave face of the style: this may be a rudimentary stamen.

The hermaphrodite flowers present both the pistil and stamen in as perfect a condition as they attain in the unisexual flowers. The situation of the perigonial scales varies as much in these as in the female flowers, but though they never attain the same development as they do in the males, they approach it, and often contain vascular cords. In one hermaphrodite flower (fig. 9) I found six perigonial scales, symmetrically disposed round the summit of the ovary.

There is thus in a complete flower of *Cynomorium* a superior perigonium, an epigynous stamen, a pistil consisting of one carpel with one simple style, and one pendulous ovule, succeeded by an albuminous seed:—characters common also to *Hippuris*, and indicating an affinity I have elsewhere noticed, and endeavoured to support by the structure of other *Balanophoreæ*.

I may here repeat what I have stated in the 'Flora of the Canary Islands' concerning the pistil of *Cynomorium*; namely, that the simple concave style with two parallel vascular cords terminating an ovary which undoubtedly consists of one carpellary leaf, is a strong evidence of the compound nature of a style of the simplest type; and that the two lateral stigmata are here perfectly obvious: which agrees with Mr. Brown's remarks on the composition, &c. of the pistil* (Plant. Jav. Rar. p. 110 in note). The stigmatic tissue runs down the mesial line of the style, occupying the canal, and is covered by a very delicate epidermis.

I have never succeeded in tracing the development of the ovule in *Cynomorium*. The structure of the ripe seed has been determined by Richard, Lindley, and Weddell; but admits of some little further illustration. In the first place, the embryo when fully ripe is considerably larger than is figured by any of these authors, and is never exactly globular, but sometimes broadly conical, the narrow end being placed next to the firm cellular integument of the seed. It consists of large cells with dark nuclei, full of oil, and presents no integuments whatever: it lies in a cavity of the albumen, nearer the base than the hilum of the seed, with its radicle pointing rather downwards; and it faces the same way as the concave or grooved surface of the style; thus indicating that the ovule, if perfect, would have been semi-anatropous with the raphe on the side removed from the placenta; a view confirmed by M. Hofmeister's observation of the pollen-tube in the foramen of the ovule.

The albumen is of exceedingly firm and dense structure, consisting of thick-walled angular cells with dark-coloured granular chlorophyll-grains. Dr. Lindley found starch in these cells, which is probably present in the young state only, when he describes the albumen as mucilaginous, and the cells as loosely arranged. I could not detect any, either microscopically, or by the iodine test, which, when applied to the most delicate slices of fully formed albumen, turned its granular cell-contents brown. Mr. Weddell states that the albumen as well as the embryo contains oil (Ann. Sc. Nat. *l. c.* 178): "dans les *Balanophora*, dans le *Cynomorium*, et dans le *Sarcophyte*, j'ai rencontré un albumen charneux ou huileux, et un embryon de même nature."

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* On showing Mr. Brown my analysis of the style of *Cynomorium*, he informed me that this was a case he had had in view, and that he considered it strongly confirmatory of his theory.

III. SARCOPHYTE, Sparrmann.

(TAB. I. C.)

1. SARCOPHYTE SANGUINEA, Sparrm. in Act. Holm. xxxvii. p. 300. t. 7; Schott & Endl. Melet. Bot. p. 11; Griffith, Linn. Soc. Trans. xix. p. 339; Unger, Ann. Wien. Mus. ii. t. 5. f. 28; Weddell in Ann. Sc. Nat. sér. 3. p. 14. t. 10. f. 34–38.

Ichthyosma Wehdemanni, Schlecht. in Linnæa, ii. 671. t. 8.

Hab. Africâ Australi, ad radices *Ekebergiæ* prope Grahams-town (*Wehdemann*, &c.). Ad radices *Acaciæ Capensis*, Quagga's Flat, Uitenhage (*Zeyher !*).

My observations on this remarkable plant chiefly refer to two points: the structure of the anther, and the relation of the genus to other *Balanophoreæ*, in both which I differ from Mr. Griffith.

The anther is rightly described by Endlicher as consisting of a solid capitate body, containing many loculi filled with pollen. The contracted persistent septa between these loculi have been mistaken by Griffith for pedicelled anthers, which he describes as forming together a "caput antherarum," crowning a common peduncle, which rises from the axil of a bract. On the contrary, I find that the anther* contains about fifteen to twenty cells of very variable size, radiating from a cellular axis: a transverse section shows about twelve such cells symmetrically disposed round the apex of the filament; and a vertical one exhibits about eight, which radiate from the blunt summit of the filament, and of which the outermost are very small. At a very early period the septa consist of three tissues: an inner cellular not materially different from that of the filament, from which, however, it is separated by a broad dark line; this is lined by a delicate hyaline endothecial coat, and upon this is a mass of matted filaments of excessive tenuity and pulpy nature precisely similar to the anther-lining of *Phyllocoryne*, &c., amongst which the pollen-grains nestle. Each cell is distended with spherical pollen-grains.

I have not observed the circumscissal dehiscence of the outer membrane described by Endlicher, and which was apparently suggested to that author by the appearance of an annulus at the base of the dehisced anther; as on the contrary the anther dehisces by the disruption of the membrane over each loculus, in a manner quite analogous to that of the apices of the anthers of *Rhopalocnemis*, *Helosis*, and *Corynæa*, on the one hand, and of *Balanophora polyandra*, &c., on the other; and is an instance of the general tendency to dehiscence by irregular disruption of the anther-wall, which prevails throughout the Order. I have not been able at any period of its growth to reduce the anther to the ordinary 4-locular type; the pollen being developed, as in *Viscum* and various *Rhizophoræ*, simultaneously in many independent points of the epithelium: that these points originated along definite lines, answering to the position of anther-cells of the ordinary type, can therefore only be assumed.

From the above it is evident that Griffith is perfectly correct in insisting (*l. c.* p. 339) that a continuous solid tissue must exist between the cells of the anther, if it be assumed that these cells are not separate anthers.

In assuming that the filaments of *Sarcophyte* are axillary to the lobes of the perianth

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* A correct section of the anther is given in Unger's paper; Ann. Wien. Mus. *l. c.* t. 7. fig. 48.

(which he hence considers bracts), rather than bodies forming a verticillus on an inner and different plane, Griffith overlooks the fact, that their position in no way differs from that of the stamen of other *Balanophoreæ,* and that all stamens opposite to and seated at the base of perigonial leaves, are in the same category. On the other hand, his argument against the stamens being axillary, because they do not appear to form an inner whorl, may be equally applied against considering the perigonial leaves as being bracts, for the latter decidedly do form an outer whorl, and are all on one plane; a fact which, as well as that of their decidedly valvate æstivation, is opposed to their bracteal origin.

Another remark of Griffith's is to the effect, that "the analogies of *Balanophora* are in favour of Endlicher's generic character; but that it requires a very exalted idea to be held of the value of parasitism, to conceive any affinity between *Sarcophyte* and *Balanophora*" (p. 340). If, however, the homologies in the structure of the flowers are admitted, it cannot be said that systematists have depended on an undue value attached to parasitism, for the supposed affinity; and in the second place, the argument derived from parasitism, if of any value, does not rest upon the mere fact of parasitism, but on that of the root appearing to send vascular bundles into the rhizome of *Sarcophyte* as it does into that of other *Balanophoreæ,* a kind of parasitism not hitherto detected in any other Natural Order*.

The male flower of *Sarcophyte* differs in no essential particulars from that of *Balanophora*; the pedicel (tube of perianth) and three valvate perigonial leaves being identical, and both having the stamens opposite to the latter. The chief difference is, that in *Balanophora* the stamens are united by their filaments and connectives, whilst in *Sarcophyte* they are free. The suspected analogy between the structure of the stamen of *Sarcophyte* and the sorus of *Cyathea* and *Sphæropteris,* suggested by Griffith, is under any view quite untenable.

Griffith's description of the ovarium and its contents does not accord with my observations; nor could I suggest any explanation of his "brown central nuclei, containing one, or not unfrequently two, other brown nuclei;" but Weddell points out that Griffith examined an abnormal state of the fruit, which he has frequently observed himself, and in which the embryo is abortive, and the albumen and integuments become confounded into an ossified mass. I find, in the ovarian cavity of specimens preserved in acid, an immature ovulum, consisting of loose white cells, enclosed in a delicate membrane as in *Balanophora.* This albumen and its crustaceous coat (formed of the pericarp) are well illustrated by Weddell (Ann. Sc. Nat. *l. c.*), as is the central embryo, discovered by himself.

Griffith goes too far in stating that the female flowers of *Sarcophyte* are widely different from those of *Balanophoreæ,* in their greater general perfection, the union of the ovaria, and the obvious stigmatic surfaces: for, in the structure of the female flower, and of the seed, except in the development of the embryo, they are identical: the more highly organized stigmata attain a greater degree of perfection in *Sarcophyte* than in those genera with which

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* Except *Orobanche,* the germination of which has been so admirably illustrated by Caspary (Regensburg Flora, 1854, p. 577, t. 3). It appears most probable that the germination of *Balanophoreæ* will prove very similar to that of *Orobanche.*

Griffith was best acquainted, but not so great as in *Cynomorium* and others; whilst the greater general perfection in other respects, to which he alludes only, I do not appreciate. The union of the ovaria does not indicate a difference in the female flowers, but a different inflorescence; a point of much less systematic value, and indeed of none in *Balanophoreæ*, as is proved by a comparison of *Balanophora*, *Cynomorium*, *Lophophytum*, and their allies. In this point the analogy is perhaps complete with *Thonningia* and *Langsdorffia*, whose ovaria are entirely united; as are the perianths of *Langsdorffia*, in some states at any rate. As an indication, however, of the female flowers of *Sarcophyte* being furnished with a perianth, this point is of considerable importance.

Another fact connected with the inflorescence of *Sarcophyte* is the sudden suppression of bracteal scales; these, which are very conspicuous at the base of the primary branches of the male and female inflorescence, are not developed at the base of the capitula, or of the individual male flowers. This appears, further, opposed to Griffith's supposition that the perigonial leaves of the male flower are bracts, though perhaps not conclusive against it.

The tissues of the stem of *Sarcophyte* are full of starch-granules, but do not differ otherwise from others of the Order, though in the peduncle the vascular bundles are very irregularly deposited. The roots of the plant upon which it grows are connected by stout woody branches with the rhizome of the parasite; and there seems to be a complete fusion of the vascular tissues of both.

IV. LANGSDORFFIA, Rich.

(TAB. II.)

1. LANGSDORFFIA HYPOGÆA, Martius in Eschwege's Journal von Brasilien, ii. p. 179; Nov. Gen. et Sp. iii. 181. t. 199; Unger in Ann. Wien. Mus. ii. t. 4. figs. 21 & 22, & t. 7. fig. 40.

Langsdorffia Janeirensis, Rich. Mém. Mus. viii. p. 412. t. 19; Endl. & Schott. Meletem. p. 12.
Thonningia Mexicana, Liebmann in Proceedings of Assembly of Scandinavian Naturalists, 1844.
Sendfenbergia Moritziana, Klotzsch & Karsten, Herb. Mus. Berol.
Hab. Americâ tropicâ, a Mexico ad Brasiliam meridionalem. Sylvis montis Serra d'Estrella (*Martius*); Rio de Janeiro (*Miers*, *Gardner*, *Stephan*). Sylvis montosis provinciæ Oaxaca, Mexico (*Liebmann*); *fl.* Nov. Dec. Ad radices arborum ad Tucouroma, provinciæ Ocanæ (*W. Purdie*); Colombia (*Karsten*).

After a very careful examination of specimens from all the localities quoted above, except the male and fruiting specimens of Martius and Prof. Liebmann, I have referred all to one species. As however this is a very important point, involving the question of the range of the species extending throughout the tropics of both Americas, I feel that it is necessary to dwell at length upon it. From Mr. Purdie I have large suites of specimens, which show that the capitula on the same rhizome vary quite as much as those of Mexican specimens do from Brazilian ones. Prof. Liebmann, in his *résumé* of the characters distinguishing the Mexican plant, seems chiefly to rely upon a comparison of it with the drawings and descriptions of that from Brazil; but I find that none of my Brazilian specimens agree in all their details with Martius' and Richard's drawings; nor do these quite accord with one another, but only in what I assume to be mere individual, and not specific characters.

Prof. Liebmann sums up the differences between the Mexican and the Brazilian individuals, as residing in the more globose female capitulum, shorter stem, more shortly pedicelled perianth, twisted style, binate paleæ of the male receptacle, which are also clavate and dilated at the base, white papillose (male) perianth, longer filament, globose synema and globose pollen. It is also added, that the anthers are 2-celled, and dehisce differently, leaving a triangular opening between them, and that the filaments are free immediately below the anthers.

With regard to these points, I find the capitulum if anything more depressed in the Mexican plant and in Liebmann's accurate figure of it, than in Richard's drawing of the Brazilian, or than in most of my specimens either of the Brazilian or Colombian plant. The stem (peduncle) varies extremely in length, from ½ an inch to 8 inches, and considerably even on the same rhizome. The perianths of Mexican specimens are much longer than those of Liebmann's figure, and they are of the same length as those of my Brazilian specimens, though shorter than in Richard's or Martius' figures. The styles of the Mexican plant are very slightly twisted, and that from left to right, not the opposite way, as represented in Prof. Liebmann's figure; and there is the same twist in Mr. Purdie's and in some of the Brazilian specimens. The perianths seem constantly papillose, though varying in degree with age, drying, and other less obvious causes. Globose pollen is the common form in the genus.

Of the remaining distinctive characters, I have occasionally found binate paleæ of the described shape both on *L. hypogæa* and *tomentosa*; the filament in Liebmann's figure is so extremely short, that it appears impossible to draw a character from it; the synema varies in form, according to its age, and that represented in the figure of *T. Mexicana* entirely agrees with Brazilian individuals; and finally, the anthers of all, though 4-celled in their early and perfect state, become 2-celled previous to dehiscence, by the contraction of the septum. I therefore feel justified in referring the *Thonningia Mexicana* to *Langsdorffia hypogæa*.

The parasitism of *Langsdorffia* is remarkable: the dichotomously branching rhizomes appear most frequently to corrode, as it were, the bark of the roots they encounter, which they even sever, and then enclose the end that remains attached to the parent plant: the root swells considerably at the junction, and appears to send prolongations of wood into the rhizome of the parasite, which run along its axis for several inches; but though there is an intimate union between the wood of the root and the cellular tissue of the parasite, there seems to be no blending of their vascular systems. The rhizome also invariably swells at the junction, but does not branch from that point, as is often the case with *Helosis*. Both Richard and Martius represent rootlets as given off from the rhizome at a considerable distance from any parasitic union; but I do not find such in any of my specimens, nor have any other *Balanophoreæ* rootlets, though at the junction of root and parasite similar rootlets to those figured by Martius are often given off by the root, and these being partially enveloped by the parasite, appear to proceed from it. Martius and Langsdorff further say that the plant grasps other roots by means of these fibres, and that it does not appear to be really parasitical; but in both these points I think these authors are mistaken.

In Purdie's specimens of *L. hypogæa*, which are immature, the female perianths adhere firmly, so that their tissues are torn in sundering them. I have not found this to be the case in the Brazilian or Mexican specimens. The style varies exceedingly in length, as does the perianth of the female flower and its pedicel; the mouth of the perianth is obscurely lobed, and a few slender, straight, rigid, woody tubes traverse it longitudinally, as in *Thonningia*.

In common with Richard and Von Martius, I have sought in vain for any traces of the cavity of the ovarium. For a knowledge of the fruit I am indebted to Prof. Liebmann's invaluable communications, and to specimens given me by M. Weddell. The two former authors indeed hazard the supposition that all the specimens they examined were of a barren state of the species; to which, if such were the case, would have to be added upwards of fifty specimens examined by myself. Considering the extraordinary minuteness of the seed, it seems safer to conclude that the cavity of the ovary being still smaller, sunk in the substance of the fleshy receptacle, and probably filled with the ovule, which adheres to the cavity, it has escaped observation*. The fruit-bearing receptacle is quite similar to that of *Thonningia*; it dilates greatly after flowering, causing the surrounding scales to spread horizontally; its surface is covered with the persistent fleshy conical perigonia, which adhere so closely that they may be removed in a body as a fleshy covering to the receptacle. Beneath each flower is a minute oblong seed, nidulating in the fleshy receptacle, and pendulous from the apex of a unilocular crustaceous putamen. The seed is compressed, oblong, covered with a membranous coat, and has an evident raphe down one of the edges. The specimens I have examined are immature and had no discernible embryo, as were probably those examined by Liebmann, who describes the contents of the seed as a pulpy mass of globular cells. The clavate scales of the male capitulum appear to me to be undeveloped female flowers; and the small, hard, prominent, imbricating scales which surround the base of the female capitulum, are connate articulate filaments, analogous to those of *Helosideæ*.

This species yields so large a quantity of wax, that candles are made of it in New Grenada. The secretion is contained entirely in the cellular tissue, where it appears as a large opaque mass in every utricle. Mr. Purdie informs me that near Bogota the stems are collected, and sold in the markets under the name of *Siejos*, and used as candles on saints' days.

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* Since writing the above, I have examined some excellent flowering specimens of *L. hypogæa*, which, though originally preserved in spirits and afterwards transferred to acid, have not turned brown; and in these I find unimpregnated ovules. The perianths in these specimens adhere firmly throughout the upper two-thirds of their length, but their cylindrical bases, though densely packed, are quite free. Their substance is very loosely cellular and diaphanous, and a dark spot immediately above the insertion of the flower on to the fleshy capitulum, marks the position of the excessively minute ovarian cavity and ovule. Owing to the extreme minuteness and laxity of the cellular tissue of the ovary, I had great difficulty in opening it and dissecting out the ovule, which forms a pendulous globular transparent sac, consisting of a few loosely packed nucleated cells, enclosed in a membrane of excessive tenuity. This ovule is the most minute that I have met with in the vegetable kingdom. I further found pollen-tubes in the style of some flowers, traversing a conducting tissue formed of long, soft, lax, tubular cells in the axis of the style.—Kew, March 4, 1856.

On the Tolima range it is called "Belacha;" and "Melousita" on the mountains around Bogota, where its soft receptacle is eaten when ripe, and considered stimulating and refreshing. It is remarkable that *Langsdorffia*, the only monostylous American genus, should resemble *Balanophora* in the abundance of its waxy secretion; whilst *Rhopalocnemis*, the only distylous Asiatic species, resembles the other American *Helosideæ* in the absence of wax.

2. LANGSDORFFIA RUBIGINOSA, Weddell (Ann. Sc. Nat. sér. 3. xiv. t. 11. f. 48–51), rhizomate densè tomentoso. (TAB. II. figs. 1–19.)

Hab. Sylvis montosis regionibus superioribus fluminis Orinoco, alt. 3500 ad 4000 ped. (*Schomburgk, Ic. Pict.*): locis umbrosis humidis inter Quebradas de San Juan et Panones, Parana de Ruiz (*Purdie*): provinciâ Goyaz Brasiliæ (*Weddell*).

This species does not seem to have been distinguished from *L. hypogæa* by Mr. Purdie, from whom I first received it, and who mentions its also being used for candles. It in every respect resembles *L. hypogæa*, except in the dense, matted, woolly vesture of the rhizome, which appears as if wrapped in wool. This indumentum is formed of long, simple, very sparingly articulated transparent hairs, with broad bases and blunt apices, and walls covered, especially towards the base, with minute granulations; they are quite hollow, and very flaccid. All my specimens are males, and have very short peduncles, clothed with rather narrower scales than in *L. hypogæa*. The small clavate bodies situated on the male capitulum, and placed at the angle where four flowers meet, are often connate: they are quite analogous to the similarly placed organs in diœcious *Balanophoræ*. Weddell figures the female perianths as connate throughout their length, as is sometimes the case with *L. hypogæa*; his specimens appear to be immature, and I doubt its proving eventually distinct from the last-mentioned species.

V. THONNINGIA, Vahl.

(TAB. III.)

Conophyta, Schum. *Hæmatostrobus*, Endl. MSS. (Gen. p. 76).

Dioica. FL. ♂. *Perianthium* incompletum, e squamis 2–3 subulatis inæqualibus infra medium columnæ antheriferæ insertis. *Antheræ* 3–5, longissimè lineares, in columnam conico-fusiformem elongatam solidam coadunatæ, 12–20?-loculares, loculis linearibus, extrorsis. FL. ♀ lineares. *Perianthium* superum, tubulosum, inæqualiter 3–5-dentatum. *Ovarium* lineare, perianthio æquilongum imâ basi ovuliferum. *Stylus* cylindricus, filiformis, perianthio duplò longior, supra medium papillosus stigmatiferus. *Ovulum* 1, pendulum. *Achænia* receptaculo spongioso immersa.—Rhizoma *repens ramosum.* Pedunculi *erecti,* 1–6 *unciales, basi nudi,* squamis *coccineis circa inflorescentiam elongatis tecti, inter squamas pubescentes.* Squamæ *densè imbricatæ, latè ovato-acuminatæ, inferiores* $\frac{1}{4}$ *unc., superiores* $\frac{1}{2}$–1 *unc. longæ.* Receptaculum *spongiosum latè conicum v. hemisphæricum, convexum, floribus obtectum squamisque omninò velatum.* Fila articulata *nulla.* Flores *rubri.*

1. THONNINGIA SANGUINEA, Vahl! (Act. Soc. Hist. Nat. Hafn. vi. p. 124. t. 6, 1818). Schumacher et Thonning, Dansk. Selsk. Skrivt. vi. p. 124. t. 6. Liebmann in Proceedings of Assembly of Scandinavian Naturalists at Christiania, 1844, p. 177.

Conophyta purpurea, Isert, Reise nach Guinea, p. 283.
Hab. Guinea ad Aquapim, *Thonning*. Abeokuta, *Beat. Dom. Irving* (*fid. Ic. Pict.*).

I am indebted to Prof. Liebmann of Copenhagen for the opportunity of describing this rare plant; he having forwarded to me the original specimens from Vahl's and Schumacher's herbaria, which are deposited in the museum at Copenhagen. In his paper read before the Association of Scandinavian Naturalists at Christiania in 1844, M. Liebmann discusses the propriety of restoring Vahl's name of *Thonningia* to the American *Langsdorffiæ* of Martius and others, under the impression that they are all congeneric. As his information is very curious, and as I am obliged to dissent from his conclusions, I shall give the substance of his communication here, the paper being little likely to become generally accessible in England.

Thonningia was brought to Europe by Thonning in 1804, and described, and named after its discoverer by Vahl in the same year, in a paper read before the Natural History Society of Copenhagen, and accompanied by a plate. Whether the paper was printed does not appear; but Vahl died in 1804, and the Society was dissolved immediately afterwards. The volume, of which Vahl's paper formed a part, was not completed till 1810, when a few copies were distributed, and the rest retained by Prof. Viborg, on account of an obnoxious preface by M. Ratke, detailing a controversy between Professors Viborg and Vahl, and which was suppressed on the ultimate publication of the volume in 1818.

During the same year (1818) Von Martius published the Brazilian *Langsdorffia* in Eschwege's Journal; and the question brought forward by Liebmann is: supposing it to be congeneric with *Thonningia*, which name should be retained? Prof. Liebmann advocates Vahl's, on the ground of priority, and because his plate enables the genus to be identified, though he considers his description to be faulty*. As far as priority of publication is concerned, the claims of the names are on a par; but it appears to me impossible to include the Brazilian plants in the same genus with the African, on account of the great differences between their male flowers.

My description of *Thonningia* is drawn up from Vahl's and Schumacher's specimens and drawings. The male flower consists of a very long spindle-shaped synema, curved at the base, broadest in the middle, and tapering to a sharp point: a little below the middle it bears two or three subulate narrow fleshy scales, which are the rudiments of a perianth that is never further developed. The upper half appears from Vahl's drawing to be covered with pollen; and according to his specimens this is perfectly correct, and further agrees with Schumacher's description. In Schumacher's specimens I find no traces of anthers or pollen. In Vahl's specimens, however, I find four or five vascular bundles, and as many very long linear connate anthers, each 4-valved, bursting longitudinally, and containing globose hyaline pollen-grains with transparent borders.

The female flower of *Thonningia* only differs from that of *Langsdorffia* in a more complete tubular 3–5-toothed perianth. The parenchyma of this organ is much inflated, and is formed of very lax cellular tissue, traversed by four to six remarkable nerves. These consist

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* Prof. Liebmann says that Vahl must have been in error in describing both male and female flowers, as from the plate accompanying his paper it appears that he had only female specimens: but Vahl is here right, for he certainly figures both the male plant and its flowers, t. 6. figs. *a, b, c, d*; and though not very intelligible, they are accurate, and accord perfectly with the description of Schumacher and Thonning, whose specimens Vahl examined, and which I have also examined and described here.

of one or two rigid, stout, cylindrical, yellow tubes of sclerogen, with blunt apices; their walls are transparent, but extremely thick, and they are sometimes solid in places; they entirely resemble the woody tissue commonly developed in other parts of *Langsdorffia* and *Helosis.* The style is very long, filiform, and continuously papillose along the exserted portion. I have not seen the seeds, which occupy a very minute cavity in the base of the columnar ovary, and are said to be sunk in the receptacle. The latter expands considerably after flowering, when the scales fall away from the flowering branch, and the latter turns black, and probably decays.

I know nothing of the parasitism of *Thonningia*; the rhizome is brown, slender, smooth, and sparingly branched, and rises into an obscure cup round the base of the peduncle, which is clothed with bright red scales. I find no hairs upon the rhizome, as is the case with *Langsdorffia*, but there are small woolly tufts at the bases of the leaves, on the stem. The hairs are simple, long, inarticulate, flexuose, broad at the very base, rough on the surface, and with a very large continuous cavity.

VI. BALANOPHORA, Forst.

1. BALANOPHORA INVOLUCRATA (*supra*, p. 30).

Var. *α. rubra,* pedunculis et capitulis rubris, capitulis ovoideis bisexualibus (TAB. IV., V. & VI.).

Var. *β. flava,* pedunculis et capitulis stramineis v. flavis, capitulis unisexualibus rariùs bisexualibus.

Var. *γ. gracilis,* pedunculis elongatis gracilibus capitulisque flavis, capitulis unisexualibus parvis (TAB. VII. A.).

Var. *δ. Cathcartii,* pedunculis robustis capitulisque albis roseisve, capitulis unisexualibus (TAB. VII. B.).

Hab. In Himalayæ temperatæ sylvis humidis; Sikkim, alt. 7–9000 ped. (*J. D. H.*) Simla, alt. 6000 ped. (*Thomson*) (fl. Jul.).

Rhizoma 2–6 unc. latum, pustulis parvis cellulosis asperum, variè lobatum, nodos 3–4 poll. diam. radicibus *Aceris* et *Quercûs* efficiens. *Pedunculi* graciles v. crassi, breves v. elongati, medio involucrati, interdùm compressi v. fasciati. *Capitulum* ovoideum v. globosum, rariùs depresso-globosum; ♂ profunde alveolatum. *Flores* ♂ 2–5-meri, plerumque 3-meri. *Antheræ* tot quot lobi perianthii synemate brevi sessiles, transversè oblongæ, supernè rimâ transversâ dehiscentes. *Fl.* ♀ capitulo sessiles v. circa basin bracteolæ clavatæ aggregati.

The extreme varieties which I have here included under one species are so very dissimilar, that no one who had not seen large suites of specimens, presenting every intermediate form between them, could venture to unite them under one: as it is, I found that neither colour, form, nor the sexuality of the capitula are constant characters. In the same woods wherein I gathered the var. *gracilis* growing upon roots of oak, I also gathered var. *flava* growing on those of an *Araliaceous* shrub, and differing from the var. *gracilis* only in its more robust habit. In general there is a greater tendency in the female capitula to bear male flowers than in the males to produce female; for though I often met with female capitula bearing male flowers at their base, and sometimes at their summit, and occupying a considerable portion of the surface, I never found male capitula to bear any but very rudimentary female flowers scattered along the edges of the alveoli in which the lower part of the male perianth is sunk.

The present is the most alpine species of the genus known to me, and is common in Sikkim at 8000 to 10,000 feet elevation. I have found it on the exposed aërial rootlets of oaks in very humid forests, but, like the rest of the species, it generally grows at the foot of the trees immersed in the spongy soil. It causes large knots 2–4 inches in diameter to form on the roots of oaks and maples, and these are much sought by the natives for the manufacture of the wooden cups in general use throughout the Himalaya and Tibet.

2. Balanophora dioica, Brown in Wall. Cat. 7246; Linn. Trans. xiii. 207 in note. Royle, Ill. Plant. Himal. p. 330. t. 99 or 78 *a*. Schott & Endl. Melet. p. 13 (sub *B. elongata*, Bl.).

B. typhina, Wall. Cat. 7248.

B. picta, *B. alveolata*, *B. Burmanica* et *B. affinis*, Griff. in Linn. Trans. xx. pp. 94, 95. t. 3, 4, 5 & 6.

Variat insigniter rhizomate plùs minùsve lobato v. ramoso, lobis crebrè v. laxè pustulatis, pustulis simplicibus stellatim lobulatisve, pedunculis brevibus elongatisve, flavis albis rubrisve, squamis arctè v. laxè imbricatis, capitulis omninò unisexualibus v. fœmineis basi androgynis, cylindricis ovoideis conoideisve, columnâ stamineâ brevi v. elongatâ, antheris 3–5 arctè v. laxè compactis, floribus ♀ brevè v. longè pedicellatis, capitulo v. pedicello bracteolæ clavatæ insertis.

Hab. In Himalayæ orientalis, centralis et mont. Khasiæ sylvis subtropicis vulgatissima, alt. 3–7000 ped. (*T. Thomson et J. D. H.*); Nepal (*Wallich*); Birma (*Wallich et Griffith*); Mont. Mishmee (*Griffith!*). Fl. Aug.–Decembr. (v.v.)

This is an extremely common species in the Eastern Himalaya and Khasia, and so variable, that I am quite unable to define its varieties. Specimens of all sizes may be found, from an inch to a foot high, of all degrees of robustness, and of all colours between blood-red, yellow and white, or brown. Though usually strictly diœcious, I have found capitula bearing only male flowers on female plants, and more frequently male flowers towards the base of the female capitula. Schott and Endlicher, and latterly Junghuhn, have united this species with Blume's *B. elongata*, and I should not be at all surprised that they proved the same; but I have never found the Indian to have the long branching rhizomes of the Javanese species, and there is much less wax in the plant.

B. dioica grows indifferently on the roots of many species of shrubs and trees, but I have never found that it produces knots on these, as *B. involucrata* does.

3. Balanophora elongata, Blume, En. Pl. Jav. i. 87; Schott & Endl. Melet. 13; Unger, Ueb. d. Paras. pp. 26 & 33. t. 2. f. 1, 2; Junghuhn in Nov. Act. Acad. Cæs. Nat. Cur. xviii. Suppl. 207. t. 1.

Cynopsole elongata, Endl. Gen. Pl. 74.

Var. *maxima*. *B. maxima*, Jungh. in Nov. Act. Acad. Cæs. Nat. Cur. xviii. Suppl. 209. t. 1.

Hab. Montibus Javæ alt. 5–9000 ped. (*Blume*, *Junghuhn*, *Lobb*). Fl. Mart., Maio et August. Montibus Peninsulæ Indiæ orientalis (*Wight*) et Ceyloniæ? (*Gardner*, *Thwaites*).

I have, under *B. dioica*, stated what seem to me the only differences between this species and *B. dioica*, and these are rather modified in the Peninsular specimens figured by Dr. Wight in a drawing he has had the goodness to give me, and in the Ceylon specimens.

Junghuhn's *B. maxima* seems to differ only in size from *B. elongata*, the difference between these two forms being exactly analogous to that between *B. dioica* and *B. typhina*, Wall. (*picta*, Griff.).

This species produces wax in great abundance which is used for making candles in Java.

4. **Balanophora Indica**, Wall. Cat. 7247; Weddell in Ann. Sc. Nat. sér. 3. xiv. p. 167. t. 9. f. 11–22.

Cynomorium, Herb. Wight.
Langsdorffia Indica, Arnott in Hook. Ic. Plant. t. 205, 206, et in Ann. Nat. Hist. ii. 36.
Hab. In montibus Peninsulæ Indiæ orientalis (*Wight, Gardner*) et Ceyloniæ (*Gardner, Thwaites*).

This much resembles a large state of *B. globosa*, differing chiefly in the longer peduncles of the female capitula, which also have many more scales.

5. **Balanophora globosa**, Junghuhn, Nov. Act. Acad. Cæs. Nat. Cur. xviii. Suppl. p. 210. t. 2.

Bal. gigantea, Wall. Cat. 7249, nov. gen. *Sarcocordylis* (fid. Bennett in Linn. Soc. Trans. xx. p. 94, in note).
Hab. Sylvis montosis Javæ alt. 3–5000 ped. (*Junghuhn, Lobb*). Birma (*Wallich*). Fl. April.

Junghuhn makes a very curious observation, that when growing with *B. elongata* (on the same root) he found this species to have the lobed pustules on its rhizome which distinguish that species, but not when it was solitary.

According to Wallich, this species is sold for medicinal purposes in the bazars of Burma.

6. **Balanophora fungosa**, Forster, Gen. t. 50; Richard, Elem. de Bot. (1833) t. xv. (Tab. VIII.)

Cynomorium australe, Willd. Sp. Pl. v. 177.
Hab. Insulâ Tanna Novæ Hebrides ad radices *Paritii tiliacei* (*Forster, Hinds*): ad "Goold Island" in Sinu Rockingham, orâ orientali Novæ Hollandiæ, fruticetis densissimis (*M'Gillivray*). Fl. Mai.

All the specimens of this plant which I have examined have bisexual capitula with the female flowers at the base. The surface of the rhizome is minutely granular, and not pustular; the peduncles short, stout and leafy. The male flowers have 4–5-lobed perianths, the lobes grooved inside from pressure against the anther-lobes in the bud.

I am not aware upon what plant the Australian specimens were found, but the root is very woody, as thick as a crow-quill, and consists of wood and bark with no pith, but obscure medullary rays. The wood-fibres are slender and intermixed with large cylindrical ducts and long hexagonal cells whose walls are marked with numerous short transverse bars. The vascular bundles in the rhizome are large and stout, branch in the usual manner from the root radiating outwards to the lobes of the rhizome, and consist (as in *B. involucrata*) of a thick cylinder of soft colourless parenchyma distinguished from that surrounding it by the absence of chlorophyll or wax, and in this respect resembling the bark of the root; its cells are also smaller than the other cells of the rhizome, and have rather more numerous punctuations on their walls. The individual wood-bundles form a more or less complete zone of wedges, separated by masses of the surrounding parenchyma, which also forms a broad cylinder of pith in the interior. The wood-wedges are traversed by large ducts, quite similar to those of the root; these are most abundant near the root, and become smaller and inconspicuous at a distance from it, and towards the extremity of the bundles are found as elongated hexagonal cells with barred walls.

The most curious point in the above is the tendency of the tissues forming each vascular bundle in the rhizome to arrange themselves rudely into the form of an exogenous stem, the wood forming a zone of wedges round a central pith (Tab. VIII. fig. 11) enclosed by a cellular zone that communicates with the pith by broad medullary rays: the total absence of pith in the root, with whose wood these bundles communicate, would thus seem to indicate that the wood of the rhizome belongs to itself, though it has all the appearance of being solely produced by the root; the root, in short, supplies the nutriment from its own vascular tissue, but the parasite organizes it.

7. BALANOPHORA ALUTACEA, Junghuhn in Nov. Act. Acad. Cæs. Nat. Cur. xviii. Suppl. 205; Goeppert, ibid. p. 230. t. 3. An *B. abbreviata*, Blume, En. Pl. Jav. i. 87?

Hab. Sylvis tropicis Javæ (*Junghuhn*). Ins. Philippinis (*Cuming*). Fl. Aprili.

A very much smaller species than any of the preceding, according to Junghuhn's description and plate, but probably, like its congeners, extremely variable in size. Its prominent characters are the tuberous rhizome, like that of *B. dioica* and *B. involucrata*; its few, short, broad, subvaginate scales in the peduncle, and its cylindrical capitula with a few male flowers at the base, in which character it resembles *B. fungosa* and certain states of *B. involucrata.*

8. BALANOPHORA (POLYPLETHIA) POLYANDRA, Griff. in Linn. Soc. Trans. xx. p. 94. t. 7.

Hab. Sylvis subtropicis Mont. Khasiæ (*Griffith*) et Himalayæ provinciâ Sikkim, alt. 4-6000 ped. (*J. D. H.*). Fl. August.-Novemb. (v.v.)

This species is very abundant in the localities enumerated above, and varies in height (from 2 to 6 inches), in robustness, in colour, and in the form of the capitula, which are however always short and subcylindric or conical. I have frequently not been able to distinguish female specimens of this from those of *B. dioica*, nor indeed, except by the alternate scales, from those of *B. involucrata.* The numerous anthers of the male flower and usually larger perianth of that sex distinguish it from its congeners.

I have made many detailed analyses of the anatomy of this species at all stages of growth (except the germinating), both in the Khasia Mountains and Himalaya, but do not find any point of importance except the anthers in which it differs from *B. dioica*, *fungosa* and *involucrata.* The male flowers are well figured and described by Griffith.

VII. LOPHOPHYTUM, Schott & Endl.

In habit this genus approaches to *Cynomorium* more nearly than to any other of the Order, as may be seen by comparing their very young states; in each the upper part of the rhizome is clothed with spirally arranged imbricating scales, which pass into the bracteal scales of the inflorescence. In both the flowers are aggregated into definite masses, which masses are immediately covered by the dependent portion of the peltate bracteal scales; but whereas in *Cynomorium* any further tendency to a branched inflorescence is arrested at a very early stage, in *Lophophytum* the development of the branches proceeds with that of the whole plant. The paleæ observed by Weddell amongst the female flowers of *L. mirabile* are a further point of resemblance, as are the irregular disposition of the vascular bundles in the rhizome and great abundance of starch-granules in the parenchyma.

It is a remarkable fact that impregnation appears to be effected in this genus when the greater part of the inflorescence is completely clothed with the imbricating bracteæ, and in some cases when the plant is still under the surface of the soil. Thus, Weddell's drawings of *L. Bolivianum* show that even after the fruit is mature it is wholly subterranean, the upper part of the male portion of the inflorescence alone being above ground. In my specimens of *L. Weddellii*, which have all the appearance of being subterranean, and which are very young, the pollen is partially shed and the fruit fully formed (though abortive), and yet the peduncle would have to lengthen to three times its present length before the scales fall away and the plant appears to be in perfection. With regard to Weddell's drawings and specimens, they suggest the idea that the upper or male part of the spike in elongating under ground sheds so much pollen in the soil, that the female capitula on the lower part of the spike, which are afterwards carried up through the same soil, are impregnated by the pollen-grains remaining imbedded in it. On the other hand, *L. Weddellii* being diœcious, suggests insect-agency as absolutely essential to the process.

I have already (p. 24) alluded to the remarkable similarity between the inflorescence and flower of this genus and of *Gunnera*.

1. LOPHOPHYTUM MIRABILE, Schott & Endl. Melet. i. t. 1; Weddell in Ann. Sc. Nat. sér. 3. xiv. p. 185. t. 10. f. 31–33.

Archimedea, Leandro.

Hab. Sylvis tropicis Brasiliæ meridionalis prov. Sebastianopol (*Schott*): *Leandro* (in Hb. Mus. Paris.).

This very remarkable plant is well figured by Endlicher, who however represents it in a very advanced state, when the peltate scales have fallen away from the base of the capitula of flowers; the younger specimens preserved in the Paris Herbarium altogether resemble those of *L. Weddellii*, but are much smaller. According to a drawing of M. Weddell's, apparently of this species (and which was copied from one by M. Descourtils), the whole plant appears immersed in the soil with the exception of the inflorescence, which rises up like the upper part of a long pine-cone with sharp erect brown scales that conceal the red male flowers.

The scales observed and figured by Weddell amongst the female flowers much resemble those of *Cynomorium*; they are apparently bracteolæ, subtending the female flowers, to which they are very obscurely attached.

2. LOPHOPHYTUM BOLIVIANUM, Weddell in Ann. Sc. Nat. sér. 3. xiv. p. 185. t. 10. f. 29, 30.

Hab. In Boliviæ prov. de Cordillera, sylvis humidis. Fl. Novembri (*Weddell*).

I am indebted to Dr. Weddell for a fine drawing of this species and for specimens. In general appearance it closely resembles *L. mirabile*; but the rhizome is lobed, the lobes rounded, and it appears to be buried up to far beyond the middle of the inflorescence in the soil, the whole of the female flowers and the lower half of the male or upper portion of the spike being subterranean: as however the *Balanophoræ* and *Rhopalocnemis* are sometimes wholly exposed (even the rhizome), and at others almost immersed in mould, so may these plants be; to which it may be added, that in the tropical forests wherein these plants grow, sudden accessions of rain may often alter the relative level of a plant and the soil in which it grows.

M. Weddell remarks the absence of styles in this species as constant; but all his specimens being advanced, and these organs being extremely caducous, I am not disposed to lay much stress upon the fact of none of the specimens presenting them. The form of the fruit differs from that of *L. mirabile,* being much less contracted at the base. This however is a variable character, and I am inclined to agree with M. Weddell in suspecting the possibility of its being only a variety of the Brazilian species.

The arrangement of the stamina upon the lobes or mamillæ of the peduncle appears to be definite, though at first sight they appear irregularly clustered. M. Weddell's figure and specimens show that the whole surface of each mamilla is covered with lobed conical masses, which are connate male flowers, each consisting of two mamillæ placed right and left to the axis, and two stamens, one opposite each mamilla.

3. LOPHOPHYTUM WEDDELLII, nob. (*supra,* p. 30). (TAB. IX.)

Hab. In sylvis humidis montium prov. Ocaniæ, alt. 3–4000 ped., Novæ Granadæ (*Purdie*). (*Nom. vern.* "Cardon de la Cordillera.")

I have very fine specimens of this plant sent by Mr. Purdie, but all in a young state, with the peduncle wholly covered by the imbricating peltate bracts; but the stamens and pollen fully developed, the anther-cells dehisced, and the fruit, though empty, fully formed, and its walls crustaceous or bony. It differs from *L. mirabile* in the much larger size, and in being apparently invariably diœcious: I find no paleæ amongst the female flowers.

The root upon which my specimens grew is as thick as the wrist; it is of considerable age, is not much swollen at the surface of contact, has no pith or annual rings, but very evident medullary rays. The rhizome of the largest specimens is sunk $\frac{1}{2}$–1 inch in a shallow obconical cup in the root. I find no traces of vascular bundles uniting those of the rhizome and the root.

The tissue of the rhizome consists of a very dense cortical layer of crustaceous sclerogen-cells, which sometimes separates like a bark and encloses a loose cellular mass full of starch-granules and vascular bundles traversing the whole in sinuous courses. The vascular bundles consist of fusiform ducts and tubes with barred or ringed cylindrical or angular walls, surrounded by a laxer tissue of more elongated cells. The arrangement of the peltate scales on the peduncle, and their position relatively to the masses of the flowers in the bud, are exactly as in *Cynomorium*; the lower or dependent portion of each bract immediately covers the mamilla of flowers below it, its upper or ascending portion covering the dependent base of the scale above it. The vascular bundle of each mamilla of flowers does not, however, unite with that of the bract above it, but with that below it.

VIII. OMBROPHYTUM, Pœpp. & Endl.

This genus bears the same relation to *Lophophytum* that *Balanophora* does to *Cynomorium,* inasmuch as the flowers, instead of being inserted upon the capitulum, are whorled round the pedicel of the bract. In the structure of its female flower it hardly differs from *Lophophytum*; the male flowers, according to Weddell's drawing, appear to consist of a solitary stamen with no trace of a perianth.

The figure given in Pœppig and Endlicher's 'Nov. Gen. et Sp. Plant.' is probably made up in part from notes or memory, for it can hardly be doubted that the plant they intended is specifically the same as Weddell's *O. zamioides*, as he himself informs me. The rhizome is solitary, tuberous, not lobed, and bears one peduncle, which is surrounded at the base by a large volva. The inflorescence is cylindrical, and there is no interruption between the male flowers which occupy the upper half of the peduncle and the females. The bracts are quite similar in each, are persistent, and have a broad orbicular peltate disc.

1. OMBROPHYTUM PERUVIANUM, Pœpp. & Endl. Nov. Gen. et Sp. Plant. ii. p. 60. t. 155.

O. zamioides, Weddell, in Ann. Sc. Nat. sér. 3. xiv. t. 10. f. 23–28.

Hab. In sylvis densis Peruviæ subandinæ ad Cuchero (*Pœppig*); et prov. de las Cordilleras (*Weddell*). Fl. Sept.–Nov. (*Nom. vern.* "Mays del Monte," *Pœpp.*)

IX. SCYBALIUM, Schott & Endl.

1. SCYBALIUM FUNGIFORME, Schott & Endl. Melet. p. 3. t. 2. Unger in Ann. Wien. Mus. ii. t. 2. f. 4, t. 4. f. 19, 20.

Hab. In sylvis Brasiliæ ad Sierra d'Estrella (*Schott*).

I have nothing to add to the excellent description cited above. In habit the genus approaches *Langsdorffia* more than any of the *Distyli*. In the crowded and often connate peduncles and unisexual capitula, as well as in the plane figure of the latter, it differs from its allies; also in the filiform hairs which occur amongst the male flowers and are exserted far beyond the articulated threads, and which are probably undeveloped females. The 2-celled ovary invariably (as it is described) followed by a one-seeded fruit, is unique in the Order.

The rhizome resembles that of *Corynæa*, the scaly peduncle that of *Sphærorhizon*. The fact of one male peduncle being always surrounded by several females on the same rhizome is unique, and does not necessitate the operation of dichogamy which occurs in *Helosis*. From fig. 13 of the plate quoted, it appears that the male flowers are developed in succession for a considerable period.

X. SPHÆRORHIZON, Hook. fil.

Rhizoma napiforme seu depresso-globosum, solitarium. *Pedunculus* solitarius, curvus, squamatus, basi annulo brevi rhizomatis circumdatus, junior squamis densissimè imbricatis velatus, demùm elongatus, squamis oblongis obtusis subpeltatis denique deciduis. *Capitulum* ovoideum, monoicum, squamis deciduis peltatis tectum. *Flores* et fila articulata *Helosis*, sed synemate 3-loculari apice dehiscente.

1. SPHÆRORHIZON CURVATUM, Hook. fil. (TAB. X.)

Hab. Sylvis alpinis Novæ Granadæ inter vicum Niva et montes Paramo de Ruiz dictis (*Purdie*). Fl. Jul.

Rhizoma $\frac{3}{4}$–3 unc. diametr., obscurè lobatum, radicibus validis sessile. *Pedunculus* flexuosus 1–6 uncialis, validus, $\frac{1}{2}$ unc. diametr., interdùm brevissimus et squamis multiseriatis patentibus densissimè imbricatis tectus, interdùm elongatus squamis longioribus $\frac{3}{4}$ unc. longis obtusis latâ basi subpeltatim affixis laxè velatus, squamæ infra capitulum magis peltatæ latè adnatæ basibus apicibusque truncatis sub-recurvis. *Capitula* latè oblongo-cylindracea v. ovoidea, filis articulatis densissimè operta, e squamis delapsis areolata. *Flores* masculi synemate solido triloculari (nempe antheris unilocularibus) cylindraceo, apice dehiscente, septis e strato duplici conflatis, exteriore celluloso, interiore floccoso albido e fibris minutissimis implexis. *Pollen* globosum, immaturum 3-nucleatum, maturum peripheriâ hyalinâ, tuberculis 3 notatâ. *Ovarium* lineari-obovatum compressum, perianthii labiis latè ovatis, stylis breviusculis recurvis. Fila articulata lineari-clavata simplicia v. variè coadunata.

A very curious and peculiar-looking plant, of which Mr. Purdie has sent several specimens belonging possibly to two species, and differing remarkably in the amount and disposition of the scales of the peduncle. These in small short specimens form a dense mass between the rhizome and capitulum, are very numerous, closely packed, broad, short and patent: in specimens 3–5 inches long, the scales are more loosely placed, linear-oblong, adnate by a broad base, and those towards the capitulum are completely peltate or sessile by the middle and lower part of the face of the scale; the upper parts and base being truncate, free, and slightly recurved: still larger and apparently old specimens appear to have shed these scales altogether. The bracts on the capitula are much larger than in *Helosis*, but are in an imperfect state upon the only specimen retaining them.

The plants are evidently of annual duration, penetrating the last year's wood only, and producing no injury in the layers below that.

XI. PHYLLOCORYNE, Hook. fil.

Rhizoma crassum, deforme, ramosum. *Pedunculi* crassi squamis hexastichè imbricatis tecti, supernè tuberculis conicis densissimè obsiti. *Capitula* androgyna, cylindracea, squamis imbricatis deciduis tecta: filis articulatis densissimè operta. FL. ♂. *Perianthium* 3-lobum. *Antheræ* 3 in capitulum 6-loculare apice dehiscens connatæ. FL. ♀. *Ovarium* obovatum, compressum, calycis limbo bilabiato coronatum. *Fructus* turgidus, utrinque truncatus.

1. PHYLLOCORYNE JAMAICENSIS. (TAB. XI.)

Cynomorium Jamaicense, Swartz, Fl. Ind. Occ. i. p. 11; Browne, Jam. p. 334.
Helosis Jamaicensis, A. Richard, Mém. Mus. viii. 432.
Scybalium? *Jamaicense*, Schott & Endl. Melet. p. 12.
Hab. In sylvis savannisque Jamaicæ (*Swartz, Purdie, Wilson*). Fl. Jan.–Jul. (*Nom. vern.* "John Crow's nose.")

Richard suggested the separation of this from *Helosis*, with which genus however it entirely agrees in the structure of the flowers of both sexes, but differs remarkably in habit, in the leafy peduncles, and imbricated bracts of the capitulum. Like its congeners, it varies extremely in stature and in the relative size of its organs; old specimens form subterranean masses a foot in diameter.

The rhizome on a transverse section presents a thick, brown, cellular cortical layer, formed of hexagonal cells full of starch-granules and chlorophyll, with occasionally masses of sclerogen-cells. The axis is occupied by a slender column of cellular tissue forming a true pith; it is surrounded by a layer of long woody sclerogen-cells or tubes that pass between the wood-wedges as medullary rays, and are there shorter and cubical. The wood-wedges are about twenty, lanceolate (on the transverse section), symmetrically disposed round the axis, and are composed of pale slender tubes, which are scalariform or subspirally marked. Outside of each wedge is a bundle of liber-cells, which are long sclerogen-tubes. This arrangement accords with that of *Helosis*, and is essentially exogenous.

The young peduncle and capitulum are wholly concealed by the imbricating scales and bracts, which are hexastichously arranged in my specimens, but pentastichously as described by Swartz. As the peduncle elongates the bracts fall away from the lower part of the capitulum, leaving an areolated surface; the uppermost are persistent for a considerable period. The upper part of the peduncle or base of the capitulum is rough with conical papillæ, which become fusiform and slenderer upwards as they mix with the articulated threads and female flowers, of which they appear to be arrested states.

The female flowers protrude their styles, which are bent down under the bracts, as soon as the latter fall away, and the evolution of the flowers follows the same law as in *Helosis*. The ovary resembles that of *Scybalium* more than of *Helosis*, being broader, with larger semicircular lips to the calyx and short stout diverging styles. The fruit is broadly ovoid, truncate at both ends, striate, sulcate towards the apex, and more turgid than usual amongst the *Helosideæ*. On a transverse section the style is found to consist of about eight large cells surrounding a few smaller ones that enclose a soft conducting tissue. The seed is broadly oblong, compressed, very oily, of the same structure as *Helosis*.

The articulated threads of the capitulum are (like the ovaries) much broader in this genus than in its allies, and are often fusiform and geminate. The apical cells turn black, and their cell-walls become minutely wrinkled soon after the bracts fall away.

The male flowers have often a 4-lobed perianth, and the odd lobe is as often the lower as the upper; there being no constant arrangement of the lobes with reference to the axis of the capitulum. The anthers are 2-celled, narrow oblong, and the pollen escapes through an irregular opening at the apices of the loculi: the filaments are free just below the insertion of the anthers. Pollen globose, with four minute papillæ on the surface.

XII. RHOPALOCNEMIS, Junghuhn.

CHAR. EMEND.—*Rhizoma* deforme, globosum, lobatum. *Pedunculi* basi volvâ carnosâ irregulariter fissâ circumdati. *Capitula* elongata, bracteis peltatis deciduis velata, unisexualia, filis articulatis densè obtecta. FL. ♂. *Perianthium* campanulatum, integrum, basi columnæ stamineæ adnatum. *Filamenta* coadunata, longè exserta; antheræ 3, 2–4-loculares, arctè cohærentes, apice dehiscentes. FL. ♀ oblongæ, compressæ; perianthio bilabiato; stylis 2 elongatis; ovulo 1 pendulo. *Fructus* lineari- v. ovato-oblongus, turgidus. *Semen Heloseos.*

1. RHOPALOCNEMIS PHALLOIDES, Junghuhn, in Nov. Act. Acad. Cæs. Nat. Cur. vol. xviii. Suppl. p. 215. (TAB. XII.)

Phæocordylis areolata, Griff. in Linn. Soc. Trans. xx. p. 100. t. 8, descript. incompleta.

Hab. Sylvis *Acaciæ* montibus Ins. Javæ, alt. 7000 ped. (*Junghuhn*)! Sylvis densis montium Khasiæ, et Himalayæ orientalis, Nepaliæ orientalis et Sikkim, alt. 6–8000 ped. (*Griffith, Thomson, J. D. H.*). Fl. Jul.–Sept.

This most remarkable plant has been much misunderstood, both by the author of the genus, M. Junghuhn, and more recently by Griffith. From Junghuhn's description it is probable that his specimens were most imperfect, and perhaps covered with mould. The museum at Kew is indebted to Prof. de Vriese of Leyden for beautiful Javanese specimens of both sexes, which being authentically named, enabled me to recognize Junghuhn's plant as identical with the Himalayan and Khasian one; and which, making allowance for the absence of male flowers, and for his erroneous description of the females, is also identical with the *Phæocordylis* of Griffith, gathered at the same spot in the Khasia Mountains where Dr. Thomson and I procured an abundant supply of specimens.

Rhopalocnemis is by far the largest and the handsomest of the *Helosideæ*, and it is the only one which I have had an opportunity of examining in a living state; it is most closely allied to *Corynæa*, differing in the presence of a volva and in the unisexual capitula. It grows gregariously, in shady mountain woods, its large heads of a pale yellow-brown colour alone appearing above ground: it is of a firm, fleshy consistence, perfectly inodorous even when decaying. I have vainly tried to induce the ripe seeds to germinate, and have examined many hundreds in the fruitless attempt to discover any embryo in the mass filling the whole cavity of the seed. During the shedding of the fruit, the capitula (of gathered specimens) copiously exuded a transparent sugary fluid, but I have never observed this on the living plant: it is no doubt analogous to the fluid described by Weddell as bathing the capitula of some *Balanophoreæ*, and supposed by that author to be of use in the operation of fecundation.

The rhizome varies from the size of an egg to that of the human head, and is supplied internally with many stout woody branches, which appear continuous with the wood of the rootstock, and which upon maceration are found to send continuous bundles to the top of the capitulum. The peduncles are solitary, or many together on large rhizomes, and are enveloped at the base by a hard, fleshy, erect, cylindrical volva, $\frac{1}{2}$–2 inches high; they vary in length from 2 to 6 inches, and in diameter from $\frac{1}{2}$ to 2 inches; they are altogether naked below, but in the upper part are covered to a greater or less distance below the capitulum with fleshy, patent, and somewhat recurved scales, $\frac{1}{4}$ inch long, which appear to be persistent, and to occur chiefly on the male plants. The hexagonal fleshy scales which cover the whole capitulum are altogether similar to those of *Helosis*; as are the female perianths to those of *Corynæa*, and the males to those of *Helosis*.

In flowering, both males and females expand at the same time, throwing off their cohering bracteal scales in large masses, and exposing a velvety pile of styles, and a dense mass of subjacent articulate threads. There are several crops of male flowers, which expand successively; and in the dense humid calm woods in which this genus grows, insect agency is probably necessary to impregnation. During the ripening of the fruit, the surface of the capitulum becomes areolated from the swelling of the masses answering to an obscure lobing of that organ, and at first externally defined by one of the fallen bract-scales, and internally by a vascular bundle from the plexus of vessels within the capitulum.

My examination of living specimens, both in the Khasia Mountains and in Sikkim, led to no results which may not as well be obtained from those preserved in spirits, for the sphacelation and browning of the cut surfaces were so instantaneous, that I had to put the sections in spirits as soon as made. A careful study of the ovule and seed at all stages of growth led to the same conclusions as were obtained from *Balanophora involucrata*. After flowering, the capitulum and peduncle wither, dry, and fall away from the base of the volva, but do not deliquesce nor turn putrid, nor are they attacked by insects to any extent. Each peduncle seems to become detached from the rhizome by a very obscure articulation, which may be seen as a dark transverse line, on a longitudinal section of the base of the peduncle, some time before its falling away. The rhizome is perennial, but does not give forth its buds until July, and the plant ripens its fruit in September.

The apex of the stigma, described and figured by Griffith as an opaque rounded body, is when young, and even after impregnation, perfectly simple.

The apices of the articulated hairs consist of several series of cells, which are (as figured by Griffith) much darker than the rest; and the outer cell-membrane becomes transversely wrinkled, as in the South American *Helosideæ*.

XIII. CORYNÆA, Hook. fil.

Rhizoma deforme, lobatum. *Pedunculi* nudi. *Capitula* androgyna, squamis hexagonis peltatis velata. FL. ♂. *Perianthium* infundibuliformi-campanulatum, margine crenatum. *Antheræ* 3 v. synema 6-loculare. FL. ♀. *Heloseos.*

1. CORYNÆA CRASSA, Hook. fil.; capitulis clavatis cylindraceis. (TAB. XIII.)

Hab. Sylvis densis *Cratægi, Thibaudiæ* et *Befariæ,* prope S^ta^ Fé de Bogota, Novæ Granadæ, alt. 8000 ped. (*Purdie,* 1846).

Rhizoma lobatum, a magnitudine nucis *Juglandis* ad capitis humani. *Pedunculi* plurimi, juniores basi annulo cincti, 1–8 unc. longi, $\frac{1}{2}$–$1\frac{1}{2}$ unc. crassi, nudi, cylindracei. *Capitulum* obovato-oblongum v. clavatum, in pedunculum attenuatum, flores perplurimos utriusque sexus gerens, filis articulatis immixtis. FL. ♂ ad basin capituli plurimi. *Perianthium* basi cum tubo stamineo connatum, supernè ampliatum, filis paullò longius, margine crenatum, rariùs fissum. *Columna* staminea longè exserta, filamentis omninò coalitis. *Antheræ* 3, 2-loculares, arctè cohærentes, introrsùm et ad apices dehiscentes. *Pollen* 3–4-nucleatum. FL. ♀. *Ovarium* obovato-oblongum, compressum, limbo perianthii breviter bilabiato coronatum; *styli* graciles, elongati. *Fructus* latè oblongus v. orbicularis, compressus.

This fine species often weighs many pounds, and is so abundant that the roots of a plant attacked by it resemble a mass of potatoes. The rhizome encloses the roots of the plant on which it grows parasitically. In the evolution of the flowers it follows the same law as *Helosis*. The male flower entirely resembles that of *Rhopalocnemis*. After the fall of the scales from the capitula, both the stigmata and the tips of the articulate threads covering the head sphacelate; the latter wrinkling, and the stigma, which consists of two series of globular cells (enclosing a mucilaginous passage down the style), becomes minutely punctulate. The body of the style consists of about eight large peripherical cells, enclosing the cellular conducting tissue. The cavity of the ovarium is small, compared with its congeners; and the seed * is also small and broad.

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* In Tab. XIII. figs. 11, 12, 13, I have figured a large embryo in the axis of the seed: this I found in only two fruits (now ten years ago); but having many times since attempted in vain to find another, I withheld all allusion to it in the body of this memoir. Since Mr. Weddell has informed me of the very rare occurrence of the calyx in *Sarcophyte,* I have been induced to reconsider the propriety of introducing these drawings, and now do so with the more confidence from the embryo of *Sarcophyte* being so entirely similar to this.—Kew, Aug. 2, 1856.

At the earliest period each female flower often appears as two flagon-shaped bodies, connate from the middle downwards; and at that stage is evidently composed of two ovaria: when fully formed, and the scales are still attached to the capitulum, the styles are exserted far beyond the articulate threads, and are sharply bent down, so that the stigmata are in contact with the apices of the threads. The utricular tissue of the capitulum is composed of hexagonal cells, each containing a loose inner coat, full of starch and endochrome.

2. CORYNÆA SPHÆRICA (Hook. fil.); capitulo solitario globoso cavitate rhizomatis semi-immerso. (TAB. XIV.)

Hab. Sylvis montanis Novæ Granadæ, alt. 5–8000 ped. (*Purdie*).

Rhizoma deforme, lobatum, diametro 2–4 unciali, infra capitulum in cupulam hemisphæricam marginibus crassis obscurè lobatis ampliatum. *Pedunculus* brevis, crassus, nudus. *Capitulum* exactè globosum, 2 unc. diametr., squamis peltatis hexagonis velatum. *Flores* masculi ut in *C. crasso,* sed perianthio breviore latiùs campanulato truncato obscurè trilobo.

A very different species from *C. crassa.* The rhizome completely surrounds the root of the stock; and in a transverse section I find that the latter is sometimes so completely broken up, that the end which enters seems cut off from that which leaves the rhizome. (See TAB. XIV. fig. 14.)

3. CORYNÆA PURDIEI (Hook. fil.); rhizomate depresso horizontali lato lobato, pedunculis brevibus crassis, capitulis oblongis globosisve.

Hab. Sylvis montosis Novæ Granadæ (*Purdie*), radicibus *Cinchonæ*: sylvis prope St. Juan del Oro, Peru (*Weddell*).

I am indebted to M. Weddell for an excellent drawing and specimen of this very distinct little species, of which I had previously received a small example from Mr. Purdie. The rhizome forms a continuous broad flattened lobed mass enveloping large roots of *Cinchona* several inches to half a foot in extent, and is about ¾ inch in average thickness. The lobes are but little elevated, and give off short white peduncles, ¾–1 inch high, that are conical below and about ½ inch in diameter. The capitula are nearly globose or ovoid, about 1½ inch diameter, are quite white at first, but covered with red-brown hexagonal peltate scales. The flowers entirely resemble those of *C. sphærica.*

There is sometimes a very obscure volva at the base of the peduncle.

XIV. HELOSIS, Rich.

(TAB. XV. & XVI.)

Caldasia, Mutis, Sem. Nov. Granad. *Lathræophila,* Leandro de Sacram.

Rhizoma horizontale, gracile, teres, ramosum, hic illic nodosum, ad nodos pedunculos (ramos floriferos) emittens. *Pedunculi* erecti, basi v. medio v. infra capitulum involucello annulari donati, rariùs omninò nudi. *Capitula* androgyna, filis articulatis operta, juniora squamis peltatis hexagonis velata. FL. ♂. *Perianthium* tubulosum, limbi lobis 3 valvatis, tubo intùs basi rudimento ovarii conico instructo. *Synema* fauce perianthii adnatum. *Antheræ* 3, introrsæ, in massam 6–12-locularem coadunatæ. FL. ♀ subsessiles. *Ovarium* elliptico-oblongum, utrinque obtusum, compressum, limbo perianthii breviter bilabiato coronatum, 1- (rarius 2–3) loculare. *Styli* 2, rariùs plures, filiformes. *Stigmata* subcapitata, papillosa. *Ovulum* 1, pendulum. *Fructus* subcrustaceus. *Semen* 1, achenio conforme, testâ tenuissimâ hyalinâ reticulatâ.

Helosis appears to be the commonest American genus of the Order, inhabiting both sides of the Andes, and extending from Mexico to the river la Plata. The species much resemble one another in general characters, and are of a whitish colour tinged with red, and become red-brown when dry: they are said to inhabit moist grounds, where their rhizomes spread annually by innovations to a considerable distance, seeking nourishment from various roots in their progress, and seeming to have the power of attacking such as they come in contact with. Each year's rhizome is probably annual, and it gives off an innovation before dying, as described by Richard; the whole mass sometimes perishes at once.

The parasitism is simply that of adhesion by the contact of the tissues of the *Helosis* with those of the root-stock; in the older specimens there are no vascular bundles uniting both, and the roots attacked do not swell up to any remarkable size at the point of union; though the parasite often penetrates deeply into the wood by a conical protuberance. In very young plants, however, the wood of the root-stock ramifies extensively through the tubers of the parasite. A transverse section of the rhizome shows a most distinctly exogenous structure, very curiously modified, and varying considerably in the different species, under which the details will be given which have been already referred to in the general remarks on the anatomy of the Order.

The peduncles are always erect, and rise from a swelling on the rhizome, whence they receive many vascular bundles. The bundles in the peduncle are, however, simple, and either promiscuously scattered, or arranged in a circle; each resembles in structure that of a monocotyledonous stem, having its own liber, wood, and vascular portions; but the bundles do not follow the course that they do in endogenous stems, and are not to be regarded as indicating any affinity between *Helosis* and Monocotyledons: they are, in fact, solitary bundles such as occur in the leaves, and often in the annual flowering branches of other Exogens.

An incomplete involucre, generally divided into 3–6 broadly ovate segments, is frequently present in this genus; in *H. Guyanensis* it is placed at the base of the peduncle, in the Andes variety of that species it is carried up towards the apex, while in *H. Mexicana* it is either reduced to an elevated ridge round the centre, or entirely absent. When fully developed, this involucre never encloses the young capitulum.

Hexagonal, peltate, fleshy scales cover the whole capitulum, as in the Indian *Rhopalocnemis*. In a very young state these will be found to be developed as imbricating, ascending, bracteal leaves, each covering a definite portion of the inflorescence, which is indicated by a vascular bundle, given off from a plexus in the body of the capitulum; their position is hence analogous to bracts subtending branches of a flowering axis. As the inflorescence grows, they become peltate, hexagonal from mutual pressure, and adhering by their contiguous edges, fall away in large masses, leaving corresponding areolæ faintly marked on the capitulum.

The male flowers have usually a conical body at the base of the tube of the perianth, which probably represents a rudimentary ovary. The filaments are free just below the anthers, to a greater or shorter distance, which varies in the individual species, as does the length of the filaments. The anthers burst introrsely; they are firmly united into an obtusely trigonous mass enclosing a central cavity; each is 4-celled, the mass consequently being originally 12-celled: the cells are shown in a transverse section to be disposed in two concentric series, of which the inner has much the smallest cells; generally the two rows become confluent.

The female flower offers little worthy of notice, except the occasionally 3-lobed young flowers, indicating three ovaria, as figured in Tab. XVI. figs. 8, 9, 10; and the anomalous membrane enveloping the terminal cells of the articulated threads in *H. Mexicana*, which is probably mucous, and may be the source of the fluid which is said to bathe the capitula of some species during flowering, and thus to facilitate the dispersion of the pollen.

1. **Helosis Guyanensis**, Rich. Mém. Mus. viii. p. 416. t. 20; Martius, Nov. Gen. et Sp. Plant. Bras. iii. p. 184, t. 300 & 208. fig. 2.

Caldasia Cayennensis, Mutis, fid. Steud.

Cynomorium Cayennense, Swartz, Fl. Ind. Occ. i. 13.

Var. α. pedunculo elongato gracili, volva v. involucro ad basin pedunculi.

Var. β. pedunculo abbreviato, volva v. involucro ad basin pedunculi. *H. Brasiliensis*, Schott & Endl. Meletem. p. 12.

Var. γ. *andicola*, pedunculo brevi, volva v. involucro 4–6-fido infra capitulum sito.

Hab. Sylvis humidis Guiana, *Richard*; Para, *Martius*, *Spruce* (Aug.–Dec.); Jamaica et Trinidad, *Purdie* (May 1848); Berbice, *Schomburgk*; Pampas, Buenos Ayres, *Miers*.—Var. β. Rio de Janeiro, *Miers*; Serra d'Estrella, Brasiliæ, *Schott*.—Var. γ. Vegas de Rio Quindiu, *Goudot* (in Herb. Webb, No. 140).

This remarkable plant has been well described by Swartz, and again (with illustrations) by the elder Richard, and by Von Martius. It appears to be common in damp woods, on the east coast of South America, ranging from Trinidad to south of the Equator. It varies extremely in size, being from an inch to nearly a foot in height; with slender or robust peduncles and rhizomes, and ovoid or subcylindrical capitula, which (according to a drawing by Sir Robert Schomburgk) are sometimes lobed or even deeply bifid at the summit. Schott and Endlicher have made a species of the var. *Brasiliensis*, because of its 3-lobed involucre and small size; but the involucre is generally 3-lobed, and is described as such in the Guiana species by Richard and Martius, and Miers's Brazilian specimens have 5–6-lobed involucres.

The rhizome creeps to great distances in spongy soil, forming adhesions with the roots it encounters. A transverse section of Trinidad specimens displays an arrangement of the tissues in several respects closely resembling that of many Menispermous plants.

The axis, or position of the pith, is occupied by a cylinder of elongated, hard, woody, cylindrical tubes, with very narrow, often interrupted cavities, and this sometimes surrounds a central pith of loose hexagonal cells*. These tubes become broader and shorter

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* The occasional presence of a cellular pith within this woody axis is important, as it reduces the type to which *Langsdorffia* belongs, which has no cellular pith, to that of most other *Balanophoreæ*. It is a curious fact, that in many *Balanophoreæ* the relation of the vascular system to the cellular is reversed, in respect of the latter being excessively dense, hard and rigid, whilst the true woody system is composed of extremely lax, soft, thin-walled vessels,—of ducts, in fact, with little or no pleurenchyma.

between the wood-wedges, where they appear as medullary rays, lastly passing into the loose hexagonal tissue of the circumference of the rhizome.

Seven narrow, elliptical, pale white wedges succeed the woody axis that occupies the position of the pith, then radiate, are equal in length to about half the radius of the rhizome, and placed midway between the periphery and circumference; they are separated from one another by the broad medullary rays, which assume the character of cubical, hard, brittle wood-cells consolidated into one dense firm mass, protecting the softer tissue between them. The wedges themselves are formed of delicate, white, large tubes, placed end to end, and transversely marked with short lines, annular or spiral bands.

A broadly semilunar or kidney-shaped mass of wood-cells (liber) is placed externally to each vascular wedge and curves round its outer extremity, and is either placed closely in apposition to the vascular wedge, or is separated from it by a little cellular tissue. These wood-cells are very large and thick-walled, are vertically elongated, and form long parallelograms placed end to end, and adhering firmly one with another, become of a dense yellow, almost crustaceous or osseous consistence; their walls are everywhere perforated by minute canals, giving them a punctate appearance.

The cortical portion or cellular tissue of the periphery is formed of hexagonal thick-walled, almost woody cells, with perforated faces, and there are scattered irregularly through it very large sclerogen-cells and liber-bundles. This cortical portion is spongy in consistence, and its hexagonal cells gradually pass into the cubical ones of the medullary rays.

Such appears to be the arrangement in the first year; in the second, more woody liber-bundles are formed outside the semilunar ones, and alternating with them. The wedges of vascular tissue do not appear to be added-to much, but there is an appearance of incompleteness towards their circumference, as if a cambium-layer existed there. Strictly speaking there are only two well-defined kinds of tissue in the rhizome:—1. the delicate vascular wedges, and 2. the coarse, hard, hexagonal cellular tissue of the periphery, which becomes indurated between the vascular wedges and passes into the slender woody tubes of the pith: the other tissues that are so conspicuous on a transverse section are not so on a vertical one, the broad sclerogen-tubes of the semilunar bundles of liber differing little from the cubical cells surrounding them, and the liber-bundles of the periphery altogether resembling the long woody tubes of the pith.

Many deviations may be found in different specimens from the above-described arrangements of the cellular and vascular systems of the rhizome; but all, I think, may be easily reduced to this type.

The vascular system of the peduncle consists of scattered bundles that run free and unbranched from the rhizome to the capitulum, where they partially anastomose, forming a plexus within the circumference, from which bundles are given off with great regularity towards the base of each scale. I do not find the tissues of these bundles to be more than rudimentary; but traces of their each consisting of a bundle of woody tubes towards the axis, followed by delicate transversely barred vessels, and these again by sclerogen-tubes, may, I think, be detected.

Richard describes the styles as occasionally united at their bases, which I have never seen; he also states that he has never observed the plants to be truly parasitical, though their roots intertwine with those of other plants: my specimens undoubtedly contract broad organic adhesions with the roots they encounter, and in the young state receive woody bundles from them. Richard's admirable account of the epoch of fecundation agrees with what I have observed in the monœcious *Balanophoræ* of India. The capitula are never self-fertilized; the styles of the female flowers are protruded immediately after the fall of the scales, and fertilized by the pollen of a neighbouring capitulum; the styles then fall away, and during the maturation of the fruit, the male flowers are protruded and shed their pollen to fertilize another capitulum; by the time that the latter operation is performed the fruits have ripened, are shed, and the peduncle and capitulum perish, though the latter still contains an abundant crop of young male flowers, apparently destined never to perform their functions. This apparent superfluity of male blossom is a very remarkable phænomenon, and not at all comparable with the common one of numerous male flowers on one inflorescence never becoming perfected except under favourable conditions, for in this case there appears to be a second crop of males after the first have performed their office, and after the females of the same and all the other capitula are fertilized, and it is difficult to conceive any circumstances arising at all likely to call for the operation of these complementary males.

Martius mentions that a beetle of the family of *Curculionidæ*, or its larva, possibly assists in the fecundation, as it is found nidulating in the capitula; judging however from the fact of one capitulum being fecundated by another, the larvæ could be of little use, nor can the beetles themselves be of much, under ordinary circumstances.

Martius mentions delicate thread-like radicles as proceeding sometimes from the base of the seed (embryo): that author also states that the disposition of the vascular system, both in its nature and arrangement, is monocotyledonous, an error to which I have elsewhere alluded in my general remarks on the Order.

Schott and Endlicher (Meletem. p. 8) observe, that in their *H. Brasiliensis* there are sometimes two and even three cavities in the ovarium, accompanied in the latter case by three styles. I have never seen such an arrangement in any specimens of this species, but indications of it will be shown to occur in the lobed young flowers of *H. Mexicana*. Swartz (Fl. Ind. Occ.) describes the styles as sometimes solitary, probably from one having fallen away, as he did not examine living specimens.

In the variety γ, for which I am indebted to the late P. B. Webb, Esq., the cellular tissue of the periphery consists of vertically elongated and much more delicate utricles, often filled with starch and chlorophyll grains: there is also a slender central column of true cellular pith surrounded by those woody tubes that are often seen to be the only pith of the varieties α. and β.

2. Helosis Mexicana, Liebmann, Proceedings of the Scandinavian Meeting of Naturalists, p. 181.

H. aquatica, Mutis MSS. in Herb. Hook.

Hab. Mexico montibus ditionis Vera Cruz et Oajaca, alt. 3–5000 ped., *Liebmann* (v. ic. pict. a cl. auct.). Mirador (*Linden*), Jul. Convallibus humidis Novæ Granadæ ad Melgar (*Purdie*), Febr. 1846.

Less variable in form and more so in robust or slender habit than the preceding. The earliest stage at which I have examined this plant is that of an amorphous cellular hemispherical mass nidulating within and almost enclosed by the bark of the roots, into the wood of which it had penetrated, its cellular tissue being in immediate contact with the wood-fibres: in this early stage it contained no vascular tissue and no traces of lobing or of peduncle. When fully developed, this species so entirely resembles *H. Guyanensis* in all but the nature and position of the volva or involucre (here reduced to an oblique ring about half-way up the peduncle), as to preclude the necessity of a detailed description, and I shall proceed at once to some remarks on its structure and development.

The structure of the wood of the rhizome is essentially the same as that of the preceding species. The vascular bundles of the peduncle are, however, more regularly disposed. The young peduncles arise as buds from circular depressions in the rhizome, and do not exhibit any volva or involucre.

The scales on the young capitulum are all ascending and imbricating, and do not assume the peltate and hexagonal form till a subsequent period.

At the base of the capitulum are seen several rows of small conical protuberances that appear to be undeveloped bracts. The annular projection which represents an involucre never to be developed, is situated close under the capitulum for some time after the lengthening of the lower part of the peduncle; finally, however, the upper part of the peduncle elongates most, and the annulus hence occupies a middle position upon it.

The articulated threads of the surface of the capitula are stout, of several collateral cells in breadth, and the upper eight or ten cells are smaller and become sphacelate very soon. In a young state these terminal cells are seen to contain several nuclei, and they are all enclosed in a membrane of excessive delicacy, forming a balloon around them; they appear much whiter than the other cells at this early period, but afterwards are darker and become minutely wrinkled on the surface.

At the earliest period at which the female flowers can be recognized, they appear as minute 2–3-lobed cellular papillæ, broader than long, upon the surface of the capitulum. When 2-lobed, the lobes (which lengthen into styles) are widely separated at their bases and diverge. As they increase, the lobes lengthen and approximate; and if a third one be present, it is the middle one of the three that is suppressed.

At this period the perianth is not distinguishable, but appears after the flowers have assumed their complete form, as a broadly campanulate 2- (sometimes 3–4-?) lobed superior calyx, much larger in proportion to the ovary than at any future period; the styles at the same time have approximated, and appear united at their bases into a conical body surmounting the ovary. The full-grown ovary differs in no important particular from that of the preceding species.

EXPLANATION OF THE PLATES.

TAB. I.

A. *Cynomorium coccineum*, Mich.

Fig. 1. Vertical section of a portion of very young capitulum, showing two bracts and their included masses of flowers;—though the lower limb of each bract immediately covers only the mass of flowers below it, the vascular cord of each bract unites with that of the mass of flowers above it.
Fig. 2. A very undeveloped female flower, showing the vascular cords of the ovary.
Figs. 3, 4 & 5. Hermaphrodite flowers.
Fig. 6. A male flower with a regular 6-leaved perianth.
Fig. 7. A female flower showing at *α*. a mamilla, which may be an undeveloped stamen.
Fig. 8. Portion of a male flower showing an undeveloped ovary *a*, and a wholly inferior perianth.
Fig. 9. Another male flower with undeveloped ovary and wholly superior perianth.
Fig. 10. Vertical section of immature fruit.
Fig. 11. Ripe seed and embryo cut vertically.
Fig. 12. Embryo very highly magnified.
Fig. 13. Apex of style and stigma, showing the two vascular cords and intermediate groove filled with conducting tissue.

All the figures very highly magnified.

B. *Mystropetalon Thomii*, Harv.

Fig. 1. Female flower.
Fig. 2. Apex of style and stigmata.
Fig. 3. Vertical section of unripe fruit.
Fig. 4. Ditto of ripe fruit.
Fig. 5. Transverse section of the same.
Fig. 6. Seed.
Fig. 7. Vertical section of ditto.
Fig. 8. Embryo.

All very highly magnified.

C. *Sarcophyte sanguinea*, Sparrm.

Fig. 1. Male flower.
Fig. 2. Segment of perianth with stamen with undehisced anther.
Fig. 3. Vertical section of the same.
Fig. 4. Transverse section of the anther.
Fig. 5. Vertical section of portion of anther with all the cells burst and pollen discharged.
Fig. 6. Tissues of epithelium and pollen-grains.

All very highly magnified.

TAB. II.

Langsdorffia.

Fig. 1. Portion of plant of *L. rubiginosa* (Weddell), nat. size, from a drawing by Sir R. Schomburgk.
Fig. 2. Female flower.
Fig. 3. The same in a very young state.

Fig. 4. Rudimentary female flowers that occur on the male capitulum.
Fig. 5. Unexpanded male flower with rudimentary female at its base.
Fig. 6. Expanded male flower.
Fig. 7. Transverse section of the rhizome showing the five regularly disposed vascular bundles.
Fig. 8. *a.* Tubular barred vessels that form the woody system; *b.* thick-walled elongated cells that form the liber system.
Fig. 9. Surface of rhizome with hairs.
Fig. 10. Portion of a hair.
Fig. 11. Rudimentary condition of a *Langsdorffia* on a rootlet, cut vertically.
Fig. 12. Portion of a rhizome horizontally sliced, showing the intrusion of the root.
Fig. 13. Swollen portion of a rhizome at the point of junction with a root, showing the rootlets of the latter given off apparently by the rhizome, and partially enclosed in it.
Fig. 14. Transverse section of the same, showing the abbreviated termination of the divisions of the root.
Fig. 15. Apex of a rootlet enclosed within the cellular system of the parasite.
Fig. 16. Vertical section of a portion of a rhizome corroding the bark of a rootlet which it has attacked.
Fig. 17. Another vertical section of a root and rhizome, the former sending vascular prolongations into the latter.
Fig. 18. Another section showing the first contact of a rhizome with a rootlet.
Fig. 19. A portion of a rhizome enveloping the branch of a rootlet.
Fig. 20. Ripe fruit of *L. hypogæa*, Rich.
Fig. 21. Vertical section of the same, showing the pendulous seed.
Fig. 22. Seed removed, showing at *a.* the hilum.

All but figs. 1, 12, 13 & 14, very highly magnified.

TAB. III.

Thonningia sanguinea, Vahl.

Fig. 1. Female branch from Vahl's herbarium.
Fig. 2. Male capitulum from Schumacher's herbarium.
Fig. 3. Vertical section of the same.
Fig. 4. Female capitulum from the same herbarium.
Fig. 5. Vertical section of the same.
Fig. 6. Imperfect male flower from Vahl's specimen: *a.* the bract at its base; *b.* two scales of the perianth.
Fig. 7. Male flower from fig. 2,—the anthers dehisced and partially separated at the apex.
Fig. 8. Transverse section of the synema,—the anther-cells all dehisced.
Fig. 9. Pollen-grains.
Fig. 10. Female flower.
Fig. 11. The same with the free tubular limb of the perianth laid open.
Fig. 12. Another female flower with a more developed perianth.
Fig. 13. Portion of apex of perianth, showing the strong sclerogen-tubes that form its woody system.
Fig. 14. Hair from the peduncle.
Fig. 15. Cellular tissue and vessels of the perianth.

All but figs. 1–5 highly magnified.

TAB. IV.

Balanophora involucrata, Hook. fil.

Fig. 1. Fully-formed individual, consisting of a simple tuberous rhizome, and one branch or peduncle with a hermaphrodite capitulum.
Fig. 2. Vertical section of the same.
Fig. 3. Transverse section of peduncle.
Fig. 4. Ditto of capitulum.
Fig. 5. Cellular tissue of surface of peduncle.
Fig. 6. Transverse, and fig. 7. vertical sections of cellular tissue at the circumference of peduncle, where there is a little deposit of wax.
Fig. 8. Cellular tissue of young peduncle, the cells each with a globule of wax.
Fig. 9. A single cell detached, showing its dotted walls and wax-globule with its nucel.
Fig. 10. Another cell more advanced, with the wax-secreting cell burst and its contents discharged in the cavity of the cell.
Fig. 11. Wax-secreting cells at different stages of growth.
Fig. 12. Cellular tissue of rhizome.
Fig. 13. A single cell from the same.
Fig. 14. Transverse section of portion of peduncle and vascular bundle.
Fig. 15. Vertical section of the same, showing the vascular bundle to consist of simple delicate tubes.
Fig. 16. Cuticle of rhizome with empty bladdery cells that give it a granular appearance.
Fig. 17. Vertical section of a portion of the sheathing upper part of the rhizome.
Fig. 18. Transverse section of ditto.
Fig. 19. Transverse section of the rhizome, showing the symmetrical arrangement of the vascular system.
Fig. 20. Vertical section of the same.
Fig. 21. Transverse, and fig. 22. vertical sections parallel to the radius of a portion of the rhizome, showing the termination of the vascular system.
Fig. 23. Very highly magnified view of longitudinal section of a vascular cord and its surrounding tissues; it consists of barred tubes, *a*, enclosed in a cellular tissue whose cells are filled with viscous fluid, *b*: at *c*, some of the cellular tissue of the rhizome is seen containing wax-deposits.
Fig. 24. Barred vessels from 23 *a*.
Fig. 25. Cells surrounding the same with reticulated walls.
Fig. 26. Imperfectly developed spirally marked tubes from the apices of the vascular bundles of rhizome.
Fig. 27. The same much more highly magnified.
Fig. 28. Another fully formed individual.

All but figs. 1, 2, 3, 4 & 28, very highly magnified.

TAB. V.

Inflorescence of *Balanophora involucrata*, Hook. fil.

Fig. 1. Female flowers intermixed with clavate bracts.
Fig. 2. The same with sessile female flowers and pedicelled bracts.
Figs. 3 & 4. Bracts.
Fig. 5. Two adnate female flowers.
Figs. 6, 7 & 8. Female flowers.
Fig. 9. Ovary with base of style.
Fig. 10. Transverse section of cavity of ovary.
Fig. 11. Vertical section of ovary and ovule.
Fig. 12. Ovule at earliest stage examined, supposed to consist of a simple embryo-sac.

Fig. 13. Vertical section of more advanced ovary.
Fig. 14. Immature seed.
Fig. 15. Apex of style, and pollen-grain; 15 *a*, cells of apex of style before impregnation.
Fig. 16. Base, & fig. 17. apex of style, with pollen-tube traversing it.
Figs. 18 & 19. Male flowers with 2-lobed perianths.
Figs. 20 & 21. Male flowers with 3-lobed perianths.
Fig. 22. Imperfect male flowers showing their reduction to bracts.
Fig. 23. Vertical section of male flower.
Fig. 24. Pollen-grains.
Fig. 25. *Acarus* found on the capitulum.
All very highly magnified.

Tab. VI.

Balanophora involucrata, Hook. fil.

Fig. 1. A young plant which has already caused the root upon which it grows to enlarge very much.
Fig. 2. Vertical section of the same.
Fig. 3. Very highly magnified view of the root and portion of the *Balanophora*, showing the mode of attachment, displacement of the woody system of the root, and apparent interlacement of the vascular systems of the root and parasite: *a.* indicates the bundles of the peduncle, *b.* of the rhizome.
Fig. 4. Very highly magnified slice of the root and parasite at the point of attachment of the latter.
Fig. 5. Transverse section of the root from near the swollen portion, showing the separation of the bark and wood.
Fig. 6. Woody system of the root.
Fig. 7. Vertical section of an exceedingly young *Balanophora*, nidulating in the cellular bark of a root: *a.* spongioles; *b.* position of the nascent vascular bundle in its axis.
Fig. 8. Vertical section of a more advanced, but still very young *Balanophora*, which has apparently germinated on one of the large tubers that this species eventually forms on the roots of maples, &c., and which tuber consists of a confused mass of the tissues of the parasite and root: *a.* spongioles; *b.* nascent vascular bundles in its axis; *c.* root traversing the mass; *d.* cellular tissue of parasite.
Fig. 9. Vessels and cells of the vascular bundle taken from fig. 8 *b*.
Fig. 10. Section at point of union of root, *a*, and parasite, *b*.
Fig. 11. Vascular tissue of the wood of the root taken from fig. 8*c*.
Fig. 12. Very young vascular tissue from the axis of fig. 7.
All but figs. 1 & 2 very highly magnified.

Tab. VII.

A. Male plants of *Balanophora involucrata*, var. *gracilis*, growing on the roots of an Oak. 1. male, and 2. female plant.
B. Male and female plants of *B. involucrata*, var. *Cathcartii*.
Fig. 1. Male flower magnified.

Tab. VIII.

Balanophora fungosa, Forst., from N.E. Australia.

Fig. 1. Plant of the natural size, but the flowers not fully developed.
Fig. 2. Male flower.
Fig. 3. Synema.
Fig. 4. The same with the anthers dehisced.

Fig. 5. Transverse section of column of synema, showing four vascular bundles and anther-cells.

Fig. 6. Pollen-grains.

Fig. 7. Female flowers on the pedicel of the bract.

Fig. 8. Female flower.

Fig. 9. Apex of style.

Fig. 10. Transverse section of rhizome from near the root, showing that the arrangement of the woody systems of the vascular branches that radiate outwards from the root in the mass of the rhizome is the same as that of the root, but dislocated.

Fig. 11. The same from a point further removed from the root, showing a further dislocation of the woody system.

Fig. 12. Very highly magnified vertical section of vascular bundle of rhizome, showing *a.* the cellular tissue of the *Balanophora*; *b.* the cellular tissue surrounding the woody system; *c.* the woody system.

Fig. 13. Cellular tissue of circumference and cuticle of the rhizome.

Fig. 14. Cellular and vascular tissue of the termination of the bundles.

Fig. 15. Transverse section of root of the stock.

Fig. 16. Woody tissue of the root of the stock.

All highly magnified.

TAB. IX.

Lophophytum Weddellii, Hook. fil.

Fig. 1. Portion of section of male inflorescence.

Fig. 2. Ditto of female.

Both magnified.

TAB. X.

Sphærorhizon depressum, Hook. fil.

Figs. 1–4. Individuals at various stages of growth.

Fig. 5. Very young male flower.

Fig. 6. Mature bud of male flower with articulate filaments.

Fig. 7. The same with the perianth partly removed.

Fig. 8. Transverse section of anther-cells.

Fig. 9. Ditto of one anther-cell.

Fig. 10. Tissue of anther-cells.

Fig. 11. Pollen-grains.

Fig. 12. Very young female flower and articulated filament.

Fig. 13. Mature female flower.

Fig. 14. Vertical section of ditto.

Figs. 15 & 16. Articulated filaments.

All but 1–4 very highly magnified.

TAB. XI.

Phyllocoryne Jamaicensis, Hook. fil.

Figs. 1, 2. Male individuals in different stages of growth.

Figs. 3, 4. Female individuals.

Fig. 5. Articulated filaments; 5 *a.* apex of ditto.

Fig. 6. Male flower.

Fig. 7. Male flower with portion of perianth removed.
Fig. 8. Synema with anthers burst at their apices.
Fig. 9. Transverse section of anthers.
Fig. 10. Pollen-grains.
Fig. 11. Female flower.
Fig. 12. Longitudinal section of ditto.
Fig. 13. Apex of style and stigma.
Fig. 14. Transverse section of style.
Fig. 15. Fruit, *in situ*.
Fig. 16. The same removed.
Fig. 17. Vertical section of ditto.
Fig. 18. Seed.
Fig. 19. Grains of albumen.
Fig. 20. Rudimentary flowers at base of male capitulum.
Fig. 21. One of the same detached.
Fig. 22. Another of the same, more developed.
All but figs. 1–4 very highly magnified.

TAB. XII.

Rhopalocnemis phalloides, Jungh.

Fig. 1. Male plant.
Fig. 2. Female ditto.
Fig. 3. Male flower and articulated filaments.
Fig. 4. Transverse section of anthers.
Fig. 5. Female flower and articulated filaments.
All but figs. 1 & 2 highly magnified.

TAB. XIII.

Corynæa crassa, Hook. fil.

Fig. 1. Plant of the natural size.
Fig. 2. Very young plants attached to the branches of a root.
Fig. 3. Bud of male flower.
Fig. 4. Expanded male flower.
Fig. 5. The same far advanced, the pedicel of the synema having lengthened greatly.
Fig. 6. Transverse section of anthers.
Fig. 7. Pollen-grains.
Fig. 8. Very young female flowers, showing the ovary to be 2-lobed at that age.
Fig. 9. Articulated filament and female flower before the falling away of the bracts, showing the position of the styles.
Fig. 10. Mature female flower.
Fig. 11. Vertical section of nearly ripe fruit exposing the seed and embryo*.
Fig. 12. Section of ripe seed and embryo.
Fig. 13. Embryo removed from the seed.
Fig. 14. Apex of style and stigma.
Fig. 15. Transverse section of style.
Fig. 16. Young articulated filament, its cells still nucleated.

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* See foot-note at p. 54.

Fig. 17. Cells from fig. 16, showing the cell-contents.
Fig. 18. Fully formed articulated filaments after the fall of the scales of the capitulum.
Fig. 19. The same, showing the appearance of the terminal cells.
Fig. 20. Old terminal cells of the articulated filaments, showing their wrinkled walls.
All but figs. 1 & 2 very highly magnified.

Tab. XIV.

Corynæa sphærica, Hook. fil.

Fig. 1. Mature, and fig. 2. Immature plants.
Fig. 3. Vertical section of fig. 2.
Fig. 4. Peltate bract.
Fig. 5. Immature male flower and articulated filaments.
Fig. 6. Ditto more advanced.
Fig. 7. Ditto expanded.
Fig. 8. Transverse section of anthers.
Fig. 9. Articulated filaments.
Figs. 10 & 11. Mature female flowers.
Fig. 12. Vertical section of fruit.
Fig. 13. Seed.
Fig. 14. Section of portion of rhizome showing the two portions of the root to be completely severed in the axis of the rhizome.
All but figs. 1, 2 & 3, highly magnified.

Tab. XV.

Helosis Mexicana, Liebm.

Fig. 1. Plant of the natural size.
Fig. 2. Vertical section of capitulum and upper part of peduncle.
Fig. 3. Very young peduncle on a branch of the rhizome.
Fig. 4. Vertical section of the same magnified.
Fig. 5. Portion of capitulum vertically cut, showing the imbrication of the very young bracts.
Fig. 6. Fully developed bract.
Fig. 7. Vertical section of ditto.
Fig. 8. Nascent *Helosis* on a rootlet.
Fig. 9. Vertical section of a very young *Helosis* which has fully established itself on a root.
Fig. 10. Vertical section of a full-grown tuber of the rhizome, showing its attachment to the root.
Fig. 11. Similar section of another and larger one.
Fig. 12. Transverse section of the peduncle, showing eight regularly placed vascular radiating bundles.
Fig. 13. Vascular tissue of the same.
Fig. 14. Transverse section of the rhizome, showing—*a.* lobed medullary sheath surrounding the axis or pith; *b.* wedges of vascular tissue; *c.* liber; *d.* detached masses of sclerogen-cells.
Fig. 15. Cells of liber.
All but figs. 1, 2, 3, 8 & 10, very highly magnified.

Tab. XVI.

Helosis Mexicana, Liebm.

Fig. 1. Bud of male flower.

Fig. 2. More advanced male flower.

Fig. 3. Fully formed male flower with the lobes of the perianth spreading.

Fig. 4. Young synema.

Fig. 5. Fully formed synema.

Fig. 6. Pollen-grains. These are probably incorrectly represented; the appearance of pollen-tubes may be due to the presence of the mycelium of a fungus: these and the pollen-grains were black.

Fig. 7. Tube of the male perianth laid open, showing the conical rudiment of an ovarium at its base.

Figs. 8, 9 & 10. Very young state of female flowers with articulated filaments, showing the compound nature of the ovarium.

Fig. 11. Fully formed but immature female flower, with the limb of the perianth laid open.

Fig. 12. Another female flower of a different form.

Fig. 13. Vertical section of young female flower showing the albumen of the seed to be already formed, apparently before fecundation has taken place.

Fig. 14. Mature female flower.

Fig. 15. Vertical section of the same, showing the pendulous ovule.

Fig. 16. Apex of style and stigma.

Fig. 17. Vertical section of nearly ripe fruit.

Fig. 18. Transverse section of ditto with the seed removed.

Fig. 19. Seed.

Fig. 20. Transverse section of ditto.

Figs. 21 & 22. Articulated filaments, showing the bladdery membrane enclosing the uppermost cells.

Fig. 23. Apex of the same more highly magnified.

Fig. 24. Apex of another articulated filament.

Fig. 25. Transverse section of portion of rhizome: *a.* vascular axis; *b.* medullary sheath; *c.* vascular wedge; *d.* liber; *e.* sclerogen-cells.

Fig. 26. Vertical sections of tissues forming the vascular system from the axis to the circumference: *a.* pleurenchyma that occupies the axis; *b.* medullary sheath; *c.* vascular wedge of wood formed of angular thin-walled vessels; *d.* liber-cells; *e.* cellular tissue.

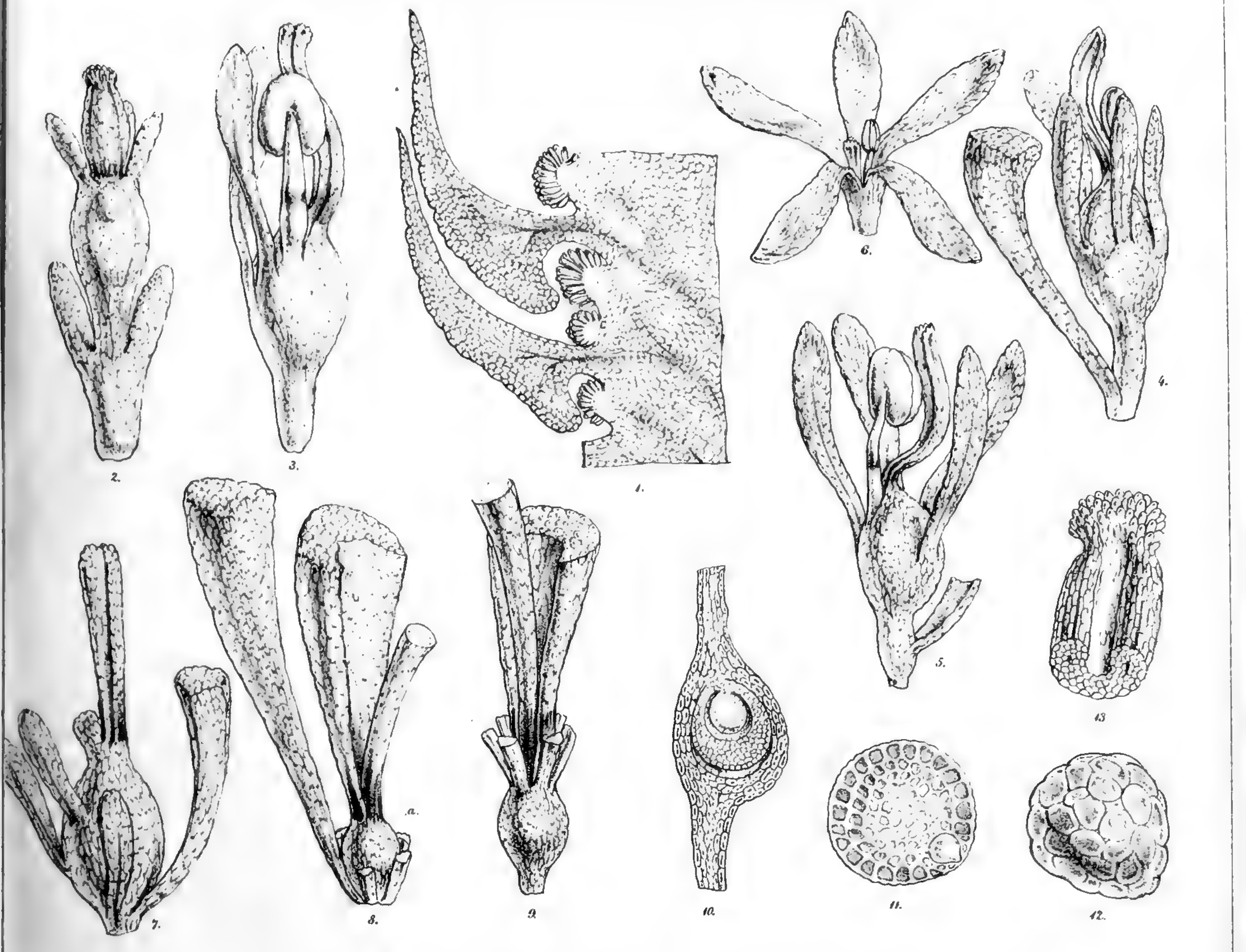
Fig. 27. More highly magnified vessels of axis or pith.

Fig. 28. Ditto of wood.

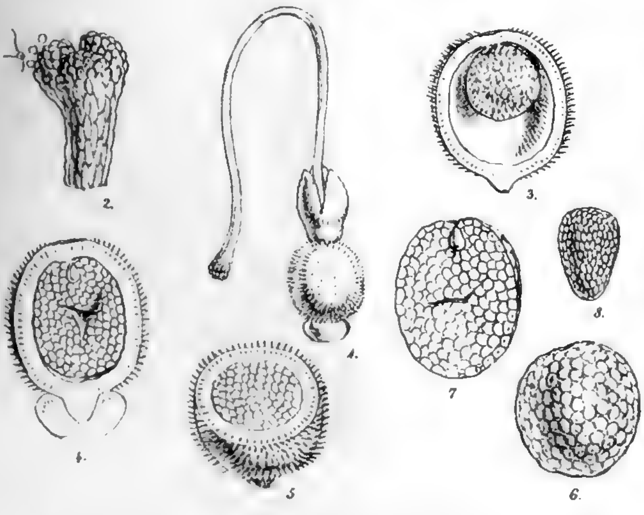
Fig. 29. Transverse section of vascular system;—the letters refer to the same tissues as in fig. 26.

Fig. 30. Section of stem of *Helosis Guyanensis* from Brazil (Mr. Miers), showing the supplementary liber-bundles alternating with those first formed.

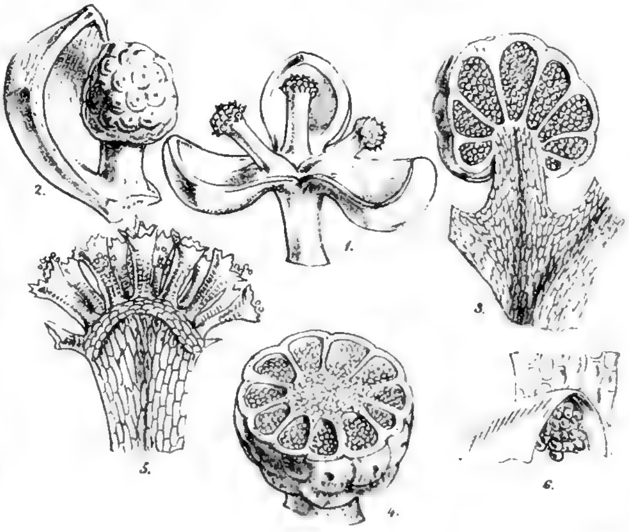
All very highly magnified.



A. Cynomorium coccineum. *Mich*



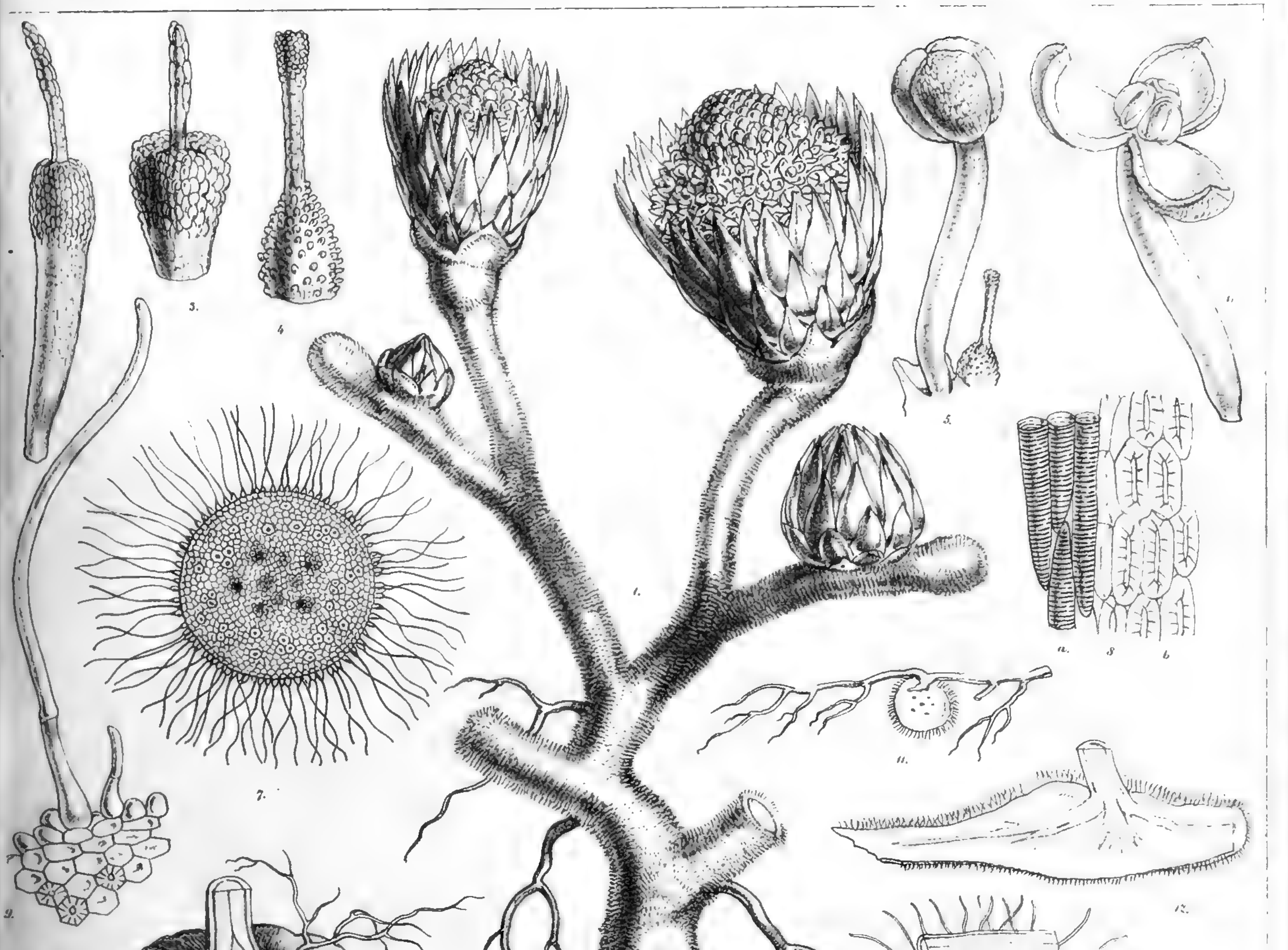
B. Mystropetalon Thomii, *Harv.*



C. Sarcophyte sanguinea, *Sparrm*

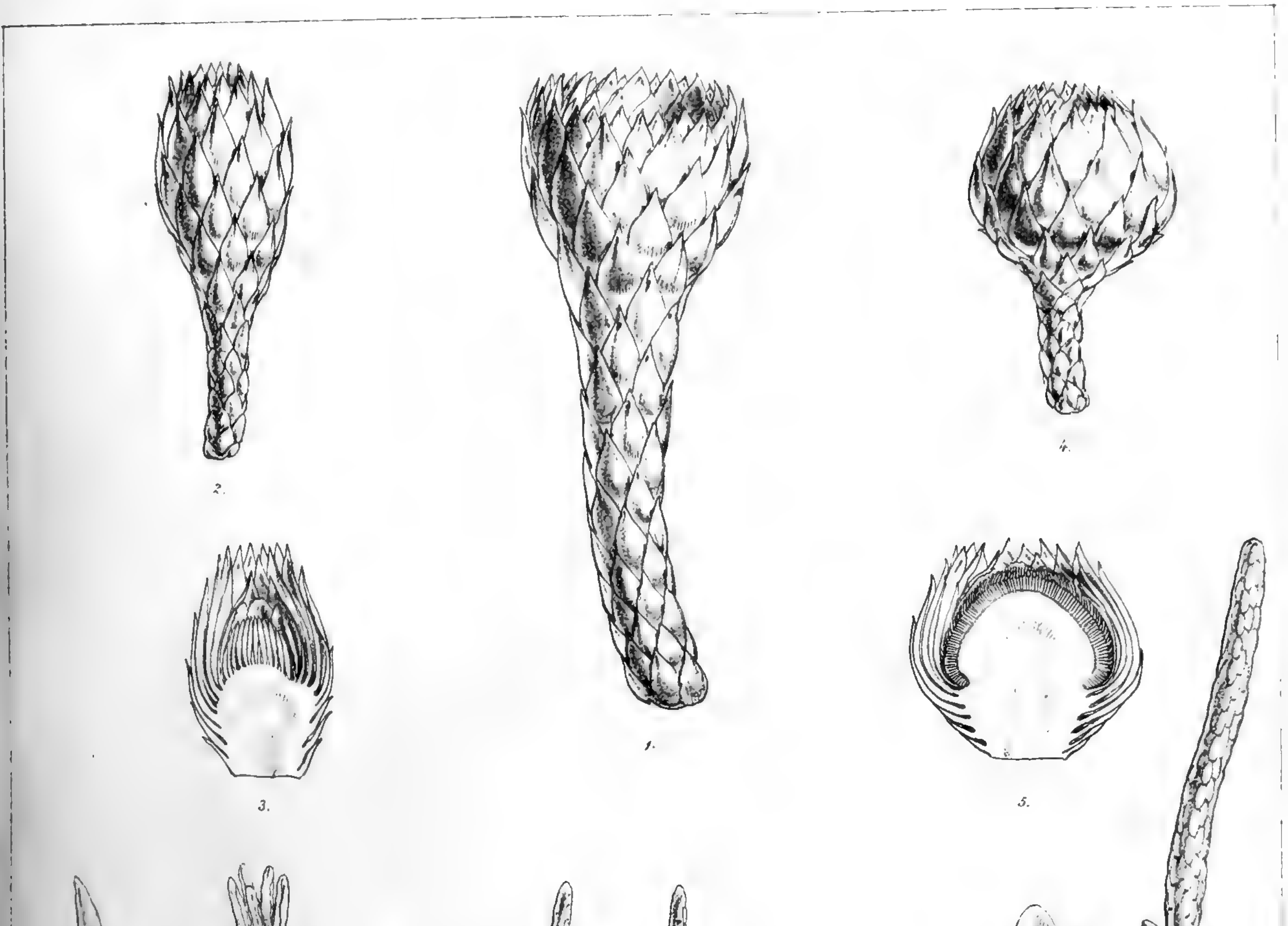
del W. Fitch lith.

Vincent Brooks Imp



J.D.H. del. W. Fitch lith.
Vincent Brooks Imp.

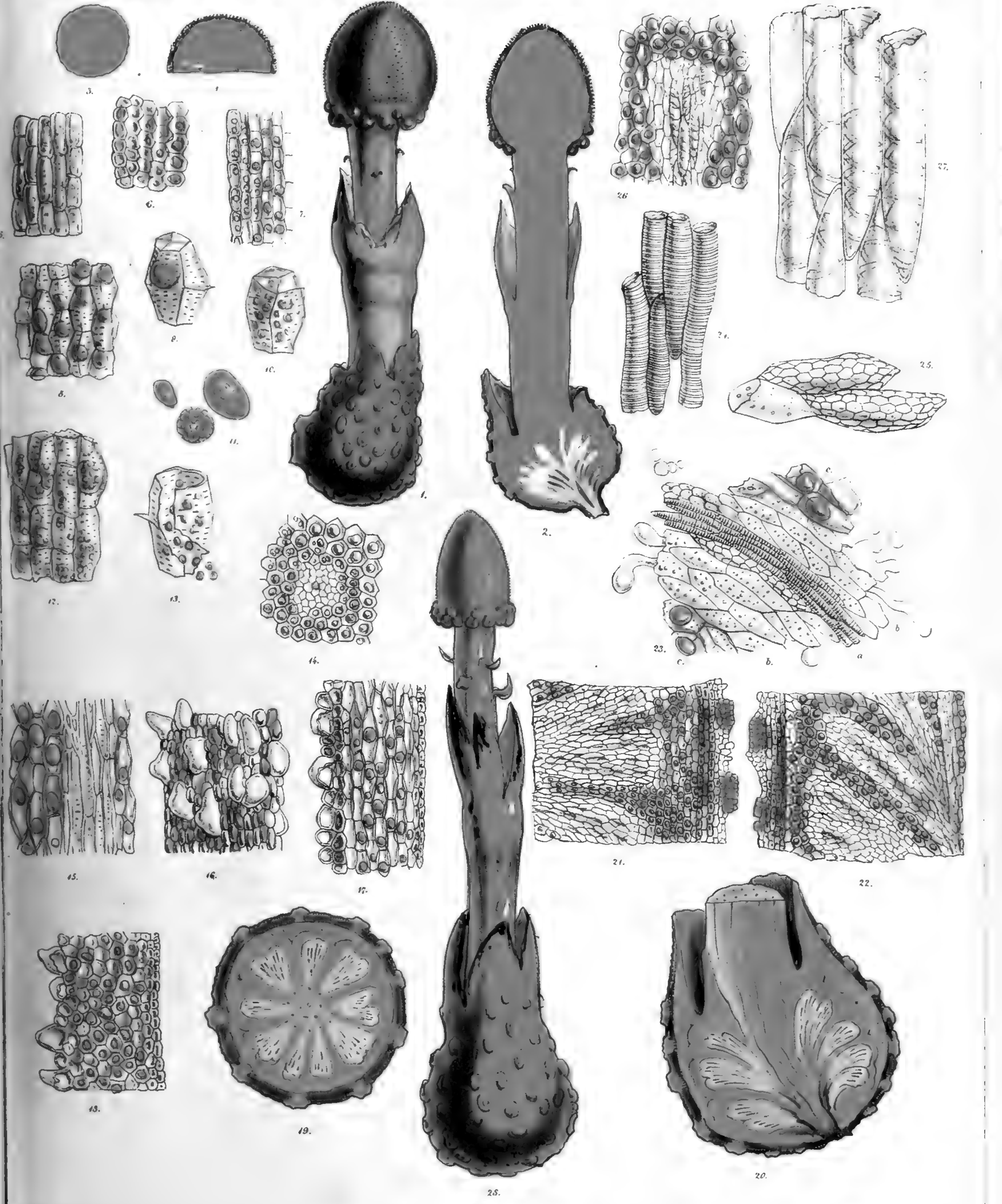
Langsdorffia rubiginosa, *Weddell. (Figs. 1_19.)*
——— hypogæa, *Rich. (Figs. 20_22.)*



J.D.H. del. W. Fitch lith.

Vincent Brooks Imp.

Thonningia sanguinea. Vahl



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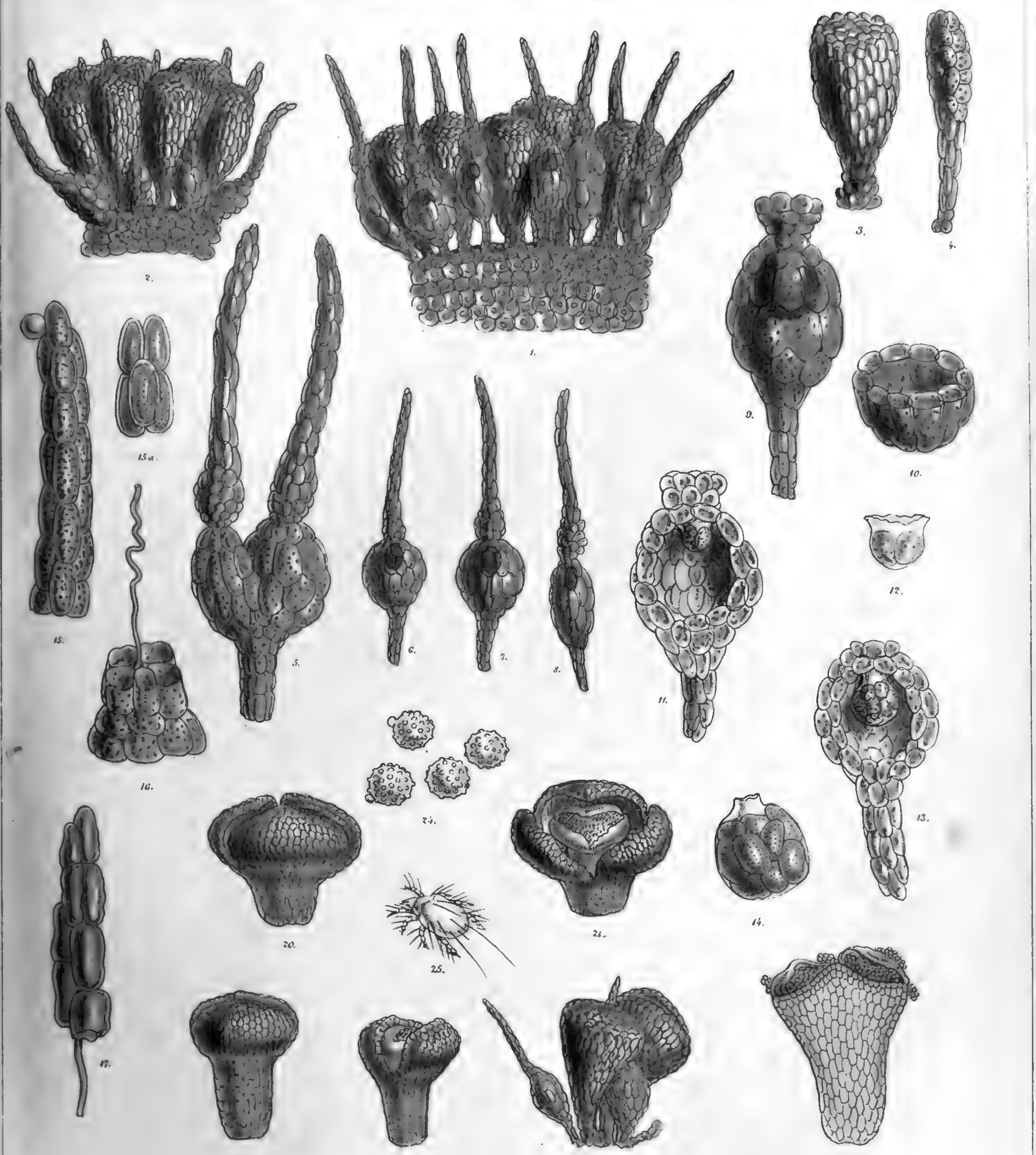
Vincent Brooks Imp.

Balanophora involucrata, *Hf.*



J.D.H del W. Fitch lith.

Vincent Brooks Imp.

Balanophora involucrata H.f.

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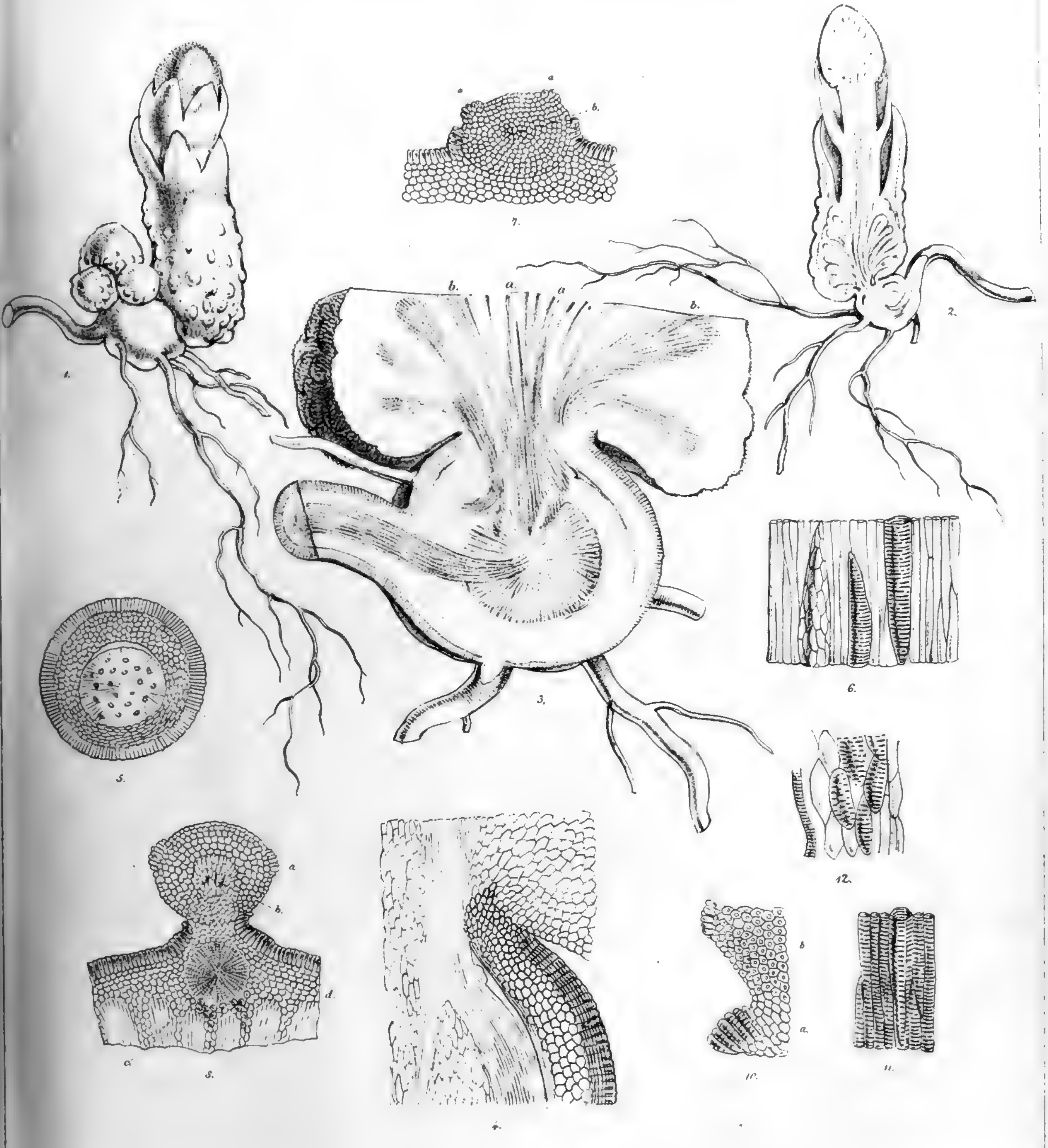
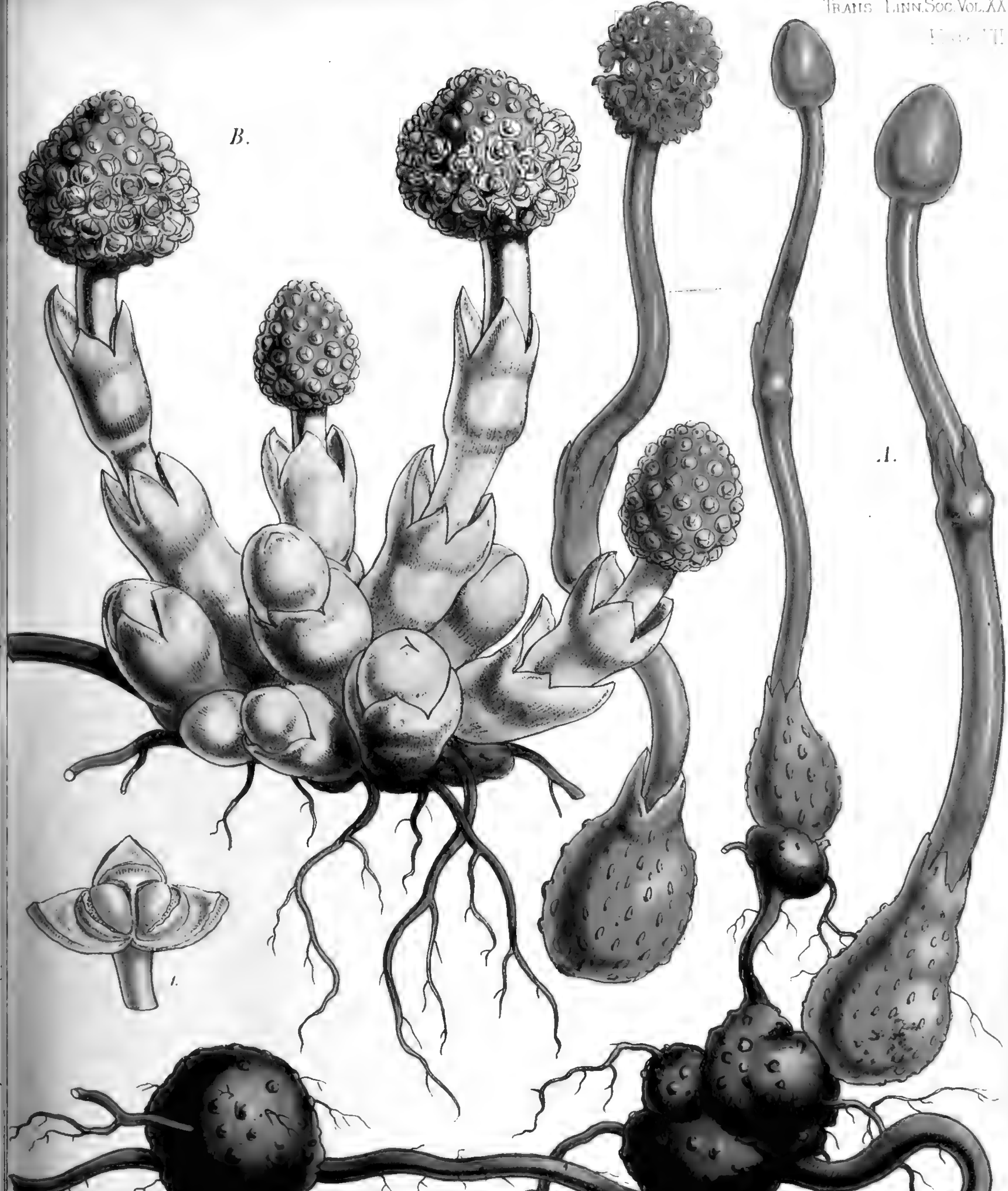
Plate VI.



H del W Fitch lith

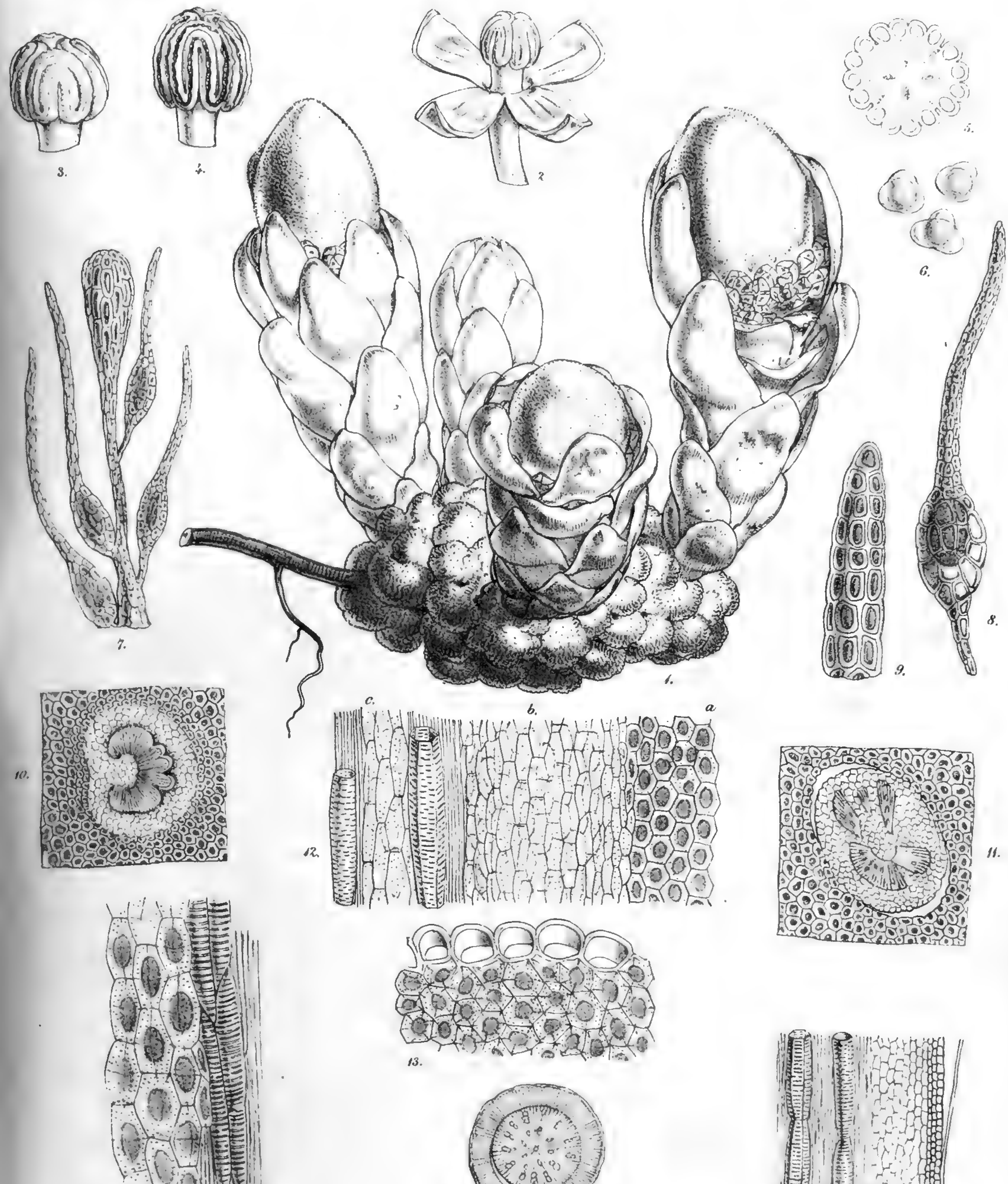
Vincent Brooks Imp

Balanophora involucrata, *Hf.*



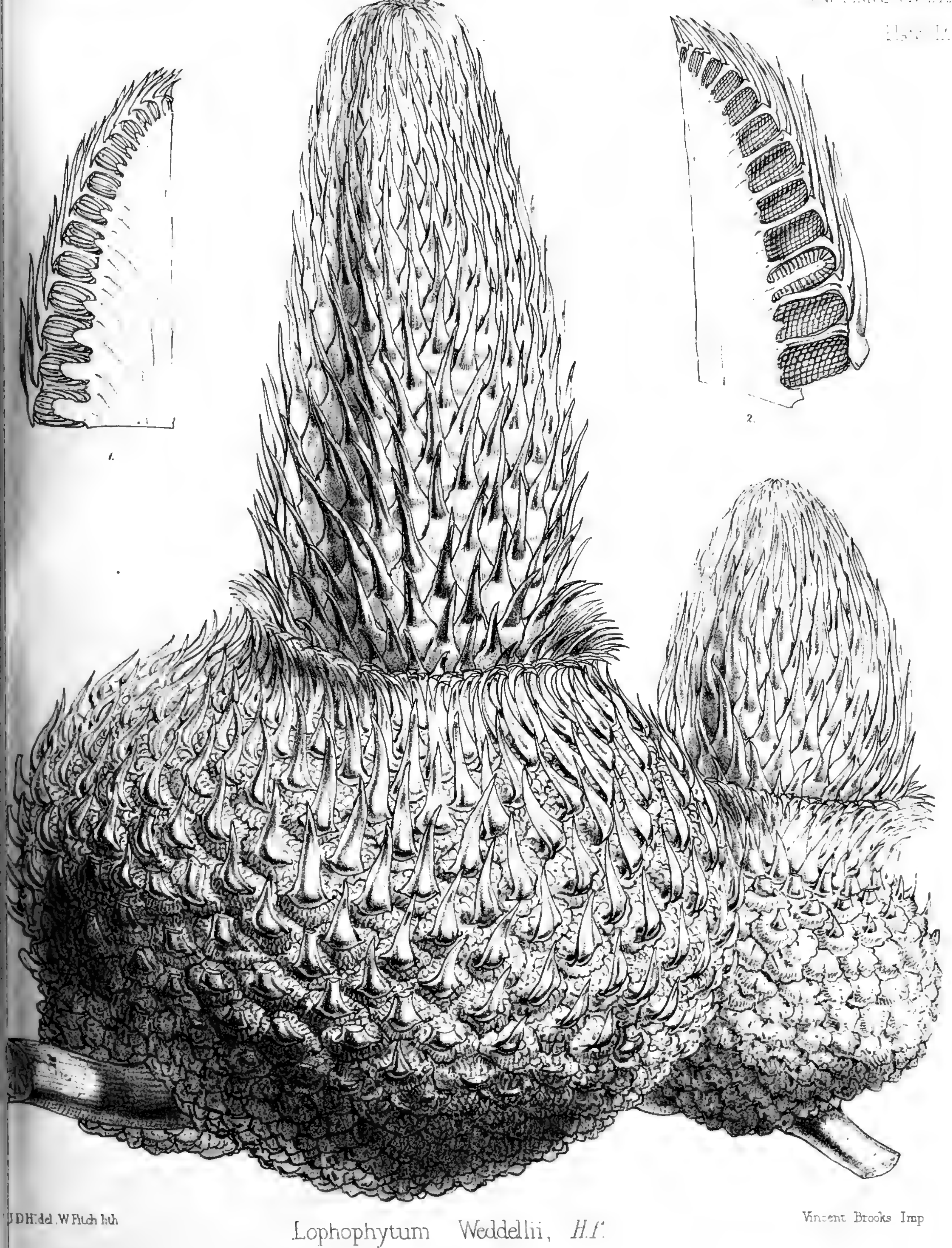
H del. W. Fitch lith. [illegible]

Balanopora involucrata, H.f.
A. var. gracilis. ♀
B. var Cathcartii. ♂



J D H. W Fitch Lith.
Vincent Brooks Imp

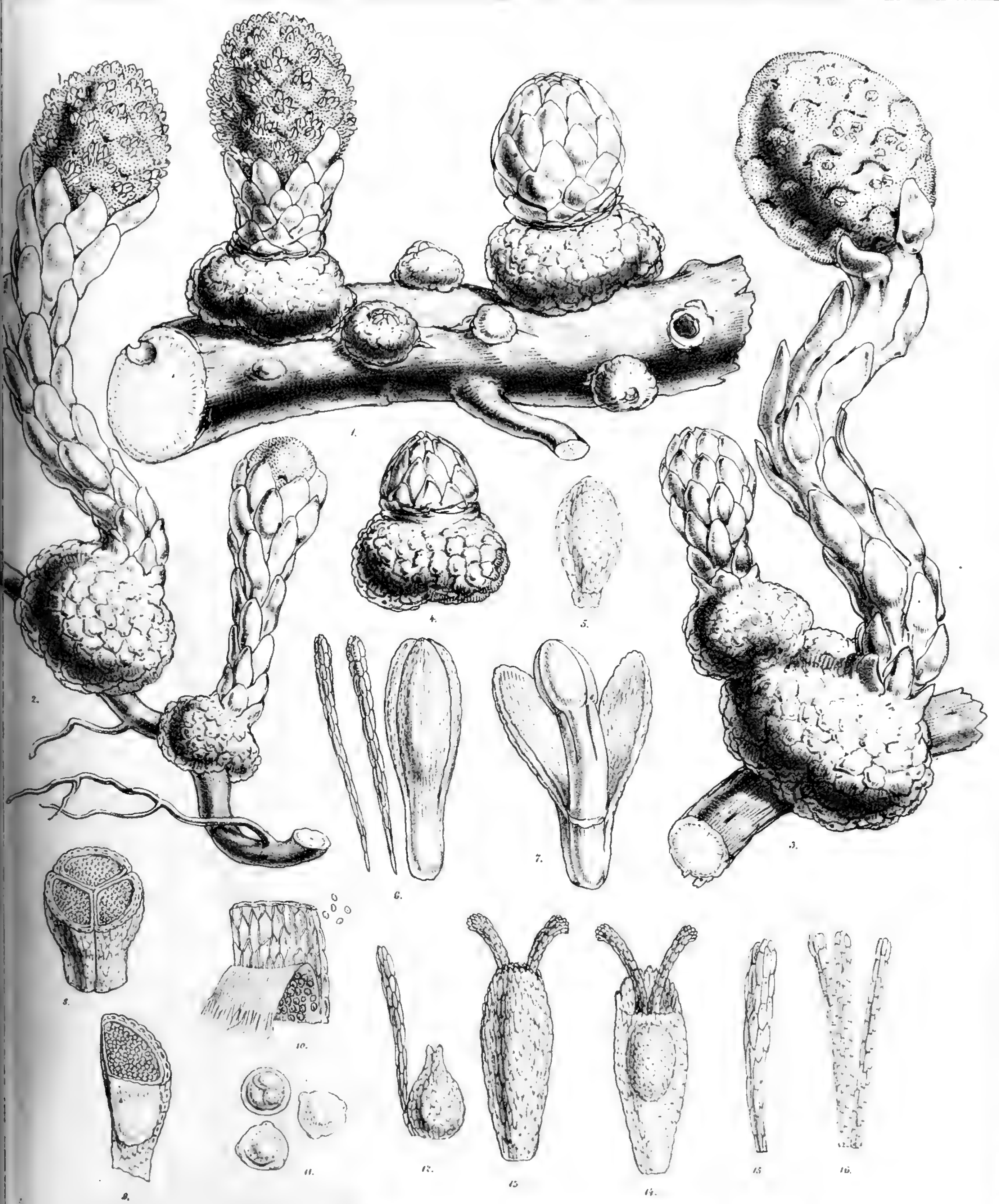
Balanophora fungosa, *Forst.*



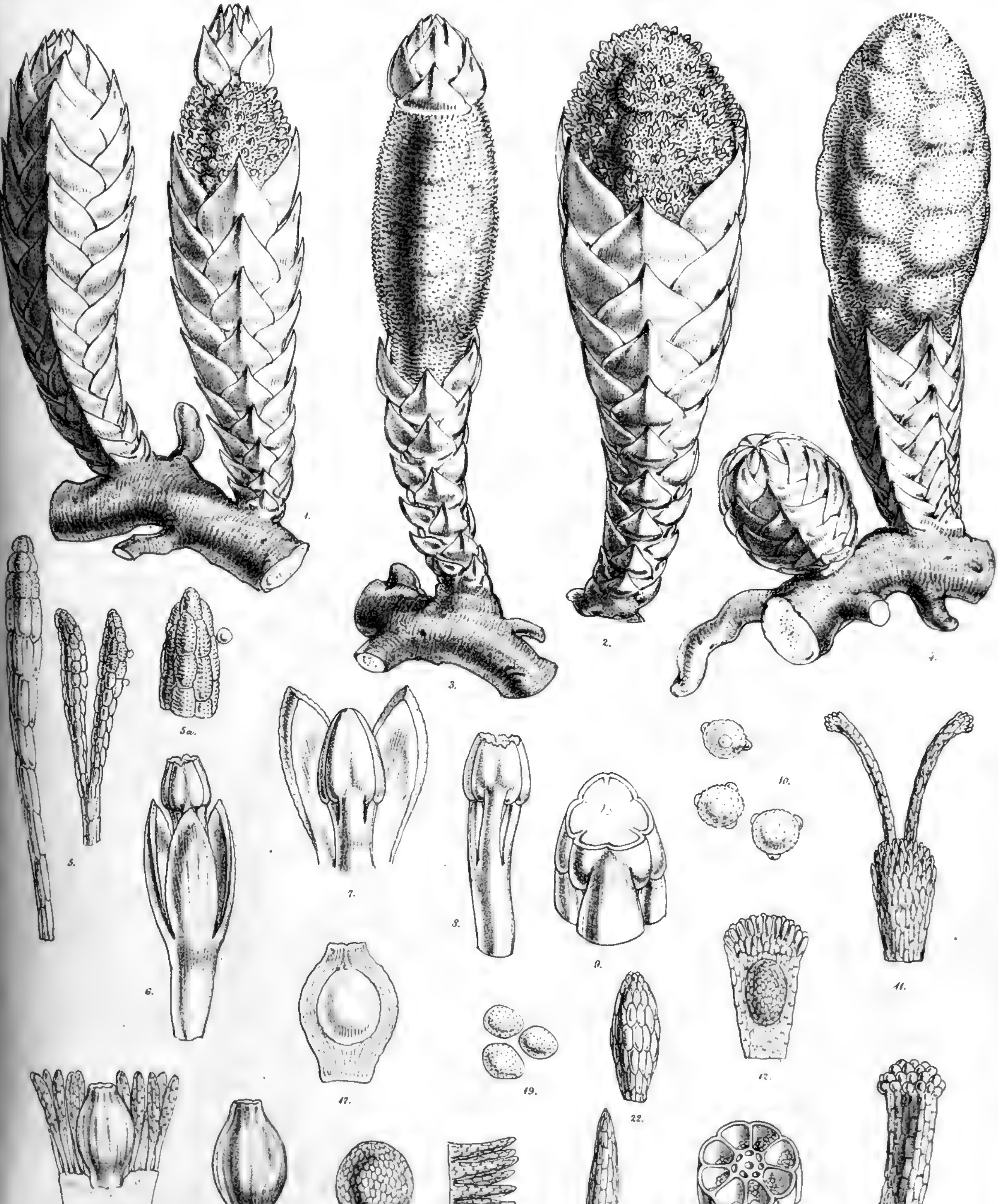
J D H. del. W Fitch lith

Vincent Brooks Imp

Lophophytum Weddellii, *H.f.*

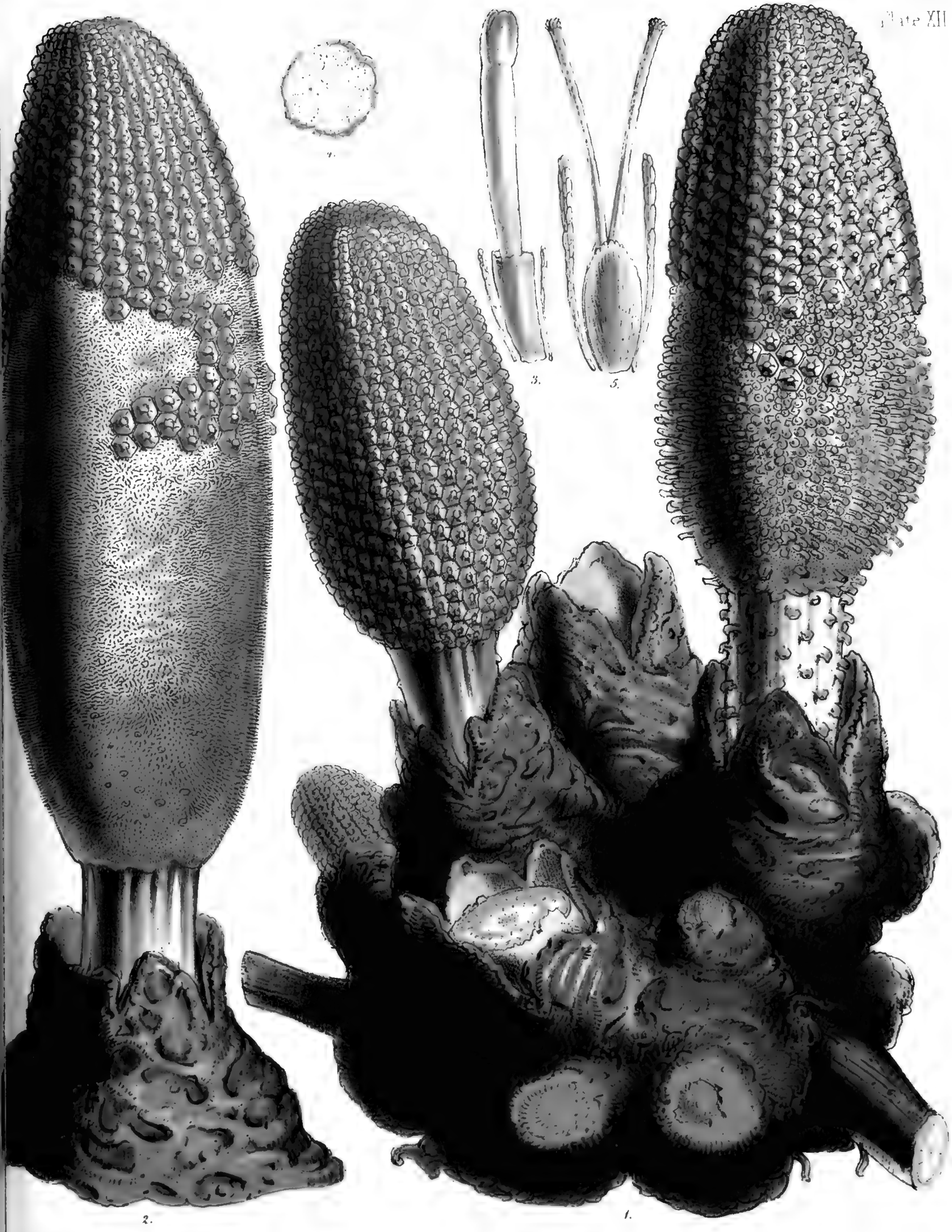


Sphærorhizon depressum, *Hf.*



J.D.H. & W. Fitch lith. [illegible]

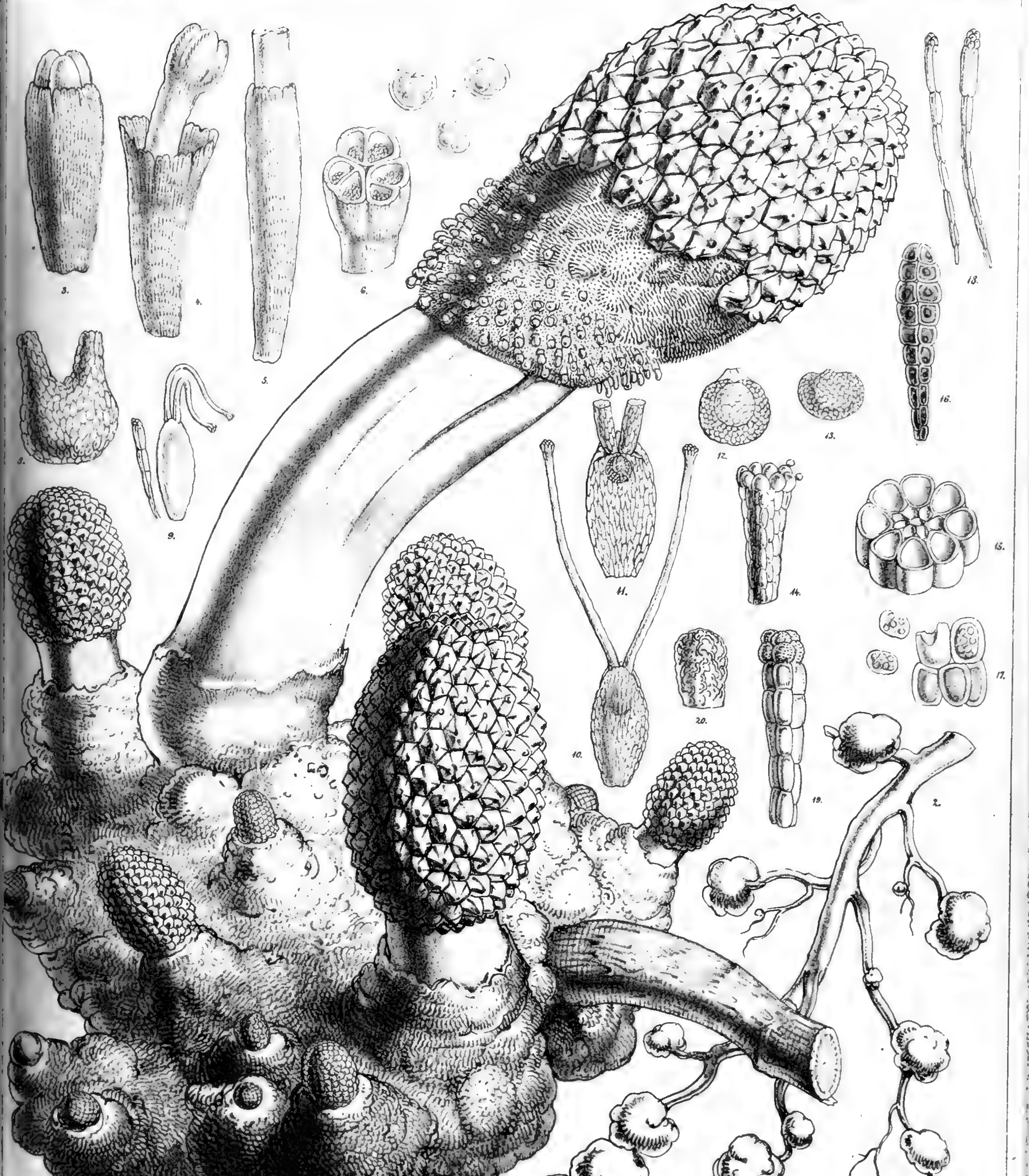
Phyllocoryne Jamaicensis, *Hf*



J. D. H. del. Fitch lith.

Vincent Brooks Imp

Rhopalocnemis phalloides, Jungh.

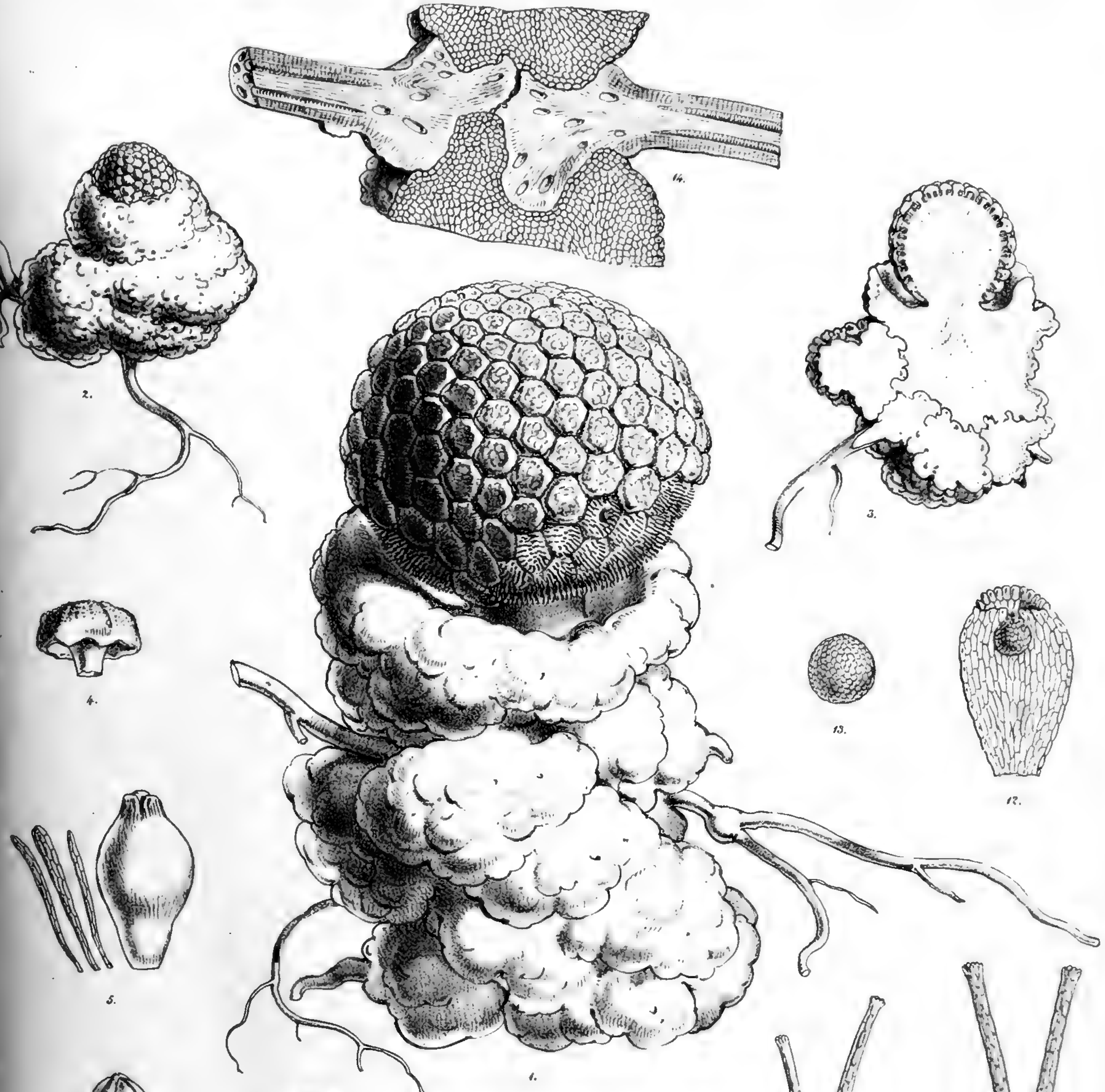


J D H del. W Fitch lith.

Vincent Brooks imp.

Corynæa crassa, *H.f.*

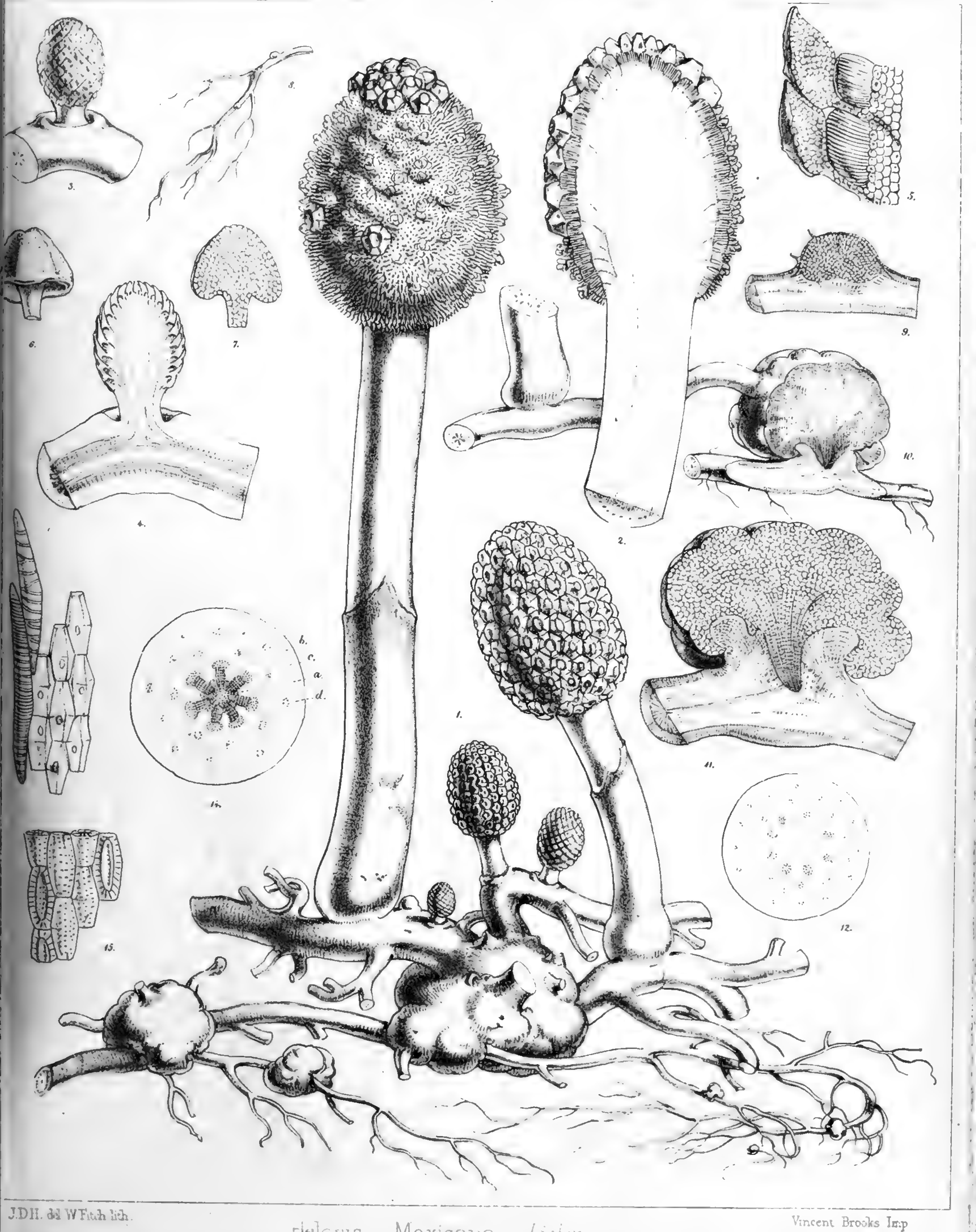
Plate XIV



J.D.H. del. W. Fitch lith.

Vincent Brooks Imp.

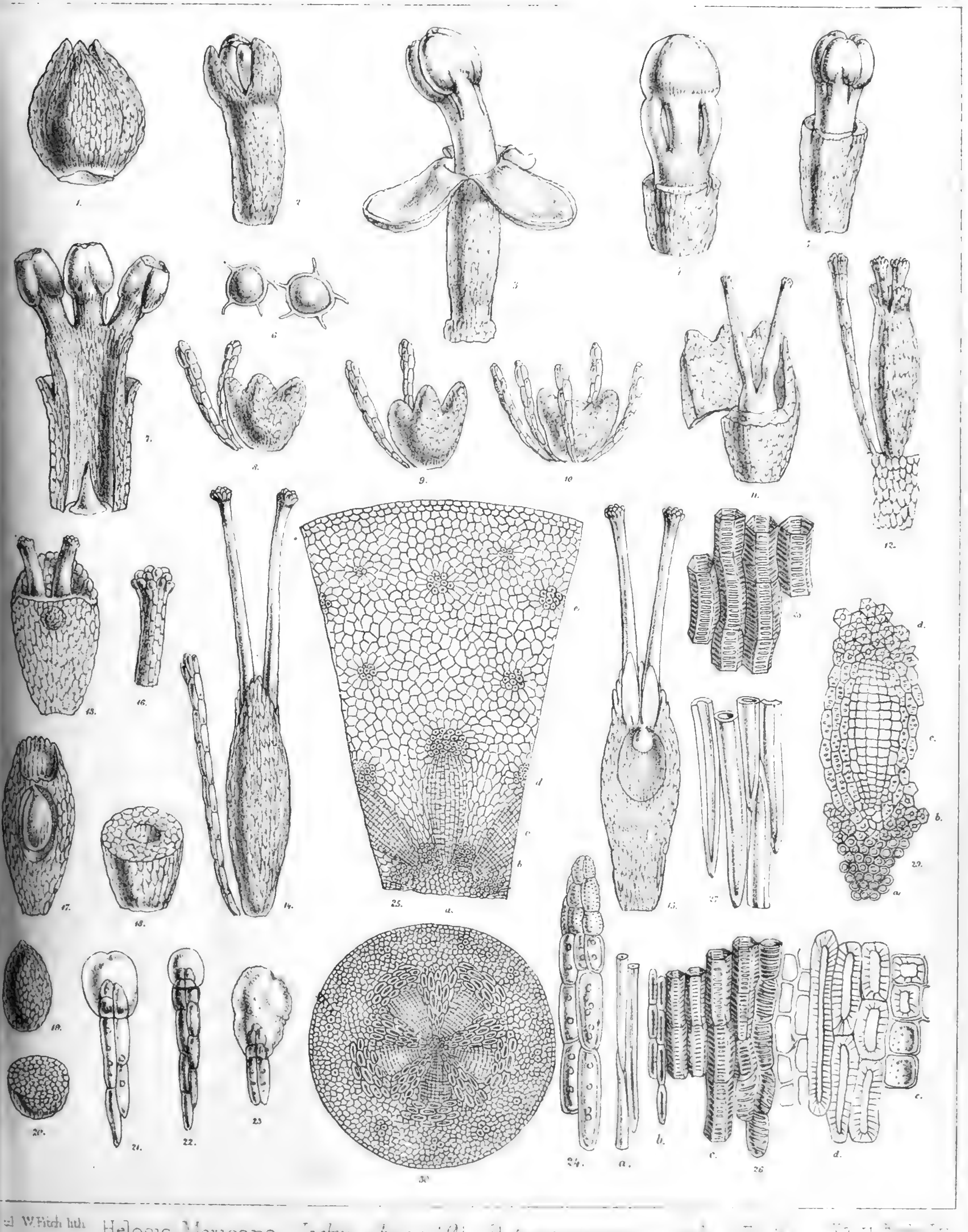
Corynæa sphærica, *H.f.*



J.D.H. del. W. Fitch lith.

Vincent Brooks Imp.

Helosis Mexicana, *Liebm.*



el W.Fitch lith Helosis Mexicana, *Liebm* (*figs 1-29*) H guyanensis, [illegible] (*Fig* [illegible])

II. *On the Development of the Ovule of* Santalum album; *with some Remarks on the Phænomena of Impregnation in Plants generally. By* ARTHUR HENFREY, *Esq., F.R.S., F.L.S., Prof. of Botany in King's College, London.*

Read March 4th, 1856.

IN the 21st volume of this Society's "Transactions" are published the results of some of my earliest observations on the phænomena of fertilization and development of embryos in flowering plants. To myself, these were at that time conclusive, and they were in accordance with those published shortly before by Amici, von Mohl, and Müller, subsequently confirmed, with far more extensive illustration, by Hofmeister and Tulasne. In spite of all the adverse evidence, however, Schleiden still continues to maintain the doctrines he formerly propounded, and during the last few years he has found a most active supporter in Schacht.

Those who have not directed their labours to the practical examination of these delicate points, may feel surprise at the discrepancy existing between the statements of different observers. Those who have been engaged in the dissection of ovules in the earlier stages of development, will not much wonder at doubts arising in my mind whenever I have met with statements directly contradicting those made in my former paper. The number of instances in which a satisfactory observation is made, is very small in comparison with the number of specimens examined; and notwithstanding that I have year after year devoted much time to the dissection of ovules, these time-devouring researches have yielded me a far smaller number of facts than I could wish.

A certain amount of discrepancy exists even between the statements of the disciples of Amici, in regard to the origin of the germinal vesicle (*Keimbläschen*); and to whether it exists before, or is formed after fecundation. Hofmeister[*] says before; Tulasne[†] says he never could find it anterior to the fertilization. The latter, in the memoir just referred to (page 115), adds, "This delicate question no longer (1849) perhaps possesses all the interest which was accorded to it by MM. Mirbel and Brongniart, and more recently by Mr. A. Henfrey, in his 'Report on the Progress of Physiological Botany[‡].' It is true, the existence of the embryonary vesicle at a period anterior to the arrival of the pollen-tube would, if placed beyond doubt, prove invincibly that this vesicle could not owe its origin to the latter organ; even now that the error of the pollinists is no longer uncertain, the question seems to me worthy of the attention of botanists, especially on account of the theoretical consequences involved in its solution."

Confidently as Tulasne expressed himself as to the origin of the germinal vesicle inde-

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[*] Entstehung der Embryo. Leipsic, 1849.

[†] Annal. des Sciences nat. 3^{me} sér. xii. p. 114.

[‡] Ann. Nat. History, ser. 2. i. p. 49 (1848).

pendently of the apex of the pollen-tube, this very point is most warmly contested by Schacht*, and notwithstanding that I have tolerably positive opinions derived from a certain number of cases, where the end of the pollen-tube and the germinal vesicle (the summit of the suspensor) were seen together, but distinct, in one preparation, the objects are so delicate, and the cause producing obscurity of the preparation so difficult to guard against, that I cannot but think the demonstration of the pre-existence of the germinal vesicle in the embryo-sac, the most important fact that can be brought forward in opposition to the views of Schleiden. As remarked by Tulasne, it has a great philosophical importance in reference to speculations as to the source of the vitality of the new being; and, as will be shown below, it is of no less importance for the establishment of the relations of the processes of embryogeny in the various classes of plants, and of the analogies which these present to phænomena attending the reproduction of animals.

As in my former paper I selected one well-established series of observations for the support of the doctrine I advocated, passing over without notice numerous fragmentary researches which, although corroborative, had in themselves nothing absolutely decisive, I shall here confine myself to the course of development of the ovule of one plant, in which the complete series of observations have been repeated many times. I feel the less hesitation in laying before the Society a paper thus restricted, from the circumstance that the example brought forward possesses features of great interest in other respects besides the main point of the fertilization. The principal facts are not indeed now brought forward for the first time, even before this Society, but they are such as few botanists have the opportunity of testing for themselves, and hence may be admitted as supplementary, partly confirmatory, partly emendatory, of the memoirs on the same subject by the late William Griffith†.

A melancholy interest is attached to the investigations now presented; for the materials which have enabled me to repeat and control the observations of Griffith, were furnished by my lamented friend Dr. Stocks, another Fellow of this Society, suddenly cut off from us in the midst of active labours for the advancement of Indian botany.

A bottle containing a large quantity of blossoms and fruits of *Santalum album*, in all stages of growth, preserved in spirit, enabled me to trace the development of the ovules and the embryos from a very early period; the preservation in spirit seemed rather favourable than otherwise for the dissections required, since the albuminous matters were coagulated, and thus did not run out over the sections, and the cell-membranes seemed to have acquired a firmer consistence than I have usually found in fresh objects.

When very young buds are examined in vertical sections (Tab. XVII. fig. 1) the ovary is found superior, forming a conical body arising in the centre of the flower; as the bud advances in age, the adherent tube of the calyx and the side-walls of the ovary grow rapidly (Tab. XVII. figs. 3–5), so as at length to render the ovary altogether inferior (Tab. XVII. fig. 14); the original conical summit (continued into the style) becoming gradually flattened by the lateral elevation (Tab. XVIII. figs. 22, 27, 28).

The ovary never exhibits any open cavity; the centre is occupied by an elongated,

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* Flora, 1855, p. 145; Botanische Zeitung, 1855, p. 641.

† Linn. Trans. xviii. pp. 59 & 71; xix. pp. 171 & 487.

conical, or rather spindle-shaped pillar, the free placenta of authors, arising from the centre of the base; the internal surface of the walls of the ovary are closely applied to the placenta, without however contracting any adherence either at the sides or above. In the youngest buds I examined (Tab. XVII. fig. 1) I found the central placenta with three cellular papillæ projecting downwards from the thickest portion, near the base, that part of the placenta below their origin being narrowed into a kind of peduncle (Tab. XVII. fig. 2). These papillæ, of cylindrical or slightly conical form, with blunt ends, pointed downward and a little outwards; they were composed of tolerably compact cellular tissue, and according to the view commonly taken of the structure of this genus, they are the nuclei of three ovules (fig. 2. *a*, *a*). In the youngest specimens examined, no trace of an embryo-sac could be seen, but a lighter streak (as seen by transmitted light) soon appears in the axis of each nucleus, indicating a cavity, and in a little farther advanced state a closed tubular process was found projecting from the point of each nucleus, the free extremity of a tubular embryo-sac extending internally up to the organic base of the nucleus. Examined in successive stages, the tubular embryo-sac is seen to extend downwards at first; then its external (or anterior) end (organic summit) turns outwards, next suddenly upwards over the side of the nucleus; it becomes then more and more elongated until it has grown up upon the side of the placenta so far as nearly to reach its free summit. It lies upon the outside of the placenta in the form of a slender filamentous tube (Tab. XVII. fig. 4, *b*). At the same time the posterior or internal end of the tube elongates in the substance of the placenta until it makes its way nearly to the apex. These phænomena occur in all the other (occasionally four) ovules, alike. The tubular embryo-sacs contain protoplasmic matter with a few granules, but are comparatively clear as contrasted with the cells of the nucleus, which are filled with dense protoplasm and (starch-) granules.

The next stage is the formation of a bulbous enlargement of the embryo-sac at the point where it turns up to rise over the placenta (Tab. XVII. fig. 6). The free points of the tubular sacs also contract a slight adherence to the side of the placenta near the summit, remaining free however in the greater part of their length, although closely applied to the side of the column. The protoplasmic contents next begin to increase in quantity and consistence, especially at the apex and below the bulb. A septum is soon afterwards formed at the bottom of the bulb, which, at first flat, becomes convex (looking upwards), and finally appears as an inner bulb projecting up into the cavity of the primary bulb (Tab. XVII. fig. 7). The septum divides the embryo-sac into two distinct portions; I have never discovered any cell-formation within the cavity behind (or below) the septum, either externally or internally to the nucleus. The only change this posterior (or organically inferior) part of the embryo-sac undergoes, is a tubular ramification in the substance of the placenta, to be described presently.

About the time of the formation of the septum just referred to, which is about the period of the opening of the flower, the apex of the embryo-sac becomes a little swollen (clavate), and protoplasm accumulates on it. Soon after this, before any pollen-tubes reach the placenta, from the stigma, a granular cell-nucleus, becoming gradually better defined, makes its appearance in the protoplasm of the clavate end, not quite at the extremity (Tab. XVII. figs. 8 & 9, *e*). A portion of the protoplasm in the absolute extremity (adherent to the placenta) collects into two granular masses, which become much darker-coloured than the surrounding substance, and apparently almost solid, while the closed end of the embryo-sac becomes moulded as it were on these so as to present a kind of notch or depression between them (figs. 8 & 9, *d*, *d*). They lie nearly in contact, occupying (like a plug) the summit of the embryo-sac; the nucleus before mentioned being quite below them. At this period the nucleus is devoid of a cell-membrane.

The summits of embryo-sacs, examined soon after the above period, present the ends of one or more tubes adherent to them; these tubes extend down to the embryo-sacs from the summit of the placental column; I have never traced them up the style, for this structure was so hard and resisting in my preserved specimens as not to allow of my examining the canal minutely; but there can be no doubt as to their nature. They are the ends of pollen-tubes. Usually one applies itself upon the very apex of the embryo-sac (Tab. XVII. figs. 10 & 11 *f*). The tubes appear to creep down between the papillose projections of the cells of the surface of the placenta, being moulded in some degree on them; and these grooves appear to conduct the tubes to the points of the embryo-sacs, which themselves adhere to the superficial cells of the placenta; sometimes so firmly as to carry away fragments of their walls when dissected out free (Tab. XVII. figs. 9–11).

I have directed my utmost efforts to the accurate observation of the ends of the embryo-sacs with the pollen-tubes adherent. They are tolerably easily extracted free from the ovary, with needles under a low doublet; I have examined at least five-and-twenty at various times during the last year and a half, and in the course of the observations, have applied every means to make the structures clear; mounting in water and then in glycerine, between very thin glass, so as to observe both sides; boiling in nitric acid; treating with dilute sulphuric acid alone, and with this and solution of iodine; examining the objects with a $\frac{1}{4}$ and $\frac{1}{8}$ object-glass under the compound microscope, with and without the condenser for illumination, by direct and oblique light.

The end of the pollen-tube adheres so firmly to the end of the embryo-sac, that it cannot be torn away in a really fertilized ovule.

My decided opinion is that Griffith was in error in stating that the pollen penetrates into the embryo-sac; I believe that it only applies itself firmly against it, over the point where the line of division exists between the two coagula lying on the apex of the embryo-sac, in the situation of the 'notch' above mentioned (figs. 10 & 11). But I incline to believe that a phænomenon analogous to *conjugation* takes place. For, as I have said, the adhesion is intimate, but the nucleus before spoken of (Tab. XVII. figs. 8 & 9 *e*) lies away from the pollen-tube, separated from it by the two coagula (*d*, *d*); the fissure, however, between these leads exactly from the end of the pollen-tube to the nucleus (figs. 10 & 11). Moreover, very soon after the pollen-tube becomes adherent, the nucleus acquires a proper coat of cell-membrane,—becomes a real cell, the germinal vesicle, from which the suspensor is developed. This cell is slightly pyriform, with an obtuse projection directed toward the fissure between the coagula (Tab. XVII. fig. 11 *g*).

I think that the pollen-tube, after becoming adherent to the summit of the embryo-sac, bursts into it, and that the contents pass into the embryo-sac, reach the nucleus, and determine its conversion into a cell. The nucleus becomes perfectly defined, as separate from the surrounding protoplasm, just at the period of fertilization. At the same time this surrounding protoplasm (contained in a 'primordial utricle' lining the entire embryo-sac, down to the septum of the bulb (Tab. XVII. fig. 6)), becomes more dense and granular, sometimes exhibiting largish starch-granules.

Little further change occurs at the apex of the embyro-sac for some time; merely the cell-membrane enclosing the nucleus becomes thicker, and the cells assume a more elliptical form. The next step is the formation of endosperm-cells from the protoplasm of the embryo-sac. This takes place by segmentation, or free cell-formation from the whole abundant mucilaginous protoplasm, commencing always in the bulb, often advancing from them before it proceeds up the tubular part of the embryo-sac, which at first presents only a single row of 'primordial utricles' (Tab. XVII. fig. 12); the latter then divide perpendicularly (Tab. XVII. fig. 13), and the cells produced, appear to apply themselves to the side-walls and multiply for some time by free cell-formation in the centre (Tab. XVII. fig. 15). Ultimately cell-division occurs, and the whole cavity of the swollen embryo-sac being filled up with cellular tissue analogous in character to that of the nucleus,—namely, composed of squarish cells with thin walls, filled with dense protoplasm, containing increasing quantities of minute starch-granules,—the *albumen* of the end becomes a distinct structure, on the surface of which all trace of the originally bounding embryo-sac is soon lost (Tab. XVII. fig. 16).

The first change in the germinal vesicle is its elongation downwards into a cylindrical form; then cross septa appear (Tab. XVII. fig. 15 *g*, Tab. XVIII. fig. 19 *g*) one after another, so that it is converted into a short row of cells. The uppermost remains appressed to the coagula in the apex of the embryo-sac, and does not appear to become developed further; forming a kind of suspensor. The lower cells multiply greatly (Tab. XVIII. fig. 23) and form an elongated, clavate cellular body, the embryo, in which at first no trace of regions can be detected,—only a greater density of the tissue and abundance of granular contents at the cotyledonary (inferior) extremity (Tab. XVIII. figs. 22 & 24 *g*, fig. 25).

The conditions of the walls of the ovary during these changes deserve some attention; the outer substance of the young fruit is formed of a firm layer of tolerably equal thickness all over, constituting what we may call the epicarp together with the mesocarp (Tab. XVIII. figs. 27 & 28 *s*). These define and correspond to the outward form of the fruit. The portion immediately beneath the epidermis is composed of oblong cells with their longest dimension in the direction of the axis of the fruit; these pass insensibly into a denser layer of closely-packed polygonal cells with thick walls. These two regions are coloured, while the endocarp is nearly colourless (Tab. XVIII. figs. 27 & 28). The cells of the mesocarp (well defined internally to the naked eye) appear, under the microscope, to pass again insensibly into the soft endocarp (figs. 27 & 28 *r*), composed of membranous, globular, and polygonal cells, loosely packed, of much greater diameter, for the most part, than those of the mesocarp. The endocarp (figs. 27 & 28 *r*) fills up the whole space between the dark rind of the fruit (*s*) and the placenta (and ovules) (*o*, *p*), during the earlier expansion of the ovary. Where in contact with the embryo-sacs and placenta, it is of denser texture and of darker colour, having a definite, separable boundary. A perpendicular line is seen leading from the apex of the placenta to the point corresponding to the base of the style; the cells of the endocarp exhibit a radiating linear arrangement on the upper half, the lines running upwards and outwards from the placenta (fig. 27).

A remarkable phænomenon occurs meanwhile in the interior of the placenta. It has been stated that there is never any appearance of development of cells in that part of the embryo-sac, behind (or below) the septum formed a little way outside the nucleus Tab. XVII. figs. 7–12). The inner bulbous expansion, formed by the septum itself, which becomes convex, and protruded upwards into the centre of the larger bulb, is found in the same condition, as long as the structures are traceable, and it finally forms a kind of stalk or "funiculus" to the seed, inserted into the substance of the albumen (Tab. XVII. figs. 12, 17, and Tab. XVIII. fig. 26), and connecting this with the remains of the placental structure. I have already mentioned, that while the tubular prolongation of the embryo-sac, outside the nucleus, is growing up over the placenta, the posterior end, inside the nucleus, also grows up, breaking down the tissue before it, into the substance of the placenta (Tab. XVII. fig. 4). Within this organ it proceeds nearly to the summit, and then turns round somewhat suddenly, and grows down again, with various ramifications, in the centre of the placenta, and even into the receptacle below where these arise (Tab. XVIII. figs. 20, 21): I have never seen anything like cell-formation, or even production of septa in these posterior branches of the embryo-sac; they contain a granular protoplasmic substance, which, in my preserved specimens, is of a red colour. The ends of the barren embryo-sacs undergo the same kind of development within the placenta, although the changes in the external portion cease at the period of the formation of the germinal vesicle. The ramifications of the three distinct embryo-sacs become somewhat interlaced, but I have never certainly detected any conjunction or adhesion of them, as suspected by Griffith.

It remains only to notice the further changes exhibited by the ovule. The endosperm or albumen of the embryo-sac increases enormously in quantity, so as to expand the sac in all directions (Tab. XVIII. figs. 16, 20, 26); the placenta is broken off just below the point of origin of the ovules (fig. 26), and pushed outwards and upwards by the enlargement of the albumen (Tab. XVIII. figs. 27, 28 *p*); in the ripe fruit it is found lying upon the surface of the latter (Tab. XVIII. figs. 30 & 32 *p*), which, through the displacement and destruction of the endocarp, is finally in immediate contact with the woody mesocarp. On examining the remnant of the placenta, even in the ripe fruit, it is found to be connected with the endosperm by the bulb. When the placenta is then broken away from the receptacle, and pushed up, the receptacle upon which it was seated is also carried away towards the same side of the albumen, on the outside of which, near the base, it is ultimately found (Tab. XVIII. figs. 28, 30, 32 *v*) as a little mass of sphacelated tissue overlying a pit or foramen, which leads to an internal dark line, running through the endosperm to the cotyledonary extremity of the embryo (Tab. XVIII. fig. 30 *v*). In this line, and in the sphacelated mass, are found remains of the posterior ramified processes of the embryo-sac, some of which are also found attached to the upper fragment or placenta*. In the ripe seed, the embryo is found lying a little out of the axis of the albumen, in a

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* This seems to resemble what Mr. Bentham describes in *Olacaceæ*, Linn. Trans. xviii. p. 675.

vertical position (fig. 33), or with the cotyledons curved a little towards the lateral basilar scar just mentioned (fig. 35). The radicle is at the upper end of the seed and terminates in an acute apiculus (Tab. XVIII. figs. 34 & 36).

In the mature fruit the mesocarp forms a hard shell, outside which the epicarp forms a thin layer of pulpy substance (Tab. XVIII. fig. 22). The woody shell is slightly pointed and trigonal above, presenting three converging ridges (Tab. XVIII. fig. 31) when the epicarp is removed. Within the woody mesocarp the albumen or endosperm of the seed lies free; the coat formed by the embryo-sac is no longer distinguishable, but the endosperm is covered with brownish membranous scales (Tab. XVIII. fig. 32), composed of compressed withered fragments of the lax cellular tissue of the obliterated parenchymatous endocarp.

The above observations confirm in almost every respect those published by Griffith in the Transactions of the Linnean Society, the main point of difference lying in the statements made with respect to the phænomena presented at the summit of the embryo-sac at the time of fertilization; in which my account is strongly opposed to those given by that author, not only in *Santalum*, but in *Osyris* and the *Loranthaceæ*. Notwithstanding the high value I attribute to Griffith's labours, increased and confirmed by the researches now brought forward, I feel very confident of the correctness of the account I have given of the origin of the embryo from a pre-existing germ, and I have little doubt that the process of fecundation is such as I have described in *Osyris*, and the other cases. The importance attaching to the truth of the view I have propounded will be farther illustrated below.

Every one who has studied the development of the ovules of *Santalum*, and the allied genera, has been struck by the remarkable anomalies which present themselves. The entire protrusion of all the (apparently) essential part of the embryo-sac from the apex of the nucleus, the development of the endosperm in the external compartment of the sac, altogether independently of the nucleus, are very remarkable; while the posterior development of the embryo-sac is no less singular. The idea has been suggested that the entire central body here described as a free placenta with the ovules reduced to nuclei, might be one ovule with three embryo-sacs; and also that the central body is all placenta, the nuclei being merely the funiculi of ovules reduced to embryo-sacs. There does not seem to be sufficient ground for either of these assumptions, although the former is in some respects plausible.

The principal reason which could be advanced in favour of the second idea, is the apparently abnormal position of the embryo, the cotyledonary extremity of which is next the apex of the nucleus, and the radicle end pointing in the direction of the base of the nucleus. But this is rather an apparent than a real irregularity. It would be a pedantic insistence upon terms to call that end of the embryo-sac engaged in the apex of the nucleus, the micropyle-end; it is really the middle, and the embryo-sac is in fact campylotropous, its organic base or chalazal end being in the interior of the nucleus, while the micropyle-end is prolonged out beyond the micropyle, and turned up so as to lie (outside) against the chalazal end.

In regard to the first of the two views above referred to, the only circumstances which it appears to me can be urged in favour of the idea that the central body is not a placenta, but a compound nucleus with three embryo-sacs, are as follows:—

The central body is stated by Griffith to form at first, in *Osyris*, but a slightly-elevated cone with three (or four) papillæ (or nuclei) at its sides. In the youngest specimens of *Santalum* I examined, the placenta was highly developed as a pillar in the centre of the ovary (Tab. XVII. figs. 1 & 2). The papillæ might be either three points of one ovule, or three nuclei with three chalazal ends blended in the centre, and the growing-up of the central column, which goes on for a certain time after the embryo-sacs are distinguishable, might be regarded as a conversion of the compound ovule, or the three conjoined ovules, into an anatropous structure, the chalazal end being at the apex of the conical mass, the micropyles free and turned down next the "funiculus." The subsequent retroversion of the embryo-sacs would still be anomalous, connected however in some degree, through *Osyris*, *Avicennia*[*] and *Myzodendron*[†] (in which the embryo-sac is not extended unless fertilized) with the ordinary conditions. Then the growth of the posterior ends of the embryo-sacs would seem to represent a kind of chalazal structure, connecting them below in a kind of central raphe with the peduncular placenta. The relative positions of the remains of the nuclei and the central body, and of the remains of the peduncle of the placenta, in the ripe fruit, would then indicate a rupture at the umbilicus, which was carried up to near the top of one side of the seed, while the funiculus was driven outwards on the same side, and almost obliterated[‡].

Some degree of likelihood attaches to the explanation just given when the *Santalaceæ* are compared with the *Loranthaceæ*, with which they appear to be nearly connected through *Myzodendron* (which genus is nearer the former than the latter family as regards ovulary structure[§]). In the *Loranthaceæ* the supposed compound, triple ovule, being atropous instead of anatropous, would naturally be still more completely combined into one piece; it would here be almost a question of words whether there were confluent nuclei or one nucleus with three parallel embryo-sacs. Then the phenomena observed in *Loranthus* might afford a still farther confirmation, as indicating analogy with the *Coniferæ*, in which the existence of a number of (secondary) embryo-sacs is the rule.

These points deserve further attention, and can only be elucidated by the study of the development in more of the genera of these remarkable families. I should not omit to mention here the observations of DeCaisne on *Thesium*[‖], which I have not yet repeated, but which agree essentially with the statements respecting *Santalum* made by Griffith and myself.

The reason which perhaps most of all induced me to present these observations to the notice of the Society, is the remarkable analogy which is shown to exist between the phenomena of fecundation above described, and those which have recently been demon-

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[*] Griffith, Linn. Trans. xx. p. 1.

[†] Hofmeister, in Grisebach, üb. Philippi und Lechler's Pflanzensamml. Abhandl. Götting. Gesellsch. 1854.

[‡] In *Santalum* no vascular cords can be distinguished in the conical placenta; in *Avicennia*, according to Griffith, (*l. c.*) the vascular cord reaches nearly to the base of the embryo-sac, so that the chalazal end of the ovule is marked.

[§] R. Brown, Linn. Trans. xix. p. 231; Hofmeister, *l. c.*

[‖] Ann. des Sciences nat. 2^{me} sér. xiii. p. 300.

strated to take place in some of the lower plants. I pass over the numerous discoveries that have been made of late years in the higher *Cryptogamia*, from the *Marsileaceæ* to the *Liverworts*, showing the pre-existence of a germ, and its fertilization by spermatozoids. I may refer to my own publications on this subject elsewhere*. The cases most immediately interesting to me in this instance are those described by Thuret in the *Fucaceæ*, already repeated by Pringsheim, and the researches of the latter and of Cohn on certain filamentous Confervoids. According to the elaborate investigations of Thuret† the spores of *Fucus* are discharged from the spore-sacs as globules of protoplasmic substance, bounded by the structure denominated by Von Mohl the primordial utricle, without a cellulose coat. While swimming free in the water, spermatozoids come in contact with them in large numbers, and after a certain time a cellulose coat is developed upon the surface of the spore; the latter thus becomes encysted, and forms a true cell, which then germinates, to produce a new plant. Pringsheim‡ describes essentially analogous phenomena as occurring (inside the parent-cells) in *Vaucheria*, and Cohn's§ account of the fecundation of the spores of *Sphæroplea* also agrees with these.

These facts, together with those I have brought forward in this paper, tend to prove that the process of impregnation in plants consists in the absolute admixture of the protoplasmic substance of two cells ("male" and "female"); of which the female (or germinal) substance or body always pre-exists in the form of a nucleus or "protoplast," while the male (or spermatic) substance exists in the form of a granulose fluid. In the Flowering Plants the spermatic fluid is conveyed directly into the embryo-sac by the channel of the pollen-tube; a similar process appears to exist in the *conjugation* of the lower *Algæ*; in other cases the spermatic fluid is conveyed from organs situated at a distance from the parent-cell of the germinal vesicle, by the agency of locomotive structures (spermatozoids) developed in the spermatic cells, bathed in and discharged with their contents, and themselves composed of the nitrogenous protoplasmic matter of cell-contents.

In my Memoir on *Orchis Morio*‖, I described the nascent germinal vesicles as cells. Hofmeister and others in like manner call them cells; but comparison of my older drawings and those of Hofmeister with new observations, leads me to believe that, on careful examination, these bodies will be found to consist of nuclei or "protoplasts" before fertilization¶. I may note in reference to this, that I have already some confirmation from another case besides *Santalum*, and I trust to bring forward hereafter more complete evidence on the subject.

Jan. 30, 1856.

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* Report of the British Association, 1851; Annals of Natural History, 2 ser. ix. p. 441; Linnean Transactions, xxi. p. 117.

† Ann. des Sciences nat. 4^e sér. ii. p. 197.

‡ Bericht Berlin Akad. March 1855.

§ Bericht Berlin Akad. May 1855.

‖ Linn. Trans. xxi. p. 7.

¶ Certain circumstances which I observed in the *archegonia* of the Ferns, also afford good reasons for inquiring whether the parent-cell of the germinal vesicle is not open at a certain period there, offering a passage for the spermatozoids to a naked nucleus. See especially the figures 56, 57, 63–70 of plate 16 in my Memoir on the Development of Ferns (Linn. Trans. xxi. p. 117).

EXPLANATION OF THE PLATES.

The figures magnified 50 diameters and upward were drawn by the aid of the *camera lucida.*

Tab. XVII.

Fig. 1. Vertical section of the ovary of an unopened bud.
Fig. 2. Placenta with two nuclei (*a a*) from the same.
Fig. 3. Vertical section of the ovary, &c., of a flower just opened.
Fig. 4. Placenta of the same with two nuclei (*a*, *a*) and one embryo-sac (*b*).
Fig. 5. Section of an ovary somewhat older.
Fig. 6. Nucleus (*a*), embryo-sac (*b*) with germinal vesicle and pollen-tubes at the apex; from fig. 5. septum of the bulb not yet developed.
Fig. 7. Point of a nucleus and the embryo-sac (*b*), with a fully-developed septum in the bulb (*c*).
Fig. 8. Apex and unimpregnated embryo-sac, with terminal coagula (*d d*) and a nucleus (*e*).
Fig. 9. Another more advanced.
Fig. 10. Another with a pollen-tube (*f*) applied.
Fig. 11. Another when the nucleus (*e*) is converted into a cell with a cellulose wall (*g*).
Fig. 12. Part of an impregnated embryo-sac (*b*) attached to its nucleus (*a*), with endosperm-cells formed in it.
Fig. 13. Upper end of another one with the endosperm more developed.
Fig. 14. Vertical section of an ovary some time after impregnation.
Fig. 15. Upper end of the endosperm of an ovule from fig. 14, with the germinal vesicle (*g*) undergoing division.
Fig. 16. A less advanced ovule, with the endosperm considerably developed; the dotted line runs to the point of insertion of the inner bulb (fig. 17) formed by the septum.
Fig. 17. The inner bulb (similar to that in figs. 7 & 12) drawn out from the endosperm of fig. 16; *a*, nucleus.
Fig. 18. Inner bulb drawn out from another endosperm.

Tab. XVIII.

Fig. 19. Apex of a young ovule with the embryo (*g*) dividing into four cells; *i*, endosperm cells.
Fig. 20. Placenta and ovules, one fertile, the other barren, of a more advanced ovary; the future prolongations of the embryo-sacs are seen in the placenta: lettering as before.
Fig. 21. Posterior prolongations of an embryo-sac partly dissected out.
Fig. 22. Section of an imperfect fruit.
Fig. 23. Apex of the ovule of fig. 22, with embryo (*g*); *d d.* coagula; *k.* upper cell of the row formed from the germinal vesicle (*suspensor*).
Fig. 24. Upper point of a more advanced ovule, with the embryo (*g*). The small figure on the left is a section of the ovary from which it was taken, nat. size.
Fig. 25. Embryo from fig. 24.
Fig. 26. Placenta and ovule of a fruit nearly as in fig. 27, the placenta *p.* already torn away from the receptacle: lettering as before.

Fig. 27. An immature fruit; *o.* ovule, on the side of which lies the placenta *p*; *r.* endocarp; *s.* rind composed of the blended mesocarp and epicarp; *v.* peduncle of the placenta.

Fig. 28. Another, more advanced; lettering as before.

Fig. 29. A fruit nearly ripe; part of the succulent epicarp removed, laying bare the shell or mesocarp *s*.

Fig. 30. Section of fig. 29: letters as before; *p.* & *s.* are the sphacelated placenta (*p*), and its base (*v*) removed from the points indicated by the dotted lines. The endocarp is now obliterated.

Fig. 31. Ripe fruit with the pulp removed from the shell.

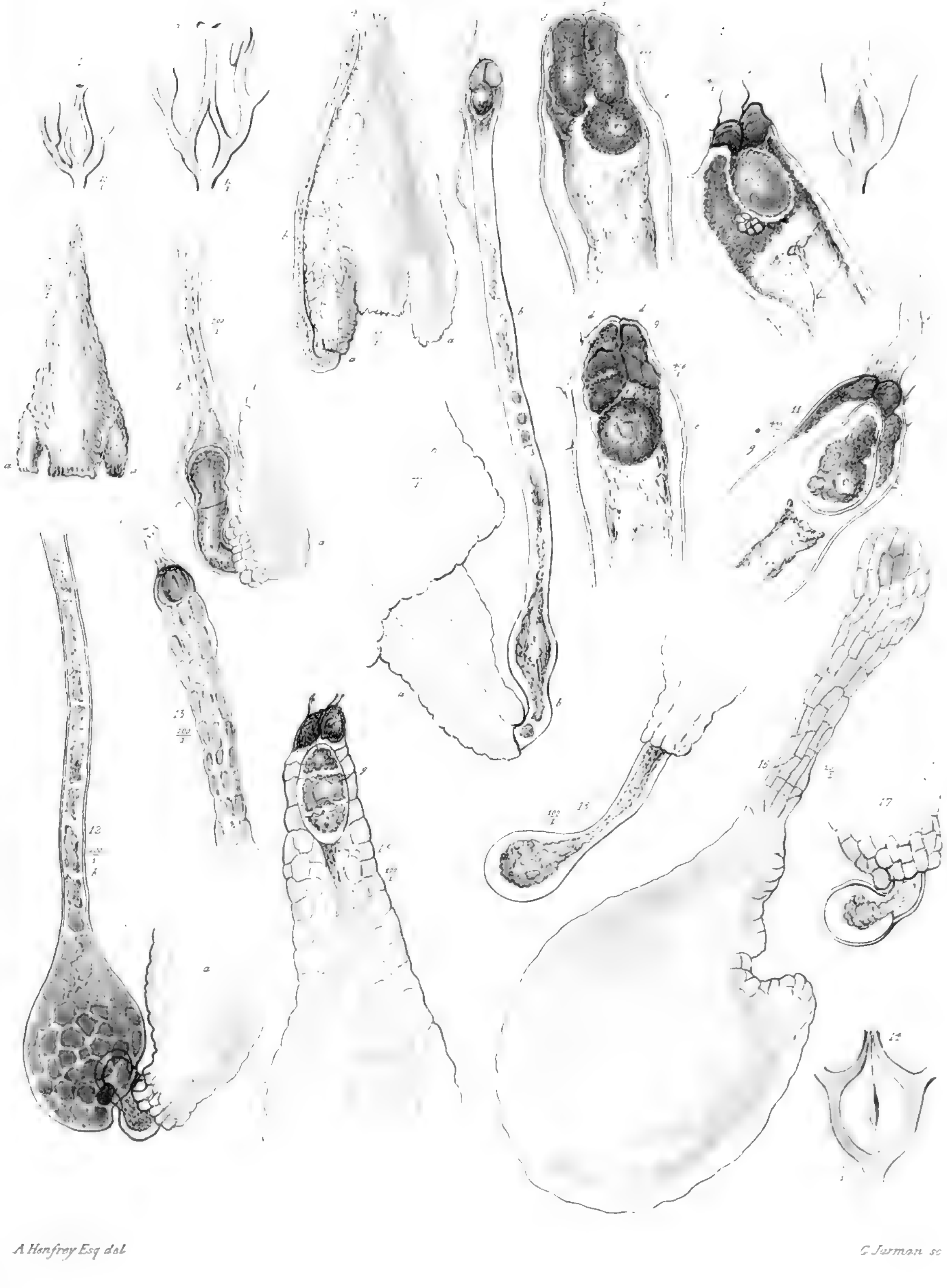
Fig. 32. The seed of the same with the shell or mesocarp removed; *r.* scaly fragments of the obliterated endocarp; *p.* placenta; *v.* its original base.

Fig. 33. Section of fig. 32 with the embryo (*g*) in the albumen *v*.

Fig. 34. Embryo extracted.

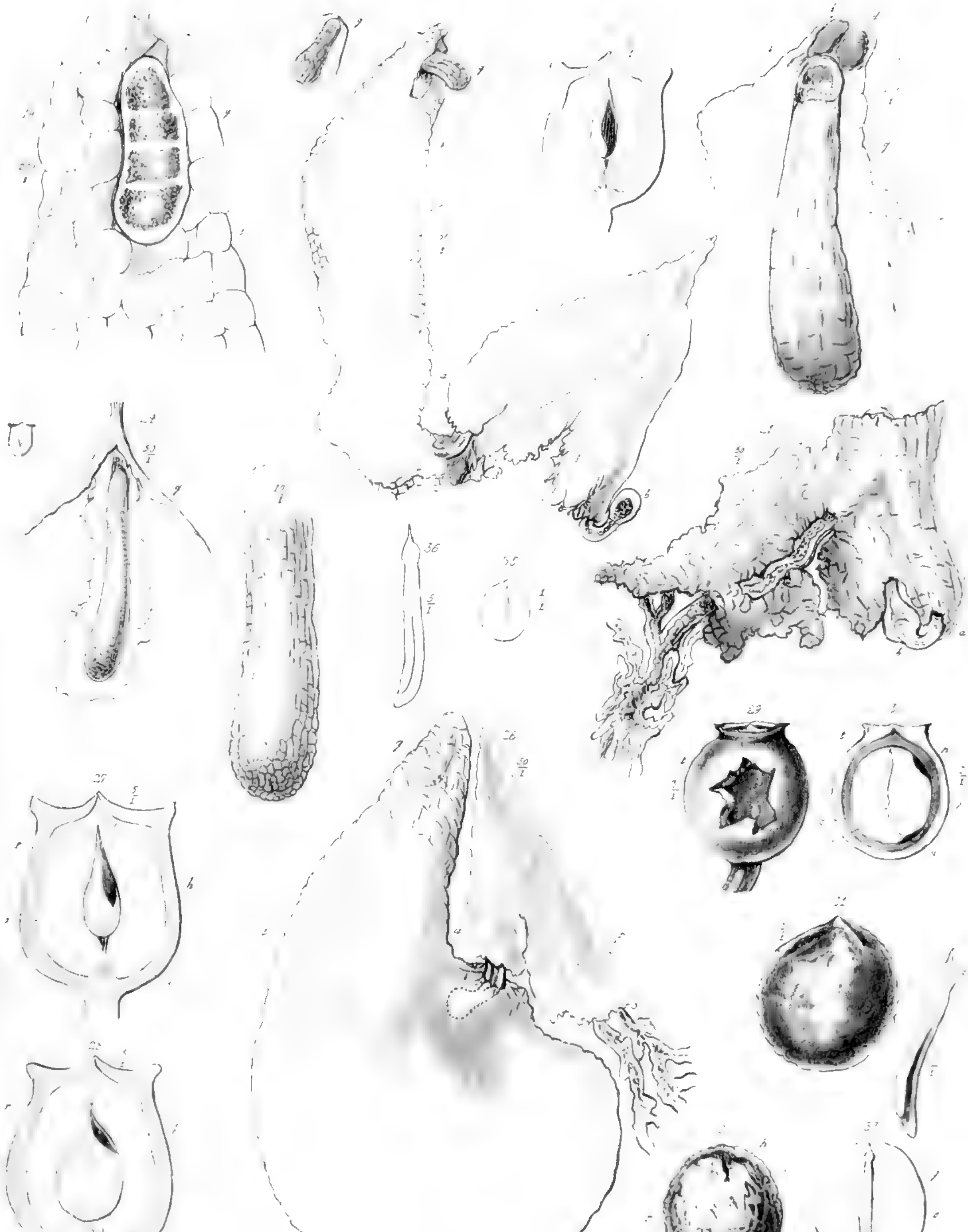
Fig. 35. Section of another seed.

Fig. 36. Its embryo extracted.



A Henfrey Esq del.

G Jarman sc



A. Henfrey, Esq. del.

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III. *Remarks on the Nature of the outer fleshy covering of the Seed in the* Clusiaceæ, Magnoliaceæ, *&c., and on the Development of the Raphe in general, under its various circumstances. By* JOHN MIERS, *Esq., F.R.S., F.L.S., &c.*

Read March 18th, 1856.

IN a notice read before the Linnean Society on the structure of the seed of the *Clusiaceæ*, I described the external fleshy envelope of the seed of the *Clusieæ*, and offered evidence to prove that this coating is a product of extraneous placentary growth, subsequent to the development of the primine, and therefore a kind of arillus. It was of some importance to ascertain this point, as in the tribe *Tovomiteæ* of the same family, the outer coating, similar in substance and colour, is unquestionably an aril: this is manifest from its peculiar form; it is free from the testa, but may be opened out like a flat plate; it is folded round the seed which it envelopes and conceals, its margins being free and overlapping one another: in the other tribe of the *Garcinieæ*, this covering is also entire, is soft, and assumes the character of an enveloping pulp. If, therefore, in the two latter tribes, the outer coating be unquestionably an aril, it was fair to conclude that the analogous envelope in the *Clusiaceæ* is of a similar nature. This inference was still farther confirmed by the presence of a distinct simple raphe, which extends from the base to the apex of the seed beneath the inner pellicle of the aril; it lies within a groove of the testa from which it is wholly free, the apex of which it perforates, and becomes lost in the chalaza of the inner integument. Under the evidence of such demonstrative proof, as far as regards the *Clusieæ*, I was led to institute a comparison of similar facts observable in the *Magnoliaceæ*, because, if that coating be considered an aril in the one family, it must be of the same nature in the other. I then referred to the admirable work of Dr. Asa Gray ('The Genera of the Plants of the United States'), where a different view is entertained: here the external fleshy coat of the seeds of *Magnolia* is described as the testa, and its thick bony shell as the tegmen, or inner integument, the true tegmen having escaped the notice of that excellent botanist. In opposition to this view, I referred to the analysis I had made many years before, of the seed of *Talauma*, a genus intimately allied to *Magnolia*: the evidence then collected, convinced me that the 'testa' described by Dr. Gray is arilliform, and that his 'tegmen' is the true testa. If we examine this outer coating in *Talauma*, where it is entire, we find it easily detached from the testa or osseous shell; and if we begin to pull it away from the summit, the raphe, as a distinct cord, will be seen quite free from it, as in the *Clusieæ*, and to lie in a corresponding groove which extends from the base to the apex: the upper end of this raphe is seen to penetrate an aperture near the summit of this osseous shell, and to become lost in the dark-coloured chalaza of a membranaceous inner integument. To all appearance, the raphe thus seems quite free; but if we examine it more attentively, a corresponding portion of the extremely delicate inner pellicle of the aril will be found attached to it, which has been torn away by the raphe. After detailing these facts, I proceeded to show that the nature of the different coats of the seed may be always determined, with certainty, by the relation of one with the other, and from the position they bear in regard to the raphe and the chalaza of the inner integument, and that wherever the raphe is found outside the testa, any tunic exterior to the latter must be of a growth posterior to the development of the original coats of the ovule. From the position of the raphe in the seeds of *Magnolia* and *Talauma*, I consequently drew the infallible deduction, as it appears to me, that the more external fleshy envelope must be arilliform, the thick osseous nut must be the testa, and the inner integument with its thickened chalaza must be the true tegmen.

Since the reading of the above memoir, the first volume of that truly excellent work, the 'Flora Indica' of Dr. Hooker and Dr. Thomson has appeared, in which they detail the nature of the outer tunics of the seed of *Magnolia* (in p. 73), entirely in accordance with the conclusion of Dr. Asa Gray, but the reasons on which they have adopted this conclusion appear to me to involve some points which materially affect the legitimacy of the inferences there deduced. I cannot agree in their opinion of the perfect accuracy of the account of the structure of the seed of *Magnolia*, as given by Gærtner, for though nothing contrary to truth is there stated, yet the most important point which bears on the present discussion, the existence of a raphe, is altogether omitted; and I feel convinced, that if that eminent carpologist had been aware of its existence, he would not have concluded that the outermost coating forms one of the true integuments of the seed, meaning by this term, those which are developments of the primine, secundine, &c. The authors of the 'Flora Indica' and the distinguished American professor do not notice the peculiar perforation in the summit of the crustaceous envelope through which the raphe passes, and they call this extremity the chalaza, a term which, in accordance with Gærtner, I think ought always to be restricted to that peculiar thickening of the inner integument around the point where the raphe becomes lost in its substance*. I have minutely described this process of the testa in the seed of *Talauma* as a distinct perforation which I have called the diapyle; it is of frequent occurrence in the extremity of the testa of the seeds of different plants, and is destined solely to the purpose just mentioned; in fact it is the corresponding point in the original base of the primine through which the spiral vessels, represented in the figure of Dr. A. Gray, pass to communicate their nourishing influence to the secundine, and to the body of the ovule, prior to the commencement of its inversion, and is the only point in the primine in which there exists any passage for these vessels, either before or after the anatropal action, and therefore the only point in the testa (or tunic, resulting purely from the growth of the primine), that could be traversed by the raphe. The presence of a diapyle in one of the tunics of a seed, is as certain an indication that this is the real testa, as the existence of a chalaza affords the surest proof of the nature of the inner integument. The actuality of the true chalaza,

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* "Chalaza nempe nobis dicitur parva areola saturatè colorata, aut tuberculum parvum spongiosum, aut callosum, quod ex ultimis vasorum umbilicalium internorum finibus, vel et ex chorii exsuccis reliquiis originem suam trahit, et in superficie exteriore membranæ seminis internæ conspicitur."—*Gærtn. de Fruct., Introd.* p. 135.

and its connexion with the raphe, in the relative position in which the latter is found, have evidently escaped the observation of these eminent botanists, as they had previously done that of Gærtner; it is, however, important to attend to these distinctions, as they form essential and convincing elements in this inquiry.

Still more recently a paper from Dr. Asa Gray has appeared in 'Hooker's Kew Journal of Botany' (vol. vii. p. 243), "On the Development and Structure of the Integument of of the Seed of *Magnolia*." This was written in reply to my observations on the arilliform nature of the outer tunic, to which I have above referred. In that note, this accomplished botanist warmly defends his former opinion, which he maintains with great ingenuity and candour, but I find nothing there stated that disproves the conclusion of most botanists, regarding the nature of the several seminal tunics in question, which I have here endeavoured to confirm. If I had not been convinced that the issue admits of the most simple and demonstrative proof, I should not have presumed to contest the united authority of the distinguished American professor, and of the highly talented authors of the 'Flora Indica,' whose opinions are entitled to especial consideration.

The argument that the scarlet external envelope cannot be an aril, because the latter "must needs have an opening at the top," stands upon very feeble ground. This was the definition of St. Hilaire, who classed the different forms of arilliform coatings under two denominations: 1. the true aril where the envelope has an opening in the top; 2. the false aril, where the coating that surrounds the testa is entire. Dr. Planchon, however, who ably defended and extended the views of his friend, in regard to the nature and origin of the aril, has shown that this definition does not hold good, and among other cases, he cites a species of *Tetracera* from Java, where the perfectly true aril forms an entire tunic. I need hardly refer to Gærtner, who also divides the aril into two kinds, the complete and the incomplete; notwithstanding that in some of the instances of the first kind, he has mistaken the endocarp for an aril; others, which he enumerates, possess a complete arilliform covering, among them *Nephelium*, which in this respect offers a good analogy with *Magnolia*. Another instance is still more remarkable, because it is recorded by Dr. A. Gray himself, in the same admirable work, and within a few pages of his description of *Magnolia*: it occurs among the *Anonaceæ*, figured in the genus *Asimina*, (plate 27) and described (p. 57) as entirely covering the testa, without the mention of any aperture in the apex. There is indeed no reason why an aril, which is a development from the placenta, may not form an entire coating, as well as the true integuments of the seed, originally cup-shaped processes. The argument of the inadmissibility of an aril, because it is not open at the top, therefore completely fails.

In regard to the remaining arguments of Dr. A. Gray, I can only repeat what has just been demonstrated, that the nourishing vessels from the placenta, as he has figured them, only penetrate the primine of the ovule of *Magnolia* at the gangylode*; they cannot and do not enter at the opposite extremity; but if we examine the ripe seed, we find the

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* For the sake of demonstration I have here given the name of gangylode to that common point of union of the primine, secundine and tercine in the original base, now the summit of the inverted ovule, which afterwards form the diapyle of the testa, and the chalaza of the inner integument of the seed.

vessels of the raphe penetrating the outer coating at the hilum, that is to say, at the extremity diametrically opposite to that of the original gangylode, and after running along its inner surface, they find their way straight to the diapyle of the enclosed nut, through which they pass to lose themselves in the chalaza of the inner integument, both which points in the ripe seed (the diapyle and chalaza) correspond with the gangylode of the ovule.

I have endeavoured, by the accompanying figures, to render this question manifest. Plate XIX. figs. 56 & 57 represent an ovule of *Magnolia* after Dr. A. Gray, showing the broad placentary sheath which encloses the spiral vessels of the raphe. Fig. 58 is a longitudinal section of the same, showing that the spiral vessels originate at the placenta and hilum, and that they terminate at the opposite extremity, at the point of the gangylode, which is the only point of the primine where these vessels traverse, in order to convey nutrition to the secundine and nucleus: it is here evident that the sheath or extension of the placenta containing these spiral vessels, must always remain exterior to the primine, as well as to the tunic resulting from its subsequent growth. Fig. 59 shows a section of the ripe seed of *Magnolia*, where the placentary sheath (seen in fig. 58) during the increment of the ovule, has in the progress of its own growth, extended itself all over the primine, and has become enlarged into an arilliform scarlet coating, and we have proof that this coating is the result of such growth, by the fact that the raphe, retaining the same position and direction, still remains enclosed in its substance. The primine, during its increment, by the deposition of osseous cells within it, in the manner recorded by Dr. Gray, becomes converted into the bony testa, shown in figs. 60 & 61, where the diapyle or aperture is seen in its apex for the passage of the raphe, corresponding with the same point of the gangylode in the ovule, through which these same vessels there penetrated: we have evidence that this testa is the product of the primine, not only from this circumstance, but because it is exterior to another integument, the tegmen, which covers the albumen, and which exhibits a chalaza in its apex, as seen in fig. 62. The above gives us an example of the development of the simple raphe.

As an instance of a branching raphe, I will select the seed of *Licania*, shown in fig. 63; this has a basal hilum, and is the growth of an anatropal ovule. Referring to figs. 56 & 58, it is evident that the only point where the spiral vessels can enter the primine, is at the gangylode, the point which they passed through prior to the inversion of the ovule. If, therefore, under the hypothesis of Dr. Gray, the raphe insinuated itself into the substance of the primine, it must, in the case of *Licania*, begin to send out its ramifications from the point at which it entered, that is to say, from the gangylode; but on the contrary, we find that all the vessels start from the opposite point of the hilum: the main bundle directs a straight course (as in the case of the simple raphe) to the gangylode or chalazal point, throwing out its redundant vessels in many lateral branches, while other principal bundles start also from the hilar point, and spread themselves by continual subdivision all over the surface of the seed. Now it is clear, if these vessels were imbedded simply within the primine, or in the tunic resulting from its growth, that they must have escaped from the placentary sheath and have pierced their way through the outer pellicle of the primine, and insinuated themselves into its substance at a point near the micropyle, a supposition that cannot be entertained for a moment. As therefore the spiral vessels, at the period of the inversion of the ovule, starting from the hilar point, must have been contained within a simple sheath, an extension of the placenta, and as these vessels during the subsequent growth of the ovule, are found to ramify from this point over its whole surface, it is clear that the sheath which contains them must have become here extended with them, in the same manner, as has been ascertained by actual observation, that it really does grow over the primine in other cases.

This may be rendered still more palpable by reference to a simple model. This mode of demonstration was first ingeniously suggested by St. Hilaire in his 'Leçons de Botanique' (p. 541), and I will here repeat it with some modifications. Let us suppose a simple flower with a tubular calyx, closed before æstivation, enclosing a tubular corolla, which again invests a superior ovary: we have here a good illustration of an erect ovule, the calyx representing the primine, the corolla the secundine, and the pistil the main body of the ovule or nucleus. Let us farther conceive the same floral model supported on a pedicel of equal length, and that the flower be suddenly bent down upon its pedicel, becoming glued to the calyx: we have thus an excellent representation of an anatropal ovule, where the former base of the flower is now become its summit, and *vice versâ*; the calyx, corolla, and pistil still remain the analogues of the primine, secundine, and body of the ovule: the foot of the calyx or torus, through which the nourishing vessels pass to promote the growth of the several parts, corresponds to the spot I have called the gangylode, and the adherent pedicel will represent the nourishing vessels enclosed in form of a sheath, or extension of the placenta, and the origin of the future raphe. It is evident, that during the subsequent growth of these tunics, this raphe must always remain exterior to the primine, as we see it in this model. Now if, as it has been contended by Dr. A. Gray, the arilliform coat of the seed of *Magnolia* be only the primine of the ovule enlarged in growth, and if, as he admits, the raphe be found within this coating, it is evident, referring to our model, that the pedicel must have become detached from the calyx, and made to penetrate not through the original point of its attachment to the torus (corresponding with the gangylode), but in some unaccountable manner, and for no purpose, must have pierced its way through the calyx near its summit (at a spot corresponding to the hilum in the ovule), and thus have insinuated itself inside the calyx, traversing its whole length in order to form a new line of communication of the vessels proceeding from the base of the pedicel to the torus, within, instead of without, the calyx: this is so manifest an improbability, as to carry conviction in the simple statement of the fact.

Doctor Asa Gray now candidly confesses that he had overlooked the existence of the inner integument, and therefore the true chalaza, and to avoid the intricacies into which this admission would naturally lead him, he has, in great measure, renounced his former argument of considering the fleshy covering and the crustaceous nut, the one as a product of the primine, the other of the secundine, and has now most ingeniously substituted an entirely new view of the subject, suggesting that these two seminal envelopes constitute in fact one coating, both proceeding from the simple increment of the primine, forming a drupaceous testa; his words are, "the external coat of the ovule becomes drupaceous in the seed, its outer portion forming the pulpy, the inner the crustaceous seed-coat." This ingenious reasoning cannot however be maintained in view of the real circumstances of the case, for it does not in any degree remove the insuperable obstacle which I have urged against his doctrine, in the position of the raphe with regard to the several coatings of the seed and to the true chalaza. But supposing, for argument's sake, we waive that objection, the reasoning is not tenable upon other grounds, because if such were the origin of these two envelopes, there ought to exist an intimate union of the fleshy exterior with the bony nut, having its several osseous and fleshy deposits enclosed within the two original epidermal pellicles of the primine. We find, on the contrary, that the osseous substance of the nut is furnished internally with a smooth skin, and externally with a distinct hardened epidermis, which in *Talauma* I found to be black and polished in the living state; the fleshy coating is also furnished on both surfaces with a distinct reticulated membrane, the inner pellicle being clearly seen with a lens. The arilliform coating, in every case examined, I have found provided with a double (that is an endodermal as well as an epidermal) membrane, showing it to be a distinct formation from the testa. Although perfectly free from the latter in *Passiflora*, &c., it is generally more or less adherent to it, especially in those cases where the raphe is spread over its whole area in branching ramifications: by its close adhesion to the testa, it then forms a compound tunic, and when the external coating is fleshy and the raphe is simple, as in *Magnolia*, &c., it can often be easily separated from it in an entire state: this is what Gærtner calls, a baccate or fleshy testa*.

My view of the nature of this development is simply the following: that in the act of inversion of the ovule, the spiral vessels destined for its nourishment and always retaining their original attachment to it at the gangylode, are drawn out, together with an enveloping portion of the placenta, so that by means of these spiral vessels and this placentary sheath, the same communication between the placenta and the gangylode of the ovule is maintained that had existed prior to the act of its inversion. This placentary sheath with its enclosed spiral vessels, appears like a prominent broad external band, as shown and figured by Dr. Asa Gray, both in relief and in section, in his analysis of *Magnolia*, to which I have referred: up to this point we are both in accord. This band afterwards becomes expanded by almost imperceptible degrees over the primine, until it finally envelopes it in the manner I shall presently demonstrate: it then becomes thickened by internal deposits, and assumes the form of a distinct scarlet fleshy covering over the testa, being quite arilliform in its structure and appearance. The testa is a distinct development, formed by the secretion of transverse crystalline cells, closely compacted within the substance of the primine, the deposition of which cells has been noticed and recorded by Dr. Gray†. The only circumstance that bears any weight in the opposite

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* "Testa carnosa solis competit seminibus baccatis, et respectu situs sui nonnunquam exceptionem a regulâ facit, cum sæpè tertium a nucleo inter integumenta teneat locum; ut in *Bixâ* atque *Magnoliâ*. Hinc proximam cum arillo habet affinitatem, atque hac solâ notâ ab eo discernitur, quod carnosa testa semper arctissimo nexu cum totâ seminis sui superficie cohæreat: ut in modò dictis, nec non in *Gloriosâ*, &c., in quibus nullum inter carnem atque semen ipsum intercedit spatium liberum, sicut in seminibus arillatis *Scytaliæ* (*Nephelii*) et aliarum."—Gærtn. Introd. p. 133.

† Hooker's Kew Journ. Bot. vol. viii. p. 23.

view of the question is one which certainly ought to have its due importance, and is one which I have never doubted in the smallest degree, viz. that Dr. Gray has watched the progress of the growth of the seed from the ovule and could never detect any subsequent or extraneous production over the primine. In the fullest credence of this assertion I still think we have convincing proof that such extraneous growth, though he failed in distinguishing it, must have taken place imperceptibly, in the same way that other observers have witnessed a similar gradual extension over the primine.

The foregoing discussion has induced me to offer a few additional observations on the nature of the raphe. I have been led into this inquiry by the phænomena that present themselves in the *Clusiaceæ*, where I found it difficult to assign a reason, why the raphe should in one case consist of a single cord of vessels, almost in a free state, within the inner pellicle of the external arilliform coating, and wholly free from the testa, as invariably occurs in the *Clusieæ*, while in the *Tovomiteæ*, the raphe has no connexion with the enveloping aril, but appears imbedded in the slender chartaceous testa, not as in the former case like a simple cord, but spread in the form of several branching nervures continually subdividing themselves, and distributed in new ramifications throughout the whole area of the testa. There appears here a difference of structure somewhat inexplicable, but after a little consideration, we may trace to one uniform rule the varying appearances of the raphe under these different forms and position. We owe to the profound investigations of our great countryman Mr. Brown, most of the knowledge we possess regarding the growth and development of the ovule and its original tunics, the changes they undergo during and after the anatropal metamorphosis, the gradual transformation of these tunics into the different coatings of the seed, and the share they afford in the nourishment and development of the growing embryo: but the phænomena attendant on the formation of the raphe, the modifications which these nourishing vessels undergo, and the different modes of their distribution, appear to have excited little notice, for we find few observations on the subject in the works of physiological botanists. On this account I will venture to offer some remarks that have occurred to me in my pending investigation of the *Clusiaceæ*.

Let us now examine some of the circumstances attendant on the inversion of the ovule. Prior to this action, the body of the ovule or nucleus is generally seated within two cups, to which the names of primine and secundine are given: these cups gradually increase in size, and grow into complete tunics which envelope and conceal the nucleus, also called the tercine: during this early stage, the vessels destined to nourish the ovule pass immediately from the placenta into the gangylode or common point which unites the nucleus with the secundine and primine then in contact with the placenta; but during the progress of inversion, the gangylode, as before shown, becomes removed to some distance, and a portion of the placenta is drawn away with it and extended over one side of the primine, at first in the form of an elongated sheath or band, as figured by Dr. A. Gray, carrying with it the spiral vessels proceeding from the placenta and terminating in the now remote gangylode: this placentary extension, whatever form it may assume in its subsequent growth, must always remain outside the primine notwithstanding that it may become agglutinated to it. Now these nourishing vessels may be all compacted in a single cord, or a portion of them in excess may become branched and extended with the growth of the placentary sheath over the whole surface of the ovule, and thus spread into numerous ramifications; but however they may become thus distributed, they must in all cases remain enclosed within their placentary envelope, and, as above shown, be necessarily exterior to the primine. This placentary sheath, first seen as an adnate longitudinal band, and afterwards extended in the form of a complete investiture over the primine, will be found to assume different phases of development: it may, during this subsequent expansion, be reduced to a degree of attenuation not thicker than a mere skin, and by desiccation of the matters secreted between it and the primine, both may become intimately fastened together, as we know occurs frequently with the primine and secundine, in which case the ramified bundles of vessels would thus become enclosed within this apparently simple, but really compound tunic, presenting a series of anastomosing nervures, such as I have figured in the testa of *Tovomita* and *Commirhea**, and by a careful dissection of this sort of tunic, we find the confirmation of this structure. In other cases, where the nourishing vessels remain compacted in one simple bundle or cord, we may conceive that the placentary sheath, which originally enclosed them, has extended itself over the primine in the manner described, and has become developed in the form of such an arilliform tunic, as we find in the *Clusieæ* and *Magnoliaceæ*, the raphe in such case necessarily remaining quite free from the testa. Inconsistent in result as the two opposite cases just referred to, may at first sight have appeared, it is evident from this explication, that both are in perfect harmony with one simple and uniform action, varied in effect according to the peculiar circumstances under which the secretory productions modify the nature of the developments.

This extension of the placentary sheath may be either complete as I have described it, or only partial: such a partial expansion is known to occur in *Turneraceæ*, and the circumstances under which it is there developed, offer still further confirmatory proofs of the placentary origin of the arilliform expansion in the manner above detailed. St. Hilaire in his 'Flora Bras. Merid.' pl. 120, figs. 4 and 5, exhibits the seed of *Turnera hermannioides*, where the raphe proceeds from the hilum, one-third way long its ventral face, like a cord: beyond this to the summit, and half way down the dorsal face, it spreads in the form of a broad fleshy plate or incomplete tunic. The same development is shown in plate 121, fig. 5, where, in the seed of *Turnera genistoides*, the raphe is seen to extend above half way from the hilum, as a cord, whence it expands as far as the summit, in the form of two broad auricular plates, nearly the length of the seed, one lobe being seen upon each of the lateral faces of the testa, forming, as in the preceding species, a partial fleshy envelope. Another instance of the enlargement of the placentary sheath occurs in *Asarum*, called by Gærtner an epiphysum†: Dr. Planchon also describes the seed of *Asarum Canadense*‡, as being greatly swollen upon its ventral face, along the line of the raphe, by a large glandular mass extending from the base to the apex, and filled with oily vesicles, as in the fleshy coating of *Magnolia*; this he denominates a strophiole, and

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* Linn. Trans. xxi. tab. 26. figs. 22 & 31.

† Gærtn. de Fruct. 48. tab. 14.

‡ Mémoire sur les développements des vrais et des faux arilles, p. 34. pl. 2. figs. 10 & 11.

Endlicher calls it a fleshy raphe, but this origin is evidently due to the same source as that of the outer tunic of *Magnolia.*

It is here necessary to point out the distinction between the different kinds of arilliform coatings of the seed. We have strong evidence to show that the scarlet covering in the *Clusieæ, Magnoliaceæ,* &c., is derived from a growth of the placentary sheath, which is a production of the funicular cord, whose origin is coæval with the anatropal inversion of the ovule: other cases however occur, where another still more exterior development is generated at a subsequent period: this is well known to proceed from the main placenta, or more often from the short funicular cord, which is the foot-stalk of the placentary sheath by which the ovule is attached, sometimes forming a thick cup as in the *Sapindaceæ,* &c., or at other times extending itself like a fleshy, coloured plane sheet completely enveloping the seed, as in the *Tovomiteæ,* or which form branching fleshy segments embracing the seed, as in *Myristica, Samydaceæ,* &c. These several varieties derive their origin from a growth of the placenta and are not developed from the original coats of the ovule; they are therefore arilliform in their nature, but as they are produced under different circumstances, I propose to confine the term aril (arillus) to the kinds of coating last described, always void of spiral vessels, and to denominate that sort found in the *Clusieæ, Magnoliaceæ,* &c., the arilline (arillinus), in which the vessels of the raphe are always imbedded. Both may and often do exist at the same time, in the same seed, or they may make their appearance independently of each other.

There is said to be still another kind of extraneous fleshy coating, produced over the testa in the manner first pointed out by St. Hilaire, to which he gave the name of false aril, and which was afterwards ably investigated by Dr. Planchon, who substituted for it the name of arillode*. This tunic is described as originating in the expansion or reversion (*dedoublement*) of the mouth of the exostome or foramen of the primine, which gradually extends itself over its whole surface, and forms an extraneous envelope around the testa. The formation of the arillode from such a source, rests upon the authority of Dr. Planchon, to which I attach its due weight; and although in support of his views, he described, with great minuteness†, the gradual formation of the arillode in *Euonymus latifolius,* it is certain that in drawing the conclusion that the arillode proceeds from the extension of the exostome, he expressed at the same time some misgiving on the subject‡. Examining therefore the details as there represented, and comparing these with my own observations on the seed of *Euonymus,* I think it may be inferred, with equal, if not with

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* Mem. ante cit. p. 10.

† Idem, p. 7.

‡ "En disant que ce dernier sac (le faux arille) procède uniquement de l'exostome, peut-être ai-je un peu sacrifié l'exactitude à la clarté. Comme l'ombilic, en effet, est très voisin du micropyle, l'expansion arilliforme partant des bords de ce dernier, devrait rencontrer dans le funicule un obstacle à son extension et offrir une solution de continuité. Mais c'est là au contraire *que l'expansion est la plus épaisse, et même elle adhère avec la base du raphe sur une partie de sa longueur de manière à ce qu'elle semble sur ce point naître de cette dernière partie.* Il faut donc nécessairement, pour expliquer une pareille disposition, admettre *une soudure congeniale entre l'expansion et le funicule.* Je crois devoir ajouter pour prévenir tous les doutes, que chez les *Euonymus, le micropyle est fort difficile à voir, lorsque l'ovule est déjà très développé, parceque le faux arille est plissé autour de son ouverture, et la cache complètement*: mais en détachant avec soin l'enveloppe accessoire, on peut facilement s'assurer qu'elle naît des bords de l'exostome."—*Loc. cit.* p. 9.

greater probability, that the extraneous coating is produced from the funicular cord, rather than from the foramen or micropyle of the primine, and in such case the arillode would not differ from the aril.

I have had no opportunity of examining the ovule during its growth, but have lately observed ripe and living seeds of *Euonymus Europæus*. Here the outer coating is entire fleshy and scarlet, with a smooth inner skin, and we find beneath it, another polished, thinner, though somewhat fleshy tunic, that closely adheres to the seed. If this tunic be removed carefully from the thin pergameneous testa, it will be found to consist of two delicate reticulated pellicles, having cellular and fleshy matter interposed between them, the raphe being completely immersed in its substance, in the form of a simple cord, which originating at the basal hilum, proceeds along its face to the apex, where it pierces the inner pellicle of this tunic, passes into a small opaque speck in the summit of the testa (the diapyle), and is lost in the chalaza of the inner integument which is adherent to the shell. Here we have demonstrative evidence of the nature of these several envelopes; the outer coat is manifestly a true and entire aril, for we cannot suppose it to be a development of the primine, that is to say, an extension of its exostome, as Dr. Planchon almost doubtfully concluded, because it is altogether free from, and exterior to a more internal tunic which encloses the raphe: it follows, therefore, as a necessary consequence, from the position of the nourishing vessels, that it must be a production emanating from the main placenta or a growth from the funicular support of the seed. The fleshy epidermoid tunic which encloses the raphe, and which immediately invests the pergameneous shell, appears to be an arilline, resulting from the growth of the placentary sheath: the thin pergameneous shell is, of course, the true testa, marked at its base by a small prominent nipple, close to the hilum, which is no doubt the thickened border of the true micropyle figured by Dr. Planchon, and from which he inferred that the growth of the aril had emanated: the apical speck through which the vessels of the raphe penetrate, is the diapyle: it is hardly necessary to add, that the radicle of the embryo, enclosed in albumen, points to the micropyle, while the extremities of the cotyledons are directed towards the diapyle. I do not find the aril pervious in the apex, as stated by Gærtner, and as figured by Dr. Planchon in another species, although this, no doubt, sometimes occurs; but in the instance above mentioned, the inner skin of the tunic, though slightly crumpled, is entire, while its outer pellicle is deeply plicated in flattened folds, so that the aril appears cleft into numerous fissures externally.

Among the many interesting facts detailed by Dr. Planchon in the work just quoted, we meet (*loc. cit.* p. 25) with an account of the circumstances under which the seeds of *Opuntia* become covered by two distinct extraneous envelopes, both exterior to the testa: the first is a somewhat thin, hard, coriaceous tunic, according to his observations; the second is a soft, mucilaginous, pulpy coat by which the former is encircled. The growth of the former was traced by Dr. Planchon from the period of the anatropal inversion of the ovule, which was carried to an extent of a complete gyration, so that the placentary sheath I have before described, appeared at first like an annular band around the periphery of the ovule; from this ring, on both sides, membranaceous expansions were seen gradually to extend themselves over the intervening spaces, until they met in the centres, and thus formed one complete tunic, which finally assumed the solidity and texture of a crustaceous shell, which he called a "false testa": this again became enveloped by a second placentary extension, in the form of a transparent soft pulp. These facts had been previously authenticated by the careful observations of Gasparini*, who describes, with great apparent accuracy, the curious phænomena attendant on the growth of the ovule of *Opuntia*, from its earliest development to the state of its ripe seed. After its anatropal inversion, the ovule is seen suspended by its short funicular cord (podosperm) from the hilum, which cord, in form of a placentary sheath, or thick cylindrical filament, is seen to extend itself round it, until it encircles the ovule like an annular ring: from this ring, on each side, a distinct membrane, at first very thin, expands itself by slow degrees, until at length, on both sides, it becomes extended in a complete tunic, over the entire surface of the ovary. After the period of fecundation, he farther observes, if we watch every now and then the growth of the ovary, during its transformation to the state of seed, we see the tunic just mentioned, as well as its very short podosperm, become covered, little by little, with a pulp. In proof of the fact that the production of this more external tunic originates in the extension of the podosperm, he states that sometimes, in some ovules, from some unknown cause, the above-described annular prolongation of the placentary sheath is not formed, and in such case the seed is not covered with the usual pulpy envelope. Some explanation, however, is here requisite, which I am enabled to give from the examination of the large seed of a species of *Opuntia*, collected by me in Chili many years ago. This has convinced me of the correctness of the details given by Gasparini and Planchon, with this exception, that the thin pellicular membrane, which both actually witnessed in the act of its growth and extension over the primine, and which the latter imagined became converted into the thick osseous shell, is no other than the intermediate epidermoid tunic, which I found still covering the shell. We may feel assured that the deposition seen of osseous cells, to form the crustaceous shell, took place in the substance of the primine, and not in its arillinar covering, as Dr. Planchon inferred, for Gasparini makes no mention of such an occurrence. That such is the case, is manifest from the position of the raphe, and it is not less clear, from the phænomena observed, that the membrane, as they saw it in the progress of its growth, is a production of the placentary sheath, and is therefore of the nature of an arilline. So, in like manner, the pulpy envelope emanates from the placentary sheath or funicle; and that such is really its origin is proved by the curious fact related by Gasparini, that when, as it sometimes happens, the placentary sheath is unformed, no growth of pulpy matter takes place over the seed. From the circumstances above detailed, we may safely conclude that the hard crustaceous shell in the seed of *Opuntia* is its testa, that its annular ring is the raphe, and that the intermediate tunic coating the testa is an arilline; while the more exterior pulpy envelope, whether originating in the placentary sheath or the funicle, is still an aril, because it is void of spiral vessels.

Another striking confirmation of the fact of the gradual increment of the fleshy coating over the primine, is cited by Dr. Planchon, and is the more important, because it occurs in *Clusia*, and bears immediately on the question at issue. In the work before

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* Osservazioni intorno alla struttura dell' arillo. Rendiconto dell' Accad. delle Scienze di Napoli, an. 1843, p. 260.

quoted (p. 31), as an instance of the progressive formation of the false aril, he describes and figures (in plate 2. figs. 7 & 8) the ovule of *Clusia flava*, which he examined after the fall of the corolla, at which period he observed that the primine adjoining the funicle became enveloped for a quarter of its length by a cup-shaped arilliform process, and there can be little doubt that this expands into the entire fleshy coating, which at a later period we know envelopes the testa in the manner I have described in the *Clusieæ*.

M. Dutrochet, a very able physiological botanist, in discussing the nature of the aril, denies that its growth proceeds immediately from the placenta, and declares his conviction, formed after many years of patient investigation of the subject, in the following words:—"L'opinion qui me paraît aujourd'hui la plus conforme à l'observation, est que l'arille est une extension de la partie inférieure ou de l'enveloppe corticale du funicule*."

Mirbel has furnished us with evidence of great importance in the solution of this inquiry: he minutely describes the growth and development of the ovule of *Cucumis Anguria*, in which he observed, after the period of its fertilization, the production of two distinct layers of cellular tissue over the primine, originating, no doubt, from an emanation and extension of the placentary funicle. His words are, "deux couches de tissu cellulaire, qui n'appartient pas primitivement à l'ovule, mais qui s'applique à sa surface et finit par lui servir d'enveloppe comme ses téguments propres†," thus affording unquestionable evidence of the extraneous growth of the arilline, evidence since confirmed by the observations of Gasparini and Planchon. I shall be able to show that the crustaceous tunic of the seeds of the *Cucurbitaceæ*, hitherto held to be the testa, as well as its immediate soft envelope, are both of arilliform origin, and that the true integuments resulting from the primine and secundine of the ovule are to be found in the membrane that immediately invests the embryo, and which has always been considered the tegmen: this fact is attended by some curious phænomena which will be detailed in another place, where I will adduce many instances of the anomalous development of the raphe. I will, however, here allude to the peculiar structure of the outer tunics in many of the *Cucurbitaceæ*: if the seeds of *Citrullus*, for example, be macerated in water, the outer shell will be found to consist of three distinct parts, which may be termed the epiderm, the mesoderm, and the endoderm. The epiderm is pellicular, transparent, and under the lens is seen marked by large areolar reticulations; the mesoderm is always fleshy, and composed of parenchymatous, frequently mixed with pleurenchymatous deposits; the endoderm, hitherto considered as the testa, is crustaceous, and consists of transverse hollow cylinders closely compacted and agglutinated together. The epiderm is a continuation, and a dilated termination of the external sheath of the umbilical cord; the mesoderm is also a continuation of the pleurenchymatous fibres of the funicle, where they serve to protect the more delicate spiral vessels of the raphe; but the crustaceous endoderm is a distinct deposit within the vesicle of the epiderm, forming a compressed and indurated sac, enclosing the seed, and always open at its mouth (the hilum), within which is a space filled with loose cellular tissue, which is also generally extended over the internal surface of the endoderm. These three deposits must be formed at a period subsequent to the fertilization of the ovule, as will be evident from the copious details, illustrated by

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* Mém. Mus. viii. 273.

† Mém. Acad. Paris, ix. 622. tab. 1. fig. 10 *e*; fig. 11 *h*.

admirable figures, of the growth of the ovule recorded in the valuable Memoirs of Brongniart and Mirbel, and, as will be seen, proved by the observations of the latter, cited in the foregoing page. It is not more unreasonable to conceive that the osseous deposit, forming the crustaceous covering, may in some cases be secreted in the arilliform coating, as well as in the primine of the ovule; in both instances, the secreted matters must pass through the same channel, and be supplied by the same vessels of the funicle, and such depositions at one point, instead of another, are probably regulated by the nature of the pre-existing tissues. In *Zanonia* and *Feuillæa*, the arilliform nature of the outer coating is better shown by the membranaceous state of the tunic, which is extended like a winged covering over the seed.

From these circumstances we may infer, that the arilline need not necessarily be always fleshy in its nature, as in *Magnolia*; but that it may be either membranaceous, gelatinous, coriaceous, or even osseous in its structure. Thus I have found from the position of the raphe, that the hard highly-polished tunic of the seeds of *Drimys* and *Ilicium*, usually regarded as testa, should be held to be a true aril: thus also the coriaceous coatings of many seeds will in like manner be found to be arilliform in their origin. Of that kind of seminal coating where the arilline is intimately combined with the testa, and where the raphe, greatly branched, lies imbedded between them, forming a compound tunic analogous to the structure already described in the *Tovomiteæ*, a very remarkable instance occurs in the *Oleaceæ*, where the raphe, instead of being spread into numerous branching nervures, exhibits itself by infinitely minute ramifications, as a dense network of most delicate spiral vessels, crowded together into a cottony web, like that of a spider's cocoon, and fills up the entire space between the testa and arilline; these tunics, aided by this interposition, are closely agglutinated into an apparently simple coating, but by maceration they may be separated from each other, and the interposed network may be drawn out into innumerable elegant spiral threads. This structure I have found in *Tessarandra* and *Olea*, and it probably exists in other genera of the family. Nearly the same development occurs in *Casuarina*, where a thick web of spiral fibres is found interposed between the crustaceous testa and the outer membrane, which is extended over it in the form of a wing. This structure, noticed many years ago by Mr. Brown, and at that period described as a singular occurrence (Gen. Rem. p. 40), has since been confirmed by Schleiden, and figured in Schnitzlein's 'Iconographia' (Gen. 86). The pellicular coating of the seed, here extended in the form of a wing, which covers the excessive development of the raphe, will probably be found to be an arilline.

We have a good illustration of the arilliform nature of the external coating of the seed, under somewhat variable forms, in the *Passifloraceæ*. In *Tacsonia pinnatistipula* I found the seed invested by a mucilaginous pulpy envelope, which dries into a loose pellicular vesicle, quite detached, leaving a considerable vacant space between it and the osseous testa, in every part save at a small point at the base, and at another in the apex: this pellicle shows no vessels of any kind, except in its longitudinal raphe, which is imbedded in its substance, appearing as a prominent white nerve, running from the basal hilum to the summit, where it finds a passage through a caruncular spot (the diapyle) in the apex of the testa, beneath which it becomes lost in the chalaza of the inner integument. In

Ryania (*Patrisia*), as shown in Delessert's 'Icones,' iii. tab. 14, the seed is covered by a similar arilline, and along the whole length of a similar longitudinal raphe, a lateral cupular fleshy expansion is developed, manifesting the coexistence of aril and arilline, emanating from the same origin. Both these developments also occur in *Paropsia*, where the seeds are suspended by a long funicle, which, at the hilum, is expanded into a fleshy cup, that envelopes the lower half of the seed. In *Acharia* the longitudinal raphe becomes distended on each side, forming a lateral gibbous process (Ann. Nat. Hist. iii. pl. 9. fig. 15) analogous to that before referred to in *Asarum*. In *Modecca palmata* an entire and very thick fleshy tunic invests the osseous testa, marked by a prominent longitudinal keel, enclosing the raphe (Wight, 'Icon.' tab. 201. fig. 12, 13, 14, &c.), and in *Modecca Wightiana* (id. tab. 179. fig. 3) we see precisely the same development, with the addition of another crenated hemispherical fleshy cup, covering the base of the seed. This is also seen in *Modecca australis* (Endl. 'Icon.' tab. 115). In all these cases, the raphe is perfectly free from the testa, and always forms part of a more external tunic more or less adherent to it, the arilliform nature of which has never been doubted; the structure is quite analogous to that found in *Magnolia*, &c., and distinct from the still more external development, the true aril.

The mass of evidence here adduced, strengthened by the observations of botanists of high repute, showing the nature of the several metamorphoses which accompany the production of the raphe under its different forms, indicate the real placentary origin, whether mediate or immediate, and therefore the arilliform character of the several extraneous tunics, which assume such various textures and conditions around the testa,—restricting this latter term within the limit usually assigned to it—a simple development and growth of the primine of the ovule. The question appears to me so simple and manifest, that I should have considered it unnecessary to enter into such full details in its support, if this point of structure had not been so positively denied by the high authorities to which I have referred: a desire for the solution of the truth has alone induced me to extend these observations to a greater length than otherwise would have been requisite. Many other interesting topics of physiological inquiry are connected with the farther consideration of this subject, and I have prepared another paper, in which are discussed many of the phænomena attendant on the peculiar direction of the raphe, especially in reference to the anomalies before alluded to, in *Stemonurus*, *Anona*, the *Cucurbitaceæ*, and other instances, with a view of tracing the causes of such unusual deviations from the ordinary course of structure.

EXPLANATION OF THE FIGURES.

TAB. XIX.

Fig. 56. Represents an anatropal ovule of *Magnolia,* after Dr. Asa Gray, seen on its ventral face.

Fig. 57. The same viewed sideways.

Fig. 58. A vertical section of the same. In all these the letter *a* shows the placentary sheath, enclosing *b.* the spiral vessels of the raphe; *c.* is the primine; *d.* the secundine; *e.* the tercine or nucleus; *f.* the gangylode; *g.* the hilum.

Fig. 59. Is a longitudinal section of the ripe seed of *Magnolia.*

Fig. 60. Is the crustaceous testa, cleared of its fleshy covering, viewed sideways.

Fig. 61. The same seen on its ventral face, showing the groove formed by the pressure of the raphe.

Fig. 62. The inner integument, covering the albumen. In all, the same letters refer to *a.* the scarlet arilliform outer coating, being an expansion of the placentary sheath seen in figs. 56, 57 & 58, which has grown over and covered the primine, and now completely envelopes the testa; *b.* the raphe; *c.* the testa or development of the primine; *d.* the tegmen, or inner integument, resulting from the secundine; *e.* the albumen; *f.* the diapyle or scar of the gangylode, through which the raphe passes to reach the chalaza; *g.* the hilum; *h.* the funicular cord; *i.* the chalaza upon the extremity of the inner integument, where the raphe is lost; *k.* the embryo imbedded in albumen:—*all much magnified.*

Fig. 63. Is a seed of *Licania* removed from its pericarpial covering:—*nat. size.* *a.* the tunic formed of three adherent membranes: the outermost is the arilline, the intermediate one is the testa, the innermost is the tegmen; *b.* is the hilum; *c.* the vessels of the raphe, interposed between the arilline and testa, and dividing into continual ramifications, which spread over the whole area of the seed: they all branch from the hilum, which is situated at the extremity contrary to that of the chalaza, or point corresponding to the original base of the ovule, showing that these vessels must be exterior to the real testa, and enclosed within another distinct integument; for if they were included within the substance of the testa, they would branch from the contrary extremity at the point corresponding with the original base of the ovule, the only point in which these vessels could have penetrated the primine, and therefore the testa.

Fig. 64. Is the exalbuminous embryo, also *nat. size*; *d.* the cotyledons; *e.* the radicle, placed near the hilum.

See p. 112 for Tab. XIX

IV. *On several instances of the Anomalous Development of the Raphe in Seeds, and the probable causes of such deviations from the usual course of structure, especially in reference to* Stemonurus (Urandra *of Thwaites*), *with some Prefatory Remarks on that Genus. By* John Miers, *Esq., F.R.S., F.L.S. &c.*

Read April 15th, 1856.

In a recent Number of Hooker's Journal of Botany (vol. vii. p. 211), Mr. Thwaites has recorded a new genus, of which he gives the characters under the name of *Urandra*. This he refers to "*Olacaceæ*, tribe *Icacineæ*." I have read over his description with the utmost care, and am obliged to say that I perceive no difference whatever in the characters of *Urandra*, and those I have detailed of *Stemonurus*, to which genus he confesses it is closely allied, differing only in all its flowers being fertile, in its small, not pulvinate, stigma, and in the structure of its fruit. The character founded on the constancy of the hermaphrodite flowers in the plant which he describes, cannot be considered of the smallest generic value, because this circumstance has been shown to exist not only in some species of *Stemonurus*, but in the contiguous genus *Platea*, in which, although some of the plants are unisexual, others are frequently hermaphrodite. I have also shown that the stigma in *Stemonurus* (*Gomphandra*, Wall.) is small, and not large and pulvinate as it had been described, but that it becomes subsequently immersed in the epigynous gland which crowns the ovary, a circumstance evidently not observed by Mr. Thwaites; and that it is this gland which assumes a pulvinate form on the summit of the fruit, and not the stigma, which may always be seen hidden in a small central depression of the cushion. There remains therefore to be considered only the structure of the fruit; and Mr. Thwaites's details of the ovary, fruit and seed in *Urandra*, closely agree with what I have observed in *Stemonurus*. In this genus, as in all others of the *Icacinaceæ*, where the ovule is usually unilocular, the cell is always excentrically placed on one side of the pistil, the point of suspension of the ovules not being from the summit of the cell, but constantly inclined against the side on the line of the displaced axis of the ovary: the lobes of the stigma are always two or four, thus showing *primâ facie* that the ovary is normally bilocular, and that the two ovules observed in the cell are really attached, near its summit, to the dissepiment, which, owing to the abortion of the other cell, appears to form the wall of the ovary. I was fortunate enough to meet with the proof of this conclusion in a ripe fruit of the closely allied genus *Pennantia*, where the ovary is usually unilocular as in *Stemonurus*; but in the instance alluded to, the fruit was regularly two-celled, and only one seed was perfected in each cell, the remaining abortive ovule being still visible on the dissepiment at the point of attachment of each seed; this partition was of thin texture, and the nourishing vessels proceeding from the base formed a longitudinal nervure in the line of its axis, extending thence to the point of attachment of the seeds near the summit of the cells. Here we have the most positive proof of the normal structure of the whole family, and this fact ought to be held in view in those cases which ordinarily occur, as in *Stemonurus*, where one of the cells has become obliterated by partial abortion.

The able botanist who has given us the details of *Urandra*, has had the advantage of examining the fruit in a living state, and describes it to be a somewhat fleshy drupe with a subligneous putamen, its solitary seed consisting of an embryo formed of two small cotyledons and a superior terete radicle loosely seated in the upper part of a longitudinal cleft or cell in a large albumen, which is thus nearly divided into two almost equal plates, by the intervention of two cellular strata that line this cavity, and whose margins nearly reach the testa on every side. This exactly corresponds with what I have observed in *Stemonurus*, and the same features are confirmed by Dr. Wight in his 'Icones,' under *Stemonurus* (*Gomphandra*) *polymorphus*, where they are well delineated in plate 954. figs. 11 & 12, and where the chink above mentioned is shown distinctly in fig. 13. Mr. Thwaites examined the texture of the nucleus of *Urandra* under the microscope, and he describes the albumen to consist of cells, radiating from the more central tissue to the periphery of the seed; he states that the two strata lining its cavity are formed of cells similar to those of the albumen, but differing in containing no amylaceous granules: he considers them to be organically connected with the albumen, but I succeeded most certainly in separating them as easily as the integuments, and still preserve them in this state. At the time I published my Monograph of the *Icacinaceæ*, I had been able to examine only a single drupe of *Stemonurus*; but I was fortunate enough afterwards to obtain another seed, through the kindness of the late Major Champion, which I analysed, and found that a portion of the embryo, in the first instance, had been partially eaten by a small insect, then observed within the cavity, so that the real cotyledons were gone, and I found a portion of the radicle, situated in the manner I had described, in the upper part of the axis of the albumen, and placed at one extremity of the two thin membranaceous strata described by Mr. Thwaites. I naturally concluded, by analogy, that these were the cotyledons; they occupied the same position, and were about the size of the foliaceous cotyledons I have delineated in *Mappia fœtida*, and as these are figured by Dr. Wight (Icon. 955. figs. 10 & 11) under *Stemonurus fœtidus*. In my second analysis, made soon after the publication of my Memoir on *Stemonurus*, I discovered the embryo entire, with small cotyledons, just as Mr. Thwaites has shown them; my attention was now, therefore, drawn to the consideration of the nature of the two membranaceous strata, well described by that botanist. The result of this examination, and my correction of the form of the embryo, would consequently have been given in the forthcoming volume of my 'Contributions,' where the details of *Stemonurus* and all other genera of the *Icacinaceæ* are figured. I am, however, glad of this opportunity of rectifying my previous description, and of adding a drawing of my analysis of the seed.

Another circumstance mentioned by Mr. Thwaites calls for observation. In *Stemonurus* the albumen of the seed is covered by the ordinary delicate membranaceous inner integument, and this again is invested by a very thin testa, which is intimately agglutinated to it, and which is marked by fine hexagonoid reticulations. The raphe, prominent upon the testa, and which by pressure leaves a corresponding groove on the surface of the albumen, is singular in its form, on account of its retroversion in the manner I have detailed, both here and in my Monograph of the genus. Its nature does not appear to have occurred to Mr. Thwaites, for he describes it merely as "a whitish raised line, which is very conspicuous on the outside of the seed, passing quite round it lengthwise, and consisting of a fillet of spiral vessels lying between the two thin coats or layers of the testa." The nature of this fillet is soon ascertained by tracing it to its origin, and I have again referred to the parts of my two analyses which I have preserved, and these confirm my previous inference. As its form and position involve other considerations of some importance, it is desirable to describe it more in detail. On examining the putamen, which is the lignified endocarp of the fruit, we find it of an oval form, slightly flattened on one side, along which is observed a longitudinal groove, in which is imbedded a thick cord or bundle of fibres, which is easily raised from the channel, and is found to penetrate an aperture in the upper extremity of the groove: some fibres proceeding from the stigma here join it, and the cord now reduced to a thread, after its passage through that aperture into the cell, becomes attached to the testa of the seed, on a small protuberance near its apex; it then assumes the features of a prominent line upon it, and descends along one angle of the dorsal face of the seed, to near its base, then curves round this, and ascends along the other angle of the same face, to a hollow in the summit, beneath the apical protuberance just mentioned, where it disappears, describing in its course a horse-shoe, or rather an oval curve: and this is the "whitish raised line" described by Mr. Thwaites. The nourishing vessels are thus distinctly apparent throughout their entire course, from the external base of the putamen to the vanishing point of the thread just described, in one continuous line: the external portion of this cord is evidently the placentary axis of the dissepiment of the normal bilocular ovarium, for in the 2-celled and 2-seeded fruit which I have mentioned, where the seeds were separated by a distinct partition, this same cord was seen imbedded in the line of its axis, and became furcated on arriving at the summit, each branch passing through a double aperture into the two cells, where it attached itself to the apex of each seed, and continued in its course as the "whitish raised line" of Mr. Thwaites: this thread therefore bears the character of a raphe; but as its form is very peculiar, it is well to compare it with the same organ in other genera of this family.

The development of the seed in *Stemonurus* is precisely similar to that in *Pennantia*, as I have elsewhere shown, agreeing even in the same relative size, shape, and position of the embryo, differing only in the singular extension of the raphe, and the presence of a large vacuity in the centre of the albumen, lined with thin pellicular plates. In *Pennantia*, as in other genera of the *Icacinaceæ*, the raphe originates as in *Stemonurus*; but its course is along the middle of the dorsal face, and it loses itself at the opposite or cotyledonary extremity of the testa, according to the law of anatropal development: in the latter genus, contrary to general rule, the descent of the raphe is along one side of the seed, and, after crossing the lower part, it ascends up the other side, to near the point from which it started, and is lost in the integument, close to the extremity of the radicle: the raphe in this course, which is always inclined a little towards the dorsal face, leaves by its pressure a corresponding groove close to the periphery of the albumen: the margins of the large cavity in the albumen, in which the much smaller embryo is suspended, also correspond with this line of circuit of the raphe, so that the albumen along this line is reduced to a very thin substance, and consequently is nearly separated into two parallel slabs. In *Stemonurus* I could not perceive the indication of any chalaza at either extremity of the inner integument, and there exists a more intimate union of this integument with the testa, which are both of delicate texture. In *Pennantia*, on the contrary, a distinct chalaza is visible at the cotyledonary extremity of the inner integument at the vanishing point of the dorsal raphe: the same exists in *Mappia*, and probably in all other genera of the *Icacinaceæ*. Mr. Bennett (Plant. Jav. rar. 131) quotes the observations of Mr. Brown and of M. Brongniart to show that the eversion of the raphe upon the dorsal face of the seed is of frequent occurrence in *Celastraceæ*, *Rhamnaceæ*, *Aquifoliaceæ*, and *Caprifoliaceæ*, and is fully confirmed by his own experience in the seeds of *Euonymus* and *Rhamnus*, where it is frequently everted, though often only laterally displaced; and he entirely adopts the opinion of Mr. Brown, that this eversion of the raphe in no way militates against the universal law of anatropal development; for on examining these occurrences at an early stage of their growth, he invariably found the ovule with its raphe on the ventral side, or that next the placenta, and he observed that its subsequent appearance on the opposite or dorsal face, is due to an evident torsion of the upper extremity of the raphe, or short funiculus, during the increment of the seed, and not to any original development. The eversion of the raphe in the *Icacinaceæ*, together with a similarity in other essential points of structure, strongly prove the close affinity of this order to the *Celastraceæ*, *Aquifoliaceæ*, and other families which I proposed to unite with it into one general alliance (the *Dryales*), nearly allied to the *Rhamnaceæ*.

In the above-mentioned structure in *Stemonurus*, a curious deviation from the usual development of anatropous seeds occurs. In the organization of most of its parts there exists, as before mentioned, a perfect analogy with that found in *Pennantia*: the seed is albuminous, and the radicle of the embryo is superior and pointed to the hilum; but while in *Pennantia* we trace the raphe in a straight line to the opposite or cotyledonary extremity, as in ordinary anatropous seeds, we find in *Stemonurus*, owing to the singular retroversion of the raphe (that is to say, its continuation beyond the point where it ought to have terminated, and its subsequent ascent to the summit—to the point of its disappearance near the hilum), that this unusual circumstance is not attended by a corresponding change in the position of the embryo, and offers a paradox difficult of explanation. In ordinary cases, the ovule makes a semi-gyration on its centre, thus producing a complete inversion of the embryo and its integuments, all moving together in accordance: but do we not see, from the course of the raphe in *Stemonurus*, an indication that a complete gyration or double anatropal action of one or both of the integuments has occurred, while the embryo at the same time has effected only a half-gyration, or simple anatropal movement? How can we otherwise account for the peculiar form of the raphe in this case? I will recur again to this point when I come to speak of other developments which appear to offer much analogy with this phænomenon.

In order to prepare the way for this investigation, it is of some interest to determine the nature of the two thin membranaceous plates, or cellular strata, that line the cavity of the albumen, as before described, and I think these may be referred, with little doubt, as we shall see in other well-authenticated cases, to the existence of a large persistent embryo-sac which has not been absorbed, as it usually is in most seeds. In the case in question, at the upper extremity of this cavity, the embryo only one quarter of its length is found, and here the radicle, pointing upwards, terminates in a long mucronate point, which is a kind of suspensor, by which it is pendent in the mouth of the cavity, and where it is enveloped in a small quantity of glutinous matter, which lines the internal surface of the sac. Instances of the existence of this cavity in the axis of albuminous seeds are not unfrequent, but the discovery that it originated in the persistence of the embryo-sac is due to Mr. Brown (App. King's Voy. p. 21).

The first consideration that arises is the question whether the existence of this persistent embryo-sac has any necessary connexion with, or has had any share in producing the phænomenon of the retroversion of the raphe, and the inversion of the embryo in regard to it, in the manner before stated; whether the two latter unusual circumstances are independent of each other, or whether they are necessarily connected. The only method of forming any conjecture on this head, is to search for facts that have any collateral bearing on the question. In *Diospyros* we meet with a parallel case of a large cavity in the middle of an albumen, which is open at the hilum, and is in like manner lined with an adherent embryo-sac; the embryo is found in the outer end of the much larger cavity, the end of the radicle almost protruding out of its mouth: the albumen is deeply divided into numerous lamelliform folds, as in *Anona*, and is covered by two thin integuments, of which the inner one is plicated within the interstices of its lamellar clefts, while a distinct raphe, adhering to the outer integument, proceeds along a groove formed in one of its marginal sides, from the basal hilum to the summit, or opposite cotyledonary extremity, where it disappears. We have here therefore a parallel instance of the existence of an open cavity in the albumen, lined with the embryo-sac, but this circumstance is accompanied by the presence of an ordinary raphe, while both the seminal tunics and the embryo have gone through the usual process of anatropal inversion.

In *Anona* we meet with a complete peripherical raphe, as in *Stemonurus*, but the embryo-sac has disappeared; there is therefore no cavity, as the embryo lies tightly imbedded in the substance of the albumen, and the radicular end of the embryo, with a very short mucronate point, or suspensor, is directed to the spot where the raphe, after completing an entire circuit round the periphery of the seed, disappears close to the hilum. In this instance we find that a complete gyration of the original tunics, as indicated by the raphe, and only a semi-gyration of the embryo, have taken place; thus offering a perfect analogy with the structure of *Stemonurus*, excepting the presence of the embryo-sac and its accompanying cavity. These two instances seem to prove that the presence of this albuminous cavity and the complete gyration of the raphe do not necessarily accompany each other, and they leave us as much in the dark as ever, regarding the cause of the phænomena observed in the seed of *Stemonurus*.

In *Opuntia* we have another example of a completely annular raphe, but the embryo, imbedded in a small quantity of albumen, is quite campulitropal: the raphe after completing its circuit penetrates the testa through the diapyle, at a point where the two extremities of the recurved embryo are brought into close contiguity, although separated by a peculiar inflexion of the inner integument, close to the chalaza, so that this integument is here bisaccate, one recess receiving the end of the radicle, the other the extremities of the cotyledons. In this case there appears no vestige of any embryo-sac, and although the raphe is completely cyclotropal*, only the cotyledonary or chalazal extremity of the embryo has accompanied it in effecting an entire revolution, while its radicular end has remained anatropal, having experienced only a half-gyration. This example therefore, although analogous in some respects, affords no assistance towards an explanation of the phænomena of *Stemonurus*.

In the *Plumbaginaceæ*, we have a remarkable instance of the complete gyration of the ovule under very different circumstances: in an early stage it is simply inverted according to the ordinary course of anatropal development, that is to say, a semi-gyration of the entire ovule on its centre, accompanied by the usual extension and adhesion of the placentary sheath or future raphe on the ventral side of the primine: subsequently a farther growth of the placentary sheath, or rather of the funicular attachment of the ovule, takes place, which becomes prolonged into a free cord, which, by its growth, again pushes the ovule onward, so as to turn it farther round on its centre, another half-revolution: the result is, that the funicular cord, arising in a free state from the base of the ovary, attains the summit of its cell, and from it the anatropal ovule is suspended; its cotyledonary or chalazal extremity thus returns to its normal position in regard to the carpel, after having performed a complete revolution on its centre, at the same time that it has only effected a half-revolution in respect to the point by which it was originally attached to the placenta. The embryo during all these changes continues perfectly straight; the placentary sheath or first expansion of the funicular cord remains adherent to the primine in the usual manner, while its subsequent extension is permanent as a free cord, so that the ovule, though strictly and simply anatropal in respect to the raphe, is in fact cyclotropal in regard to the carpel. This development is again different to that observed in *Stemonurus*, inasmuch as the embryo has remained stationary, or what is almost tantamount, has made a complete gyration on its centre. One parallel circumstance however exists in the form of the albumen, which, as in that genus, consists of two parallel plates united on their periphery by a thin annular zone corresponding to the commissure of the cotyledons.

In *Diospyros*, to which I have before alluded, the embryo, which remains in its original sac after the expulsion of the redundant amniotic secretions, appears to have preserved its relative position in regard to the integuments and raphe, and to be truly anatropous. It would however be desirable to ascertain, by the examination of fresh seeds, whether it offers any indication of a suspensor. I conjecture from the appearance of the dried seed, that a portion of the sac will be found to protrude from the mouth of the albuminous cavity which it lines, and from its great tenuity to have withered away, for I have always

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* By this term, I propose to distinguish an ovule, where its chalazal point, and with it the raphe, effects a complete cyclical gyration: it is an extension of the campulitropal where the same point makes $\frac{3}{4}$ths of a revolution, while anatropal it completes $\frac{1}{2}$, and in amphitropal only $\frac{1}{4}$ of a revolution.

found the end of the radicle extending a little beyond the mouth of the cavity: this conjecture is confirmed by the drawings of Gærtner (De Fruct. tab. 208). A similar persistence of the embryo-sac, and its forming the lining of a large cavity in the albumen, which is thus nearly separated into two parallel plates, and the occasional protrusion of this sac beyond the limit of the albumen, occur also in *Strychnos* and *Ignatia*, as may be seen from the figures given by Gærtner (De Fruct. tab. 189). The protrusion of a portion of the embryo-sac, and with it of the radicle, in the manner above conjectured to exist in *Diospyros*, is known to occur in *Myzodendron*, where it is well figured by Dr. Hooker in his 'Flora Antarctica,' plate 104. fig. 18 & 19; and in plate 105. fig. 17, 18 & 19*. A singular example of the persistence of the embryo-sac is afforded in *Marantaceæ*: this occurs in the genus *Thalia*, where two large vacuities are seen in its copious albumen, on each side of the embryo: these are the persistent sacs in which two abortive embryos had existed: this curious fact was first recorded by Mr. Brown nearly fifty years ago (Prodr. p. 307): it is one of the few instances that occur, where several embryo-sacs are generated in the same ovule.

In regard to the origin of the albumen in seeds, it was shown by Gærtner (*loc. cit.* Introd. 138), and Mr. Brown confirms it as a well-established fact (Linn. Trans. x. 36), that it is merely that condensed portion of the amniotic fluid which remains unabsorbed by the embryo at the termination of its growth. This excessive portion of the fluid is generally expelled from the embryo-sac (quintine, *Mirbel*), and is deposited and consolidated in the cellular tissue of the quartine, which lines the tercine (nucleus, *Brown*) when it constitutes the albumen, and in ordinary cases the sac becomes absorbed without leaving any trace of its existence. Besides the instances of its permanence just given, its existence under other peculiar circumstances was first shown by Mr. Brown, in the *Nymphæaceæ*, where a portion of the redundant amniotic fluid forms a separate and second albuminous deposit, immediately surrounding the embryo, which he has aptly named the vitellus, and which in the ripe seed is found lodged in an exserted portion of the embryo-sac: it is therefore always seen at one extremity, outside of the great mass of the ordinary albumen: when this occurs, it is accompanied by the appearance of a long tubular vacant space in the axis of the albumen which is the opposite extremity of the persistent embryo-sac, of which the other portion containing the vitellus is a continuation. This has been shown to exist among *Dicotyledones*, in the *Nymphæaceæ*, *Cabombaceæ*, *Saururaceæ*, *Piperaceæ*, &c., and in several cases among *Monocotyledones* (Appendix, King's Voy. p. 21). A very excellent illustration of this occurrence may be seen in the admirable work of Dr. Asa Gray (Gen. Pl. Un. St.), where evidence of its presence is shown in the seeds of *Nymphæa*, *Nuphar*, *Cabomba*, and *Brasenia*, in pl. 38, 39, 43 & 44. Mr. Brown observes (*loc. cit.* p. 22), "that the albumen, *properly so called*, may be formed by a deposition or secretion of granular matter in the utriculi of the amnios" (embryo-sac) "or in those of the nucleus itself" (tercine or quartine); "or lastly, that these two

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* Schleiden (Linnæa, xi. 526. tab. 11. figs. 12, 13) has shown the curious fact, that in *Ceratophyllum* the principal portion of the embryo is developed outside of the embryo-sac, which in the ripe seed remains investing the plumule, and enclosed within the cotyledons; a small quantity of albumen is deposited in the embryo-sac around the plumule, but none is formed outside of the large cotyledons, which are invested only by a simple thin integumentary covering.

substances" (amnios and nucleus) "having these distinct origins, and very different textures, may coexist in the ripe seed, as is probably the case in *Scitamineæ*." In that family the embryo is enclosed in a fleshy vitellus, and this again is surrounded by albumen: owing to the difference of texture and consistence of the vitellus, its albuminous nature has been denied by some botanists. I have however met with an instance of a double albumen in *Boldoa fragrans*, a Chilean tree belonging to the *Monimiaceæ*: here the principal oval mass of the kernel of the seed consists of fleshy albumen apparently formed by two distinct deposits: the rather small embryo is seen with its cotyledons spread out quite flat by pressure, and as if they were seated astride upon the summit of the inner mass of the albumen, with its short radicle standing upwards; and the whole is enclosed within another concentric portion, much softer in substance, and formed of oily granules of much larger diameter than the close cells of the main inner portion, which is whiter, more dense, opaque, and fleshy, and from which it is easily separable in every part. Dr. Lindley (Veg. Kingd. p. 298) gives a good sectional analysis of this seed, but he has evidently not noticed the difference of the two kinds of albuminous deposit: the whole is covered by the proper inner integument, well distinguished at the extremity contrary to that where the embryo is seated, by a large dark chalaza, somewhat adherent to the outer tunic, which is recognized as being the testa, by its linear raphe, which is partly free near its origin. He justly claims for the *Monimiaceæ* a near affinity to the *Myristicaceæ*, for the form and position of the embryo quite correspond with those of *Pyrrhosa*, where, had its internal cavity been filled by a second deposit of albuminous matter, and were its outer coat not split into lamellar plates, we should have quite the seed of *Boldoa*: the whole plant of this latter genus, and especially its seed, bears a strong aromatic smell and taste, similar to that of the Nutmegs. The fact of the existence of a double albumen here fully realizes the prediction above quoted of Mr. Brown. This structure is of a generic, not of an ordinal character, for it does not exist in *Mollinedia*, a genus numerous in species, nor generally in *Citrosma*, although I have found it occur in one species of the latter genus. Brongniart also has demonstrated that albumen is generally formed in the quartine or cellular lining of the tercine, in which case he calls it the 'perisperm,' and at other times, though more rarely, within the embryo-sac, and then he gives it the name of 'endosperm*.' *Boldoa* hence possesses both a perisperm and endosperm, one concentric to the other, although the embryo-sac has entirely disappeared; but if the latter had remained persistent, if the endosperm had been absorbed, and the embryo and the perisperm had retained their present form and position, the seed of *Boldoa* would have been like that of *Stemonurus*, with the exception of the peculiar form and termination of its raphe.

In this stage of the investigation, it is desirable to recall to our memory the nature and origin of the embryo-sac. This vesicle, called by Gærtner the sac of the amnios, was first observed by Malpighi and Grew, who showed that it originated from that point of the ovule which I have called the gangylode, or the point of vascular connexion of the primine and secundine with the main body of the ovule, and with the placentary sheath, a point which afterwards becomes the chalaza of the inner integument, the diapyle in the

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* Ann. Sc. Nat. xii. 265.

testa, and where the raphe terminates. Gærtner farther affirms that the amniotic fluid is secreted at this point of the gangylode, which is also the opinion of Mr. Brown (Linn. Trans. x. 37). This point is sometimes distinguished by a peculiar protuberance, within the cavity of the main body, which Mirbel calls the chalazal appendage (appendice chalazienne), and he says that at this point the embryo-sac is first developed. We are indebted to Mr. Brown (Append. King's Voyage) for nearly all the information we now possess respecting the nature and origin of the several parts of the ovule, and the changes they undergo during the growth and perfection of the embryo, and it is impossible to estimate too highly the importance and merit of these admirable observations, the truth of which is unquestionable. A large share of credit is due to M. Brongniart, who about the same time, and to M. Mirbel, who three years afterwards, contributed many important facts on this subject, all confirming the previous observations of Mr. Brown. The latter able physiologist brought together all this information in his two celebrated memoirs "On the Development of the Ovule," &c. (Mém. Acad. Sci. Paris, ix. p. 609 & 629): he there gives a regular nomenclature to the several parts of these developments, and reduces all the evidence into a beautiful system, which has been adopted by all, and which has remained unquestioned now for nearly thirty years; but true as it may be in a general point of view, the evidence I have now brought together will show that the laws considered so universal, fail in their application in many cases, perhaps in far more numerous instances than are here offered, or will at first be credited. The existence of the two outer tunics, the primine and secundine, had long been known; but their remarkably peculiar cupuliform shape, seen alone in a very young state, was first shown by Mirbel, and by him also the metamorphoses of the main body of the ovule, called 'chorion' by Malpighi, and 'nucleus' by Mr. Brown, who first explained its functions, were now more fully demonstrated. Mirbel, who called this 'nucleus' the 'tercine,' showed that it is lined with a peculiar tissue, which sometimes becomes transformed into another tunic, the 'quartine,' and which in *Statice* he describes as forming a completely closed vesicle. Another body, which he denominates the 'quintine,' is still farther developed in the interior of the quartine: this is the 'sacculus colliquamenti' of Malpighi, the 'amniotic sac' of Mr. Brown, the 'embryo-sac' of M. Brongniart, the point of origin of which has been noticed above; when this vesicle is wanting, which perhaps more frequently happens, it is then the quartine that becomes resolved into the embryo-sac. According to Mirbel, one end of this sac is attached to the point of the gangylode, while the other is fixed to the summit of the tercine or quartine: it gradually swells from top to bottom, thrusting away the tissue that surrounds it. Brongniart first noticed the fact of the descent of the boyaux of pollen-grains, through the stigmatic channel, but failed in tracing their farther course, and the mode of their action in effecting the fertilization of the ovule, a discovery due to Amici. According to the observations of more recent physiologists, it is now admitted, that in every case of fertilization of an ovule, the boyau of a pollen-tube descends through the stigmatic channel, and is conveyed through the apical orifices of the primine and secundine (the micropyle), and passing through the tercine, thus reaches the embryo-sac, in the summit of which is a small globular body, called by Meyen 'the primary utricle,' which body, consequent on its osculation with the boyau, subsequently swells and becomes the nascent embryo. We will not here touch upon the still disputed point, whether the process of fertilization is the result of mere impact, or whether the boyau enters into the primary utricle; but will pass on to the fact admitted by all, that a new globular development subsequent to this action (the future embryo) is generated within the primary utricle, which is suspended within the sac by a delicate thread, often extending with the growth of the embryo in its young state: this is called the suspensor, which in some few instances becomes highly developed, though more frequently it is of no great length, sometimes remaining as a short distinct thread that terminates the extremity of the radicle, and which I have pointed out as existing in the embryo of *Stemonurus*. After the fecundation of the embryo, in the manner just mentioned, the embryo-sac as before stated, either by absorption, or by amalgamation with the surrounding tissues, generally disappears; but in some few cases, as we have seen, it remains persistent, and *Stemonurus* affords an instance of this occurrence.

I have entered into these details upon the nature and function of the embryo-sac, with the view of considering, whether a different amount of circumversion of this sac, respectively to that of the tunics of the ovule, may not have taken place in *Stemonurus*, which would thus account for the phænomena under consideration. May we not conclude, with some degree of confidence, that the embryo-sac has remained to form a cavity in the albumen, which has been copiously moulded around it, by amylaceous granules flowing from the redundant amniotic fluid deposited among the cellular tissue of the surrounding envelope? Has the embryo-sac in this case moved a half-revolution on its centre more than the coats of the ovule, or *vice versâ*? I cannot venture to affirm the fact, but the evidence is certainly presumptively in favour of such a conclusion. This indeed appears to me the only key to the solution of the paradoxical difficulty in question. It is, however, a point that can only be settled by observation on the growth and development of the ovule of *Stemonurus*, and as it involves a topic of great importance in a physiological and structural point of view, I would earnestly impress it on the attention of every botanist who has an opportunity of examining the ovule in a living state. In the mean time I call attention to the following evidence, which appears to favour this view of the question.

Citrosma[*] will be found to offer some points of analogy with *Stemonurus*, as far as regards the cyclotropal form of the raphe and its termination close to the extremity of the radicle, or in other words, its anomotropal embryo. *Boldoa*, *Hedycarya*, and *Mollinedia*[†] severally have anatropous seeds, and those of *Ambora* and *Monimia* are described as having a similar development, so that *Citrosma* appears to be the only genus in this family where the raphe is cyclotropal and the embryo anomotropal. Here the raphe makes nearly an entire gyration round the periphery of the seed: it originates at the

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[*] I take this opportunity of observing that the genus *Siparuna* of Aublet appears to differ in no respect from *Citrosma*: the form of its anthers and their mode of dehiscence were supposed to offer generic distinctions, but I found those of *Citrosma* quite agree with the description of Aublet; in habit and floral characters the one accords perfectly with the other.

[†] I may also affirm without hesitation that the genus *Tetratome* of Pöppig is identical with *Mollinedia* of the 'Flora Peruviana.' I have examined several species and made drawings and analyses of the living plants. I purpose at some future time to give the full characters of *Mollinedia*, *Citrosma*, and *Boldoa*, for which I possess ample materials.

hilum, near the bottom of the ventral margin of the nut, and at last arriving at the basal point, it terminates abruptly by penetrating the integuments: between this point and the hilum a very short space intervenes, which is obsoletely angular, and immediately at this angle, close to the margin, the small embryo is found imbedded in a large albumen, the radicle pointing outwards, and the two short fleshy cotyledons, greatly divaricated, being directed towards the vertex of the seed. Here then, as far as regards its direction with the hilum, the embryo is anatropal, having become inverted half a turn on its centre from its normal position, while the integuments have performed an entire gyration, by which the embryo is deprived of its anatropal characteristic. All the species of *Mollinedia* which I have examined have regular anatropal seeds, with one exception, where the raphe is cyclotropal, as in *Citrosma*. We have thus in *Citrosma* a verification of the fact observed in *Stemonurus*, the raphe terminating at a point exactly contiguous and corresponding to the radicle of the embryo, a fact quite incompatible with the laws of structure so beautifully expounded by Mirbel: it is a development that has hitherto been considered impossible, but I will proceed to show that these are not the only instances of the same occurrence we find in the structure of seeds.

In the development of the seed of the *Cucurbitaceæ*, we meet with a structure that offers much resemblance to the anomalies observed in *Stemonurus*; we find also other features, not only difficult of explanation, but contrary to all our ideas of the nature and function of the raphe. To aid us in the solution of these phænomena, we will first recur to the detailed account of the development and growth of the ovule of *Cucumis Anguria*, L., from the observations of Mirbel (Mém. Acad. Sci. Paris, ix. 621. tab. 1). The growth of the anatropal ovule is here shown in all its earlier stages, and we see that by the time of the fall of the flower, the micropyle of the primine and secundine becomes quite closed over the tercine; soon after which, a fine thread is observed to grow out of the micropyle, which was first noticed and described by Brongniart, in the ovule of *Pepo macrocarpus* and *Momordica Elaterium*. As the growth of the ovule proceeds, this tubular thread becomes covered by an envelope formed of cellular tissue: according to the drawing of Mirbel (*loc. cit.* tab. 1. fig. 10), it is a prolongation of the mouth of the embryo-sac; but Griffith says (Posth. Notes, 153), that although he had observed the same fact in several instances in *Cucurbitaceæ* and *Asclepiadaceæ*, he was never able to trace any connexion with it and the embryo-sac, and was rather disposed to consider this thread as formed by the boyaux or pollen-tubes, an opinion confirmed by the observations of Schleiden, and which appears the more probable conclusion, as no remainder of this thread is visible in the ripe seed. At the period above mentioned, the bottom of the embryo-sac breaks away from the gangylode, becoming thus suspended by its apex, and the embryo is formed in its summit: there is no appearance in the raphe at this time to indicate any other change than the ordinary anatropal development. The same course of metamorphosis is said by Mirbel to occur generally among the *Cucurbitaceæ*. We will now compare these changes with the development found in the ripe seed, and I select my analysis of *Citrullus Colocynthis* as a fair example of the structure of the seed in this family.

Here the seed is obovate, much compressed, its hilum being an open slit along its narrow basal extremity, which is enclosed in a short fleshy sheath, part of the funicle, from which it has broken away, and by which it is connected with the placenta, and suspended in the pulp of the fruit: a groove runs parallel with the margin on each face close to the periphery, forming in this manner a prominent zone all round the edge of the seed, which is broader towards the base, and which thus forms a short auricular expansion on each side of the hilum. On a former occasion (p. 92) I described the outer crustaceous tunic, hitherto considered as the testa, but which I shall prove to be of the nature of an aril, formed subsequently to the fertilization of the ovule, around its original integuments: it was there shown to be formed of three series of deposits, the epiderm, mesoderm and endoderm: the epiderm is a thin delicate membrane that covers the whole of the seed, and is extended beyond the hilum in the manner above-mentioned, as an extension of the sheath of the umbilical cord; the fleshy mesoderm has been before described, its numerous branching fibres being emanations from the bundle of simple vessels that fill the sheath of the funicular cord, and that surround the thread of spiral vessels proceeding from the placenta, that terminates in the raphe of the seed; the principal portion of the tunic is the endoderm, which is, in fact, a crustaceous compressed sac, enclosed in the above-mentioned vesicular terminal enlargement of the sheath of the umbilical cord; it forms a casing closed all round the seed, except at the hilum, where it has a long open slit, within the mouth of which is a considerable open space filled with pithy loose cellular tissue, which fills up this interval between the pointed extremity of the enclosed nucleus and the mouth of the crustaceous covering: there is no connexion whatever between any part of this crustaceous coating and the enclosed seed, which lies quite free within it, and fills up its cavity. The raphe, consisting of a number of spiral vessels enclosed in a delicate tube, is first seen to issue from the umbilical cord; it then finds its way through one of the basal auricular lobes of the endoderm, in which a channel is seen for its passage, after which it enters into the clear space between this crustaceous aril and the integuments of the contained seed, and under the form of a perfectly free delicate white thread, it runs all round the margin of the seed, forming a complete circle, until it again reaches the space within the mouth of the hilum, and when in the midst of the deposition of tissue before mentioned, it changes its course suddenly inwards, and terminates in the conical neck of the integument of the seed, by which the latter becomes thus suspended: this conical neck is of a dark brown colour, and is evidently the true chalaza of the integument. The covering of the enclosed seed is thin and membranaceous, generally of a greenish hue, is quite smooth and evidently composed of two, if not of three pellicular membranes, agglutinated into one thin integument. I have sometimes found this structure more clearly demonstrated where the nucleus has become withered from its full dimensions; it then appears as a large, perfectly transparent cyst, enclosing the diminished embryo, and by transmitted light displays the deeper colouring of the chalaza upon the inner membrane, which appears surrounded by another pellicle more transparent at this point: the presence of the spiral vessels in the suspending thread, up to the apex of the conical chalaza, is here perfectly distinct. At the other end of the integumental covering of the seed, the one contrary to that of its suspension, is seen another larger dark yellow areole, over the cotyledonary extremity of the embryo, and therefore at the point where, according to the laws of structure, the chalaza ought to be found in all cases where a raphe exists: it is precisely in the situation ascribed to the chalaza by Mirbel, in his figure before quoted of the ovule, after the formation of the embryo. It is however only a false chalaza, and is most probably a thickening of the mouth of the micropyle (exostome of Mirbel) of the ovular integuments, a circumstance of frequent occurrence in certain seeds; or it may possibly be ascribed to a scar of the embryo-sac, at the point where it has broken away from the gangylode, as figured by Mirbel (*loc. cit.* fig. 10. letter *f*). That it cannot possibly be the true chalaza, is most evident, because it has had no apparent connexion with the outer crustaceous tunic, which exhibits no corresponding scar or trace of any former connexion at this point; and still more obviously, because the raphe passes straight across it, without holding the slightest communication with it. The embryo, which has no albumen, fills the whole cavity of the integuments in the ripe seed, the radicle being directed towards the hilum and to the terminating point of the raphe, and its extremity being covered by the true chalaza; its cotyledonary extremity is in the opposite direction, terminating at the areolar micropyle or false chalaza. The fact of the existence of the free cord of spiral vessels as abovementioned (the raphe), running between the outer crustaceous tunic and the inner integuments of the seed, was evidently known by Mr. Griffith, who notices it (Posth. Notes, p. 182); but he omitted to observe the passage of this thread over the areole, which has always been considered as the chalaza, and also its course round the entire periphery, as well as its termination at the radicular extremity of the membranaceous integuments: the presence of the true chalaza at this point also escaped his observation. I do not find any mention of this curious structure by any other botanist.

We thus observe the same phænomena existing in all the genera of the *Cucurbitaceæ* that I have described as being found in *Stemonurus*, *Anona*, and *Citrosma*, that is to say, where the cord of the raphe makes a complete circuit of the seed, terminating at the same time at the radicular point of the integuments, instead of the cotyledonary extremity, as it ought infallibly to do, according to the acknowledged laws of structural development. What has been the nature of the metamorphoses within the ovule, that have produced so manifest a deviation from the ordinary course of structure? We have it demonstrated on the high authority of Mirbel, that up to the period of the impregnation of the ovule, the raphe, the chalaza, and the primine and secundine (then agglutinated into one coat), had only performed a simple anatropal inversion from their normal position; but we find that in the interval between this period and the ripening of the seed, all these parts have experienced a farther circumversion, so as to complete an entire circle, while the embryo-sac, or at least the embryo, has retained the same position which it held at the period of the simple anatropal inversion of the ovule. Mirbel notices, at this last-mentioned period, the first indication of the growth of the arillæform coating over the primine, appearing at this epoch as two layers of cellular tissue coating that integument, and which he figures (*loc. cit.* fig. 10. letter *h*): these layers of tissue are unquestionably the rudimentary secretions that subsequently form the arillus, under the crustaceous appearance of a testa, for which it has always hitherto been mistaken: it is doubtlessly owing to the formation of this coating that the subsequent movement of the coats of the ovule has been hidden from view, and has thus remained unnoticed. The assurance that such a movement must actually have taken place, is proved by the form of the raphe, and the very different position of the integuments in the ripe seed to that which they ought to have, according to the usual structural development. It is more than probable that the embryo-sac still remains immediately investing the embryo, in the *Cucurbitaceæ*, but this is not easily discernible, as there is no albumen, and as the primine and secundine, and probably also the tercine, become resolved into delicate membranes. Mirbel showed that about the period of fecundation, the embryo-sac had broken away from the gangylode; and we must assume, in order to account for the changes that subsequently occurred, that it also separated itself afterwards at the summit from the micropyle; but if the integuments received a subsequent amount of torsion, why did not the embryo-sac, or at least the embryo, follow the same movement? What could have retained the embryo in the same position it previously held, during the second inversion of the primine and secundine? The whole of this œconomy is so extraordinary, as to call for the especial investigation of some able botanist, accustomed to accurate and delicate examination. I have simply announced the facts as I have found them, leaving it to be determined how far the hints above given, respecting the nature of these changes, may prove well-founded, or how far the whole matter may be modified by farther evidence.

The facts detailed in the preceding part of this paper clearly show, that the genus *Urandra* of Mr. Thwaites bears no relation whatever to the family of the *Olacaceæ*, and we have irresistible evidence that it differs in no respect from *Stemonurus*, with which genus it must remain, like *Gomphandra*, another of its synonyms; it agrees with it in its cupuliform, 5-toothed, persistent calyx, its five acuminated linear smooth valvate petals, its five alternate stamens, with thick filaments clothed at their summit with clavate hairs, oblong anthers somewhat divergent below, a conical ovary encircled at its base by a small annular gland, and unilocular, with two suspended ovules, a short style, and a small subcapitate stigma. The drupe and seed, as described by Mr. Thwaites, agree in every respect in their extraordinary development with what I have shown to exist in *Stemonurus*, and there is not one single feature, among those described, that I can discover, at variance with that genus. The plant of Mr. Thwaites, which appears to differ specifically from others on record, must therefore bear the name of *Stemonurus apicalis*.

The remarks of Mr. Thwaites contained in his paper above cited, relative to the Ceylon species of *Stemonurus* described by me, will form the subject of a distinct notice.

EXPLANATION OF THE FIGURES.

Tab. XIX.

Fig. 1. Is a seed of *Stemonurus polymorphus*:—*natural size.*

Fig. 2 & 3. The coriaceous endocarp deprived of its pulpy covering, seen on its dorsal face and on its side.

Fig. 4. The same on its ventral face, showing the channel in which is imbedded the cord formed of the axile placentary nourishing vessels.

Fig. 5. Is a section of fig. 3. *magnified*:—*a.* is a foramen in the summit of the channel through which the raphe passes into the cell of the putamen; *b.* the longitudinal channel in which the placentary cord is imbedded, and which passes into it through a tubular passage leading from the base.

Fig. 6. The seed removed from fig. 5. seen on its edge:—*a.* is the free portion of the raphe by which the seed is suspended; it is a continuation of the axile placentary cord *c*; *b.* is the raphe imbedded in the integument.

Fig. 7. The same viewed upon its dorsal face, showing the singular course of the raphe.

Fig. 8. The same observed from above: the same letters refer to the same points in the three last figures.

Fig. 9. The integument removed and spread out to show the form of the raphe more distinctly.

Fig. 10. The albumen.

Fig. 11. A transverse section of the same, showing the cavity formed by the persistent embryo-sac.

Fig. 12. A longitudinal section of the same.

Fig. 13. The persistent embryo-sac removed from the albumen with the embryo in its natural position.

Fig. 14. The embryo removed.

Fig. 15. Same still further magnified.

Fig. 16. Is a seed of *Anona sylvatica*:—*natural size.*

Fig. 17. The same seen sideways.

Fig. 18. The same magnified, showing the marginal expansion of the crustaceous covering and its open cavity at the base.

Fig. 19. One side of the cell removed, to show the enclosed seed and the hollow chamber at the base.

Fig. 20. A transverse section of fig. 18, showing the raphe lying in a groove of the albumen along each side.

Fig. 21. The seed removed, showing the annular form of the raphe and its connexion with the ceiling of the basal chamber of the shell: from the centre of the latter a mucronate point, as long as the hollow chamber, projects, and at each angle two threads are observed in the same space.

Fig. 22. The same viewed edgeways, showing the peripherical form of the raphe.

Fig. 23. The raphe separated and remaining attached to the ceiling of the basal chamber.

Fig. 24. A longitudinal section of the albumen with the enclosed embryo.

Fig. 25. The basal portion of the same *more highly magnified,* showing the embryo, and the hollow in the base of the albumen caused by the impression of the basal chamber.

Fig. 26 & 27. The embryo seen in front and sideways.

Fig. 28. A fruit of *Citrosma Aposyce,* Mart.

Fig. 29. A seed capped by a glandular enlargement of the style.

Fig. 30. The same deprived of its cap.

Fig. 31. The same with its fleshy epiderm removed, showing an echinate nut.

Fig. 32 & 33. The same magnified, seen in front and sideways, showing the flat expansion of its border.

Fig. 34. A longitudinal section of the same, showing its hollow hilum and the enclosed seed.

Fig. 35. The seed detached, showing the annular raphe:—*a.* commencement of the raphe at the hilum; *b.* termination of the raphe.

Fig. 36. The same seen edgeways.

Fig. 37. The raphe detached:—*a.* its commencement at the hilum; *b.* its termination at the chalaza.

Fig. 38. Section of albumen, showing a minute embryo near its base:—*c.* relative position of embryo with the commencement *a*, and the termination *b*, of the raphe.

Fig. 39. Base of albumen with embryo greatly magnified, the same letters referring to the same parts.

Fig. 40. An anatropal ovule of *Cucumis Anguria* near the period of its fertilization; after Mirbel.

Fig. 41. The same seen just after impregnation; also after Mirbel:—*a.* the primine; *b.* secundine; *c.* tercine or nucleus; *d.* quartine or embryo-sac suspended at the micropyle or mouth of the primine and secundine; *e.* base of embryo-sac broken away from its attachment to the chalazal point of the tercine; *f.* the nascent embryo hung in the mouth of the micropyle by its suspensor; *g.* the gangylode or point of union of primine, secundine and tercine, and the future chalaza; *h.* two layers of solid cellular tissue forming a distinct coating secreted and deposited over the primine; *i.* the raphe originating in the funicular cord, and terminating at *g*, the gangylode or chalazal point; *k.* a pollen-tube inserted within the micropyle.

Fig. 42 & 43. A seed of a species of *Colocynth* from the Pampas of Buenos Ayres, seen in front and sideways.

Fig. 44 & 45. The same magnified, showing its hollow hilum at *f.*

Fig. 46. The same seen from below, showing the peripherical zone and the basal hilum.

Fig. 47. A longitudinal section of the same:—*a.* the crustaceous tunic; *b.* a nearly annular and perfectly free raphe lying between the crustaceous covering and the true integuments of the seed: it first passes through a tubular channel *c* on one side of the base of the crustaceous covering, and takes its course all round the enclosed seed, and again arrives at the base, disappearing in the loose cellular pith that fills the hollow space within the hilum; the spiral threads appear to separate here and again unite to form a kind of suspensor to the seed; *d.* is a reddish-coloured areole on the summit of the integument, at the spot where the chalaza should exist according to ordinary rule, but the raphe certainly does not enter or terminate here, but passes freely over it, like a bisecting line; *e.* is another dark-coloured areole around the neck of the suspensor at the opposite extremity, which appears to unite with the raphe, for it contains spiral vessels; *f.* is the hollow chamber within the hilum filled with loose pithy cells.

Fig. 48. The same viewed from the summit, showing *d* the false chalaza, and the manner in which the raphe crosses it.

Fig. 49. The raphe detached, apparently connected by very minute threads with the neck of the suspensor.

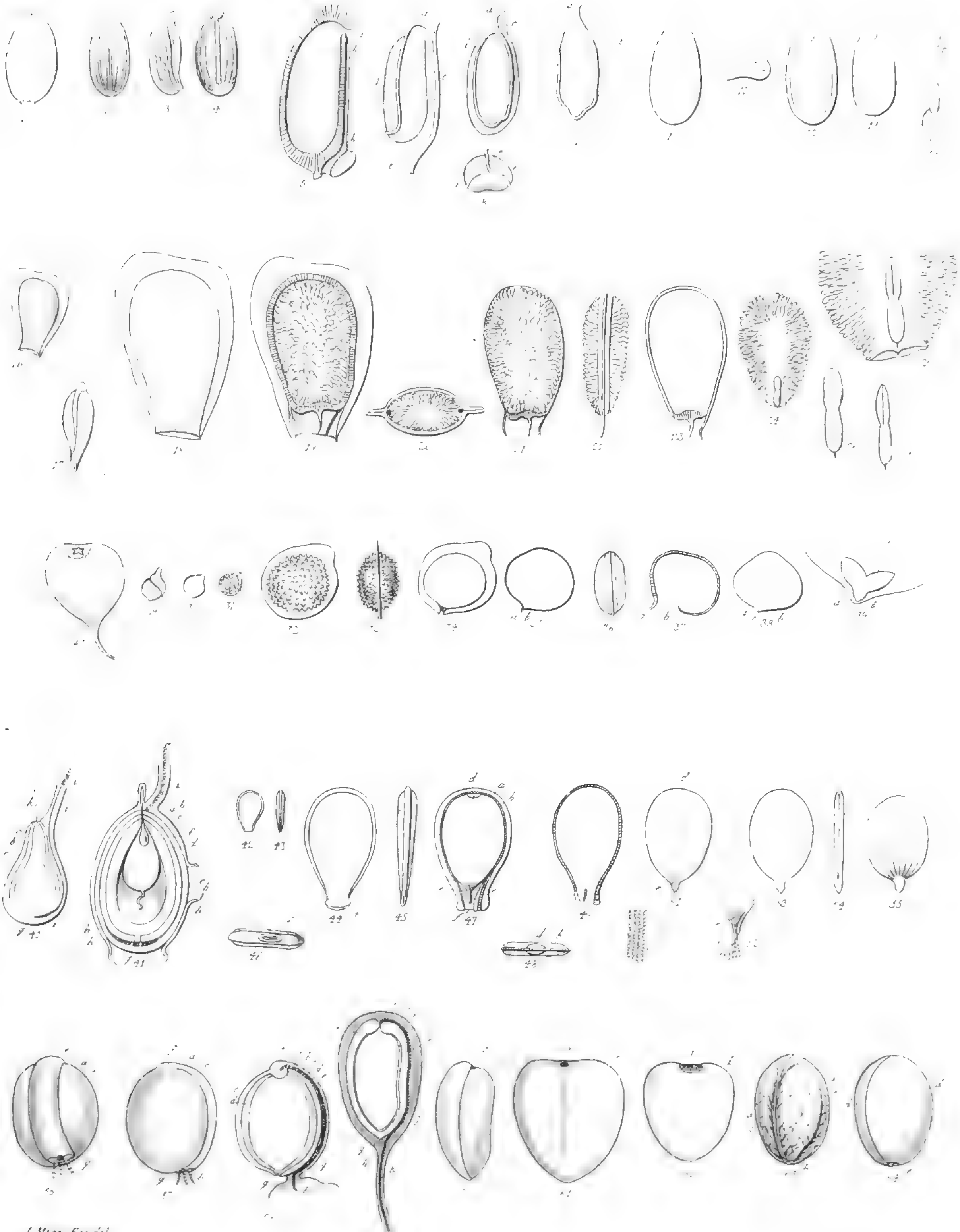
Fig. 50. The spiral vessels of the raphe highly magnified.

Fig. 51. The seed invested by the testa and tegmen, both very thin membranes: *d.* the false chalaza; *e.* probably a true chalaza.

Fig. 52. The basal termination or neck of the two investing integuments, which are distinct and separable; the outer one is the testa; the inner one only is marked at *e* with a dark areolar spot, from which the spiral vessels are extended, and this is probably the true chalaza.

Fig. 53 & 54. The embryo seen in front and sideways.

Fig. 55. The same with one of the cotyledons removed, to show its nervation.



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M.DCCC.LVII.

CONTENTS.

PART II.—1857.

V. *On a new form of* Corynoid Polypes. *By* PHILIP HENRY GOSSE, *Esq., F.R.S., A.L.S.*

Read December 2nd, 1856.

ALTHOUGH every discovery of a new species of animal ought to be recorded with as much precision as can be commanded, it is not every such discovery that is worthy of being made the subject of a memoir presented to a learned body; but the form and manners of a creature which has lately fallen under my notice appear so anomalous, that I am induced to bring it under the notice of the Linnean Society.

In the summer of 1855 I happened to have, in one of my marine aquaria, several specimens of a *Sabella*, which I believe to have been identical with the *Amphitrite vesiculosa* of Montagu (Linnean Transactions, vol. xi. p. 19). The largest of these had been some time in my possession, and, probably owing to the habitual stillness of the water in the vessel, not holding in suspension the particles of mud, that ordinarily enter into the composition of the tube, the latest-formed portion was composed of pure transparent *chitine*, without any perceptible earthy element. This clear terminal portion of the tube I perceived to be occupied by a curious parasite. About twenty bodies having a most ludicrously-close resemblance to the human figure, and as closely imitating certain human motions, were standing erect around the mouth of the tube, when the *Sabella* had retired into the interior; and were incessantly bowing and tossing about their arms in the most energetic manner.

As soon as I had a little recovered from my surprise at this strange display, I began to examine the performers more in detail. A slender creeping thread, irregularly crossing and anastomosing, so as to form a loose network of about three meshes in width, surrounded the margin of the *Sabella*'s tube, adhering firmly to its exterior surface, in the chitinous substance of which it seemed imbedded (see Pl. XX. fig. *a*). Here and there free buds were given off, especially from the lower edge; while from the upper threads sprang the strange forms that attracted my notice. These were fusiform bodies, about $\frac{1}{40}$th of an inch in height, whose lower extremities were of no greater thickness than the thread from which they sprang, with a head-like lobe at the summit, separated from the body by a constriction, immediately below which two lengthened arms projected in a direction towards the axis of the tube.

Such was the external form of these animals; and their movements were still more extraordinary. The head-lobe moved to and fro freely on the neck; the body swayed from side to side, but still more vigorously backward and forward, frequently bending into an arch in either direction; while the long arms were widely expanded, tossed wildly upward, and then waved downward, as if to mimic the actions of the most tumultuous human passion.

Whenever the *Sabella* protruded from its tube, these guardian forms were pushed out, and remained nearly in contact with the Annelid's body, moving but slightly; but no sooner did it retire, than they began instantly to bow forward, and gesticulate as before. These movements were continued, so far as I observed, all the time that the *Sabella* was retracted; and were not in any degree dependent on currents in the surrounding water, whether produced by the action of the Annelid, or by other causes. They were not rhythmical; each individual appeared to be animated by a distinct volition.

Applying a higher magnifying power than I had yet used, to the animals, I found that the head-lobe enclosed a central cavity; that the arms were also hollow, with thick walls, marked with transverse lines (internal septa?), and muricated on the exterior; and that the body contained an undefined sub-opake nucleus (see fig. *b*), doubtless a stomachal cavity.

I cut out with fine scissors a segment of the tube, including two of the parasites, with that portion of the network of threads that carried them. They were immediately paralysed by the division of the threads; but those that remained on the tube were unaffected by the violence. The hiatus in the continuity of the circle was healed in a day or two; not by the approach of the divided edges of the tube, but by the shooting of the threads across the chasm. One of the animals thus cut out is represented (at *d*), as it appeared immediately after the excision, magnified 240 diameters. When subjected to the action of the compressorium, with a power of 560 diameters, the arms were seen to be formed of globose cells, made slightly polyhedral by mutual pressure, set in single series (fig. *e*). The interior of these organs was divided by septa, placed at intervals of about the diameter. Some, at least, of the cells contained a small bright excentric nucleus (fig. *f*).

When the tissues were quite crushed down by the pressure of the compressorium, a quivering motion was visible among the disjointed granules; but it was very slight. No trace of cilia, nor any appearance of ciliary motion, was perceptible during life.

This larger *Sabella*-tube was not the only one infested with the parasites. I observed them on two, at least, of the smaller specimens, in the same situation, and with precisely the same movements. The extremity of one of these smaller tubes I cut wholly off, and placed in the live-box of the microscope. Two of the parasites only were on it, which were active at first, but in about an hour—probably from the exhaustion of the oxygen in the small quantity of water enclosed—they decomposed, or rather disintegrated; the outline dissolving, and the external cells becoming loose and ragged, and the whole animal losing its definite form.

One of these specimens, however, while yet alive and active, afforded me an observation of value. I had already associated the form with the Hydroid Polypes, and was inclined to place it in the family *Corynidæ*, considering the arms to be tentacles, and the head-lobe to be homologous with them in character, but abnormal in form. It appeared to be a three-tentacled *Coryne*, with the tentacles simple instead of capitate. But while I was observing the individual in question, I saw it suddenly open the head-lobe, and unfold it into the form of a broad shovel-shaped expanded disk; not however flat, but with the two halves inclining towards each other, like two leaves of a half-opened book (fig. *g*). This immediately reminded me of the great sucking-disk, which I had seen evolved from the obtuse summit of *Coryne Cerberus*, as I have elsewhere recorded*; and confirmed my suggestion of the natural affinities of the form.

The principal colony remained for many weeks under my observation, without any noticeable change. The terminal portion of the tube, which at first had been so diaphanous, gradually became more opake, and disfigured by the growth on it of confervoid threads, and by the entanglement of a multitude of minute *Diatomaceæ* in its surface. At length the *Sabella* spontaneously quitted its tenement: the parasites appeared at first unchanged and unaffected; but, strange to say, before the lapse of two days, they all gradually died away; as if their existence depended on the presence of their patron. They seemed to become feeble, attenuated, and almost motionless, before they disappeared.

While they lived they afforded me much entertainment, as also to those scientific friends to whom I had opportunities of exhibiting them. When I used to see them surrounding the mansion of the *Sabella*, gazing, as it were, after him, as he retreated into his castle, flinging their wild arms over its entrance, and keeping watch with untiring vigilance until he reappeared, it seemed to require no very vivid fancy to imagine them so many guardian demons; and the Lares of the old Roman mythology suggested for them a name.

Bearing in mind the extraordinary cycle of phænomena that have been proved to occur in the reproduction of the Hydroid Polypes in general, and of the *Corynidæ* in particular; it is highly probable that the animal, whose appearance and manners I have been describing, would, in the natural prolongation of its existence, have budded off some Medusoid forms, endowed with proper sexual functions. I detected, indeed, no trace of (so-called) *ovarian* capsules, nor any evidence of increase, except that of the gemination of the individual zooids from the common root-thread. This, however, by no means disproves the possibility, nor even the probability, of such developments, at a more mature stage of the polypoid condition. Had I discovered such, and were I able to follow out the life-history of the animal, and to show that it agrees in its reproductive phænomena with other Coryniform Polypes, it would still be an open question,—to which condition—whether the Coryniform or the Medusiform—specific identity is to be assigned; or, in other words, which ought to bear the *nomina generica et trivialia*, and to take its place in the System of Nature. Is the *Medusa* the animal, of which the Polype is the larva? Or is the *Coryne* the animal, of which the *Medusa* is but the detached and locomotive sexual organ?

I incline to affirm the former of these two hypotheses; but yet, in accordance with precedent, by which the *Corynidæ* and *Campanulariadæ* are reckoned as animals worthy of names, I may venture, provisionally at least, to register, under systematic appellations, the form before me, and wait for new light as to its future history.

Genus Lar (Gosse).

Zoophytum è familia Corynidarum, nudum, associatum sed sejunctum, erectum, e filo radicali repente retiformi saliens, tentaculis simplicibus filiformibus instructum.

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* Devonshire Coast, p. 223, plate xiv. fig. 4.

Species, LAR SABELLARUM (Gosse).

Species unica. *L.* tentaculis tribus, filo radicali circa Sabellarum tubos parasiticè repente.

EXPLANATION OF THE PLATE.

TAB. XX.

Fig. *a.* The extremity of the tube of *Sabella vesiculosa*, occupied by a colony of *Lar Sabellarum* (magnified 70 diam.).

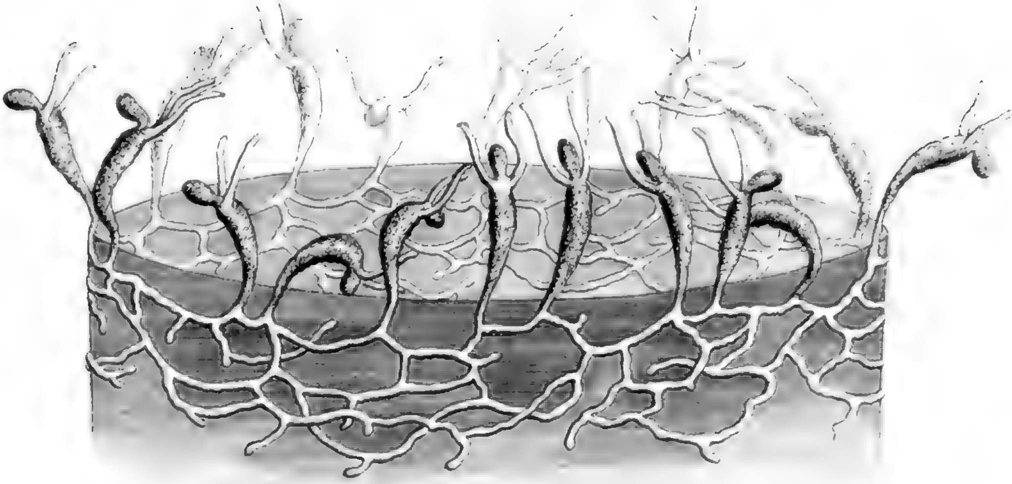
Fig. *b.* An individual *Lar*, displaying the hollow head-lobe and tentacles, and the sub-opake digestive canal (magnified 120 diam.).

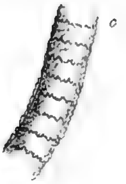
Fig. *c.* A portion of one of the tentacles, showing the muricated surface.

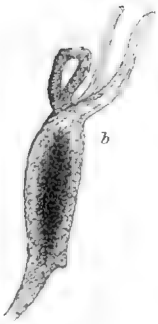
Fig. *d.* A single *Lar*, with the thread, attached to an excised portion of the tube, paralysed and somewhat contracted (magnified 240 diam.).

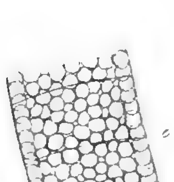
Fig. *e.* A portion of one of the tentacles, flattened by pressure; showing the parietal cells, and the edges of septa (magnified 560 diam.).

Fig. *f.* Nucleated cells from a crushed tentacle.









H. Gosse Esq. del.

G. Jarman sc

VI. *Description of a new Species of* Euplectella (Euplectella Cucumer, *O.*).

By Professor Owen, *F.R.S., V.P.L.S.*

Read February 17th, 1857.

IN 1841 I communicated to the Zoological Society of London a description of a new generic form of reticulate Alcyonoid Sponge, represented by one of the most singular and beautiful, as well as the rarest, of the marine productions with which the researches of Mr. Hugh Cuming in the Philippine Islands had enabled him to enrich his famous Natural-History collection*. For this genus the name *Euplectella*† was proposed, indicative of the exquisite regularity and complexity of the interweaving of its component threads.

The characters of the genus are:—a cylindroid hollow form of body, closed at the wider end by an irregular network, and at the narrower end by the terminal tuft of finer filaments into which the parietal fibres are there resolved.

The parietal fibres, or those that constitute the wall of the cylinder, are regularly disposed, and intersect each other at definite and nearly equal distances throughout its extent. They consist of longitudinal (Pl. XXI. fig. 1, *c*, *d*, *e*), transverse (*t*), and oblique fibres, the latter being of two kinds (*o*, *o'*), winding spirally round the cylinder, but in opposite directions: (see magnified view of part of the parietes, Pl. XXI. fig. 4). The longitudinal and transverse fibres are the thickest: they are arranged at intervals of from one to two lines, averaging one line and a half apart, and divide the cylinder-wall into square spaces (*a*) of about the latter diameter. The longitudinal fibres (fig. 4, *b*) are external to the transverse ones (*t*), to which they are bound by the oblique or spiral fibres; these are, some external, some internal, to the others, and they close by their decusastion alternate quadrate intervals (*k*) between the longitudinal and transverse fibres. The angles of the alternate open squares are intersected by finer and less regular oblique fibres, which reduce their area more or less to a circular form (fig. 4, *a*).

It appeared, in the first-described species, that the fine silky filaments into which the parietal fibres were resolved at the small end of the cylindroid, had been torn, or detached by violence from some other body. The subject of the present description, which has been liberally confided to me for that purpose by my friend Dr. Arthur Farre, F.R.S., has been fortunately preserved, along with the foreign body to which it was attached by the terminal filaments: such mode of attachment may now, therefore, be added to the generic characters of *Euplectella* as above defined.

The first-described species of this rare genus was founded on a specimen eight inches in length, of a slightly conical form, two inches across the base, and gradually and progressively decreasing in diameter to the truncated apex, which is one inch and a quarter in longest diameter‡.

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* Transactions of the Zoological Society of London, vol. iii. p. 205.

† Gr. εὖ, well, πλέκω, I weave.

‡ Trans. Zool. Soc. vol. iii. pl. 13.

The present species (Pl. XXI. fig. 1) is six inches in length, two inches across the base, whence the cylindroid body gradually expands to near the middle of its length, where it presents a diameter of two inches seven lines, and then decreases to the truncated apex, which is about one inch and a quarter in diameter; but part of this appears to have been torn away. Thus the form of the body is ventricose, not regularly conical as in *Euplectella Aspergillum*; it more resembles a cucumber than the shell after which the first species was named, whence the present species may be named *Euplectella Cucumer*.

The next difference which strikes the eye is the absence of the oblique and wavy crests or ridges which project from the network of the cone, and especially the absence of that marginal plate which divides the reticulate terminal cap or lid from the wall of the cylinder, standing out like a ruff or frill in *Euplectella Aspergillum*.

The convex reticulate lid or cap in *Euplectella Cucumer* (Pl. XXI. fig. 3) is bounded simply by the marginal ridge (figs. 1 & 3, *r*), which represents the last or lowest* of the transverse fibres, but which is thickened by an accession of the constituent fibrils, especially from the oblique series, so as to project slightly like a rim or 'bead' in carpentry. Some slightly projecting fibrils from the track of the oblique series of fibres, chiefly multiradiate, and of the kind figured in Pl. XXI. fig. 5, and which scarcely catch the eye, except when in relief at the border of the cylindroid, as at *p*, *p*, fig. 1, alone feebly represent the parietal and reticulate crests which so peculiarly distinguish the *Euplectella Aspergillum*. In this species the gradual diminution of the cylinder is produced by the convergence and confluence of two contiguous longitudinal fibres at certain parts of the circumference. The like convergence and final interblending of contiguous longitudinal fibres, as they pass from the free towards the fixed end of the body, is also manifested, though in a minor degree, in *Euplectella Cucumer*, as at *c* and *e*, fig. 1. But the gradual expansion of the cylindroid is made compatible with this diminution in the number of the longitudinal fibres by the divergence of many of the longitudinal fibres as they proceed from the marginal ridge, as at *d*, fig. 1, towards the widest part of the cylindroid, where their intervals are greater than in the corresponding part of *Euplectella Aspergillum*. Very few instances of confluence of longitudinal fibres take place before they reach the widest part of *Euplectella Cucumer*: the majority occur beyond it, as at *e*, *e*, fig. 1; and besides the diminution in number of the longitudinal fibres, they all converge as they approach the smaller and attached end of the cylindroid. Here the resolution of the several series of fibres into their constituent fibrils seems to take place, at least on one side, viz. that shown in Pl. XXI. fig. 1, more abruptly than in *Euplectella Aspergillum*: on the opposite side, as in fig. 2, the fibres in *Euplectella Cucumer* begin to be resolved into the fibrils or filaments sooner than in *Euplectella Aspergillum*. The considerably greater length of these fibres appears to offer another marked distinction between the two species: but as the specimen of *Euplectella Aspergillum* was torn by violence and brought up by the fish-hook from its place of attachment, no safe inference can be drawn as to their original length in that specimen. In the present example of *Euplectella Cucumer* the delicate separated silky filaments penetrate, and, as it were, permeate, the substance of a mass made

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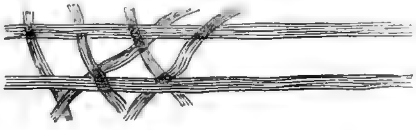
* On the supposition that the *Euplectella* hangs dependent from its filamentous attachment.

up chiefly of portions of a coarse irregular siliceous sponge, which appears to be foreign to the proper body of the *Euplectella*, and includes some shells and other marine calcareous bodies. Some of the fine long fibrils, emerging from the mass, converge, as they are reflected back (fig. 2), and, after a few graceful bendings, again diverge into separate wavy locks of the most delicate hairs, having a silken or silvery lustre (*h*, *h*, figs. 1 & 2). The whole of this beautiful elongated filamentous medium of attachment of the *Euplectella* may be compared to a lock or tuft of the hair which Poets feign to have adorned the head of the Syren or Mermaid.

The number of the longitudinal fibres at the base of the cone in *Euplectella Aspergillum* is sixty, in *Euplectella Cucumer* it is fifty-three: their number at the apex in *Euplectella Aspergillum* is thirty, in *Euplectella Cucumer* it is thirty-five. I would not, however, be understood as confiding in these particular numbers being constant and characteristic of the species. The fibres of the reticulate cap consist of converging and of connecting or transverse kinds: many of the former are continued from the confluence of two of the longitudinal fibres of the cylindroid, where they become bent at nearly right angles after leaving the connecting marginal band to form the cap: such fibres show a thickness proportionate to the additional material entering into their composition. The degree of irregularity in the converging and connecting fibres forming the reticulate cap is like that in *Euplectella Aspergillum**. The superficial fine oblique series of fibres, with the superadded multiradiate spicula, terminate abruptly at the marginal rim in *Euplectella Cucumer*, just as the ridges of the cylinder terminate in *Euplectella Aspergillum*.

Dr. A. Farre notes, as the result of his study of the structure of the *Euplectella Cucumer*, that "the oblique lines are not formed out of one continuous line of fibre for each side, wound round and round, which is the idea of a spiral, but they consist of a double series of ellipses, placed at definite distances, which intersect each other at right angles, or nearly so. These form perfect ellipses only towards the centre of the specimen, for at either end they are necessarily interrupted. In these oblique fibres there occur the same confluence of two contiguous lines, in some places, and divergence or bifurcation of simple ones in others, as happen in the longitudinal series, and evidently with the same object of adapting their arrangement to the increasing or diminishing diameter of the cylinder. With regard to the relative positions of the longitudinal, transverse and oblique fibres, I find that these lie in several alternate series. First a bundle of about half-a-dozen longitudinal close-lying fibres. These run straight from end to end of the cylinder,

except where they bifurcate or combine. Then the looser bundles of oblique fibres decussate with the longitudinal ones, the fibres separating to pass over, under, and between them, and at the same time intersecting the fibres of the opposite oblique series in a similar way,



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* Compare Pl. 13, Trans. Zool. Soc. vol. iii. fig. 2, with fig. 2 in Pl. XXI.

not with strict regularity, but in a sufficiently marked manner, and forming a rough pattern of those wicker-baskets in which the cross fibres are interwoven among the longitudinal ribs. Lastly, the transverse fibres lie below these, and are, on that account, the least easily distinguished. Then the same series of longitudinal, oblique and transverse lines is repeated, but more irregularly, until the walls of the cylinder acquire a depth of 2''' at their thickest part, which occurs at about $\frac{2}{5}$ths of the entire length of the specimen from its operculated end."—(A. F.)

The average diameter of the longitudinal fibres of the cylindroid in *Euplectella Cucumer* is one-thirtieth of an inch: that of the transverse fibres is about one-fortieth of an inch: these oblique fibres present much smaller and more varying diameters. All these fibres consist of much finer fibrils, and these are composed of a delicate siliceous sheath enclosing still more minute fibrillules. The component fibrils of *Euplectella Cucumer*, as in *Euplectella Aspergillum*, are of two kinds; one smooth, the other barbed at pretty regular distances like the hair of certain caterpillars (Pl. XXI. fig. 6): and some fibrils show both characters, and the gradual transition of the barbed to the smooth part (fig. 7). In some of the barbed fibrils, which most abound in the resolved tuft of attachment, Dr. A. Farre discovered a terminal convex disk, with a border divided into four or five retroverted spines, simulating a small anchor: one of these is represented in fig. 6. The same experienced microscopist found that he could frequently detach, with a fine pair of forceps, from the exterior of the point of decussation of the oblique fibres, in the body of the cylindroid, minute multiradiate aciculi, like the one represented at fig. 5,—one ray representing the axis, from which four other rays would diverge at right angles and equal distances on the same plane. These "multiradiate spicula invariably consist of six rays, viz. a perpendicular spine, which projects above the surface of the cylinder, a small spiculum opposite to it which lies buried in the mass, for the purpose apparently of fixing the upper spiculum, and four basal rays (one very generally longer than the rest), which take a direction always exactly corresponding with the lines of intersection of the oblique fibres, with which they become blended."—(A. F.) These detached bodies may have been the commencement of the new-forming oblique fibres in the gelatinous substance of the living *Euplectella*.

On applying the test of fire, by subjecting the fibrils of the *Euplectella Cucumer* to the flame of a candle, they generally splintered, and minute iridescent portions flew off in all directions. Some of these particles, being caught on slides of glass, showed under the microscope that they were parts of a delicate sheath of silex: their iridescent hue seemed to be due to the partially disintegrated constituent layers of siliceous matter entering into the constitution of the sheath. Portions of fibrils, submitted in a test-tube to the flame of a candle, were observed to splinter, sometimes with a slight bend; and, on being submitted to a half-inch objective in the compound microscope, showed the siliceous sheath variously cracked or splintered, enclosing a bundle of very minute fibrillules, with here and there a trace of charred gluten or organic matter. Submitted to the action of dilute muriatic, or nitric, acid, the fibrils underwent no other change than that of becoming rather more clear or less opake; and this without the extrication of bubbles, as from carbonate of lime, and with not more evidence of any liberated gas than might be accounted for by the solution of the gluten, to which act, perhaps, the greater transparency of the soaked fibril might be due. No diminution of diameter or other change of the fibril could be detected whilst it was under the action of the mineral acid.

The fibrils of the *Euplectella Aspergillum* contain a greater proportion of organic matter, but have, as described in my original memoir, the same siliceous basis as in the present species. In consequence, however, of the different proportion of the glutinous and siliceous principles, they do not behave exactly like the fibrils of *Euplectella Cucumer* under the tests of heat and acid. In general, when subject to fire, they do not splinter, but merely bend; and when afterwards microscopically examined, show more trace of charring, and sometimes present increased opacity with the appearance of dead or frosted silver. Yet some show clearly their constitution of a siliceous sheath, including fine iridescent filaments or fibrillules.

It sometimes happened, in the case of fibrils of the *Euplectella Cucumer* submitted to the acid test, that a small amorphous mass would be adherent to part of a fibril; and such mass was quickly dissolved with the extrication of abundant gas-bubbles: the inference from this was, that some fragment of a foreign body of carbonate of lime had become accidentally entangled in the meshwork of the *Euplectella*.

In the amorphous portions of sponge to which the *Euplectella Cucumer* was connected by its long filaments, two modifications of reticulate structure were discovered by Dr. A. Farre. One, represented in Pl. XXI. fig. 8, is an irregular network, more or less bent, with subquadrate meshes, sometimes crossed by oblique threads. A second and more beautiful structure is represented in fig. 9. The meshes of this network are on nearly the same plane, and of a more regular square form, with a short pointed spiculum projecting from one side of each decussation of the threads, like the teeth of a harrow. Both figs. 8 & 9 give magnified views of the above structures, with the part magnified of the natural size. Fig. 9*a* gives a more magnified view of one of the squares, with its spines, of the 'harrow' structure.

To the question put by almost every one to whom the *Euplectella* is shown, as to how the threads could have been so regularly yet intricately interwoven, I have sometimes replied, that there has been no such thing as interweaving in the case; that no thread, as such, was ever laid across another in the construction of the *Euplectella*; that the analogy of human textile fabrics does not apply to this beautiful natural object. In artificial lacework the several stages of a complex result must be taken in the succession indicated by painful and exact calculation: in organic lacework different stages are done at once. Thus it is that the Divine works surpass those of man's utmost ingenuity. The threads of the *Euplectella* were not first spun and then interwoven, but were formed as interwoven, the two processes going on simultaneously, or '*pari passu.*' Just as in the cancellous texture of bone, the plates of bone are not first formed and then fitted to one another, as in building a house of cards; but the forming and the fitting go on together in the course of molecular growth. I presume also, that in the beautiful object which we call the *Euplectella*, we have but its skeleton; and that, in the living state, the exquisite structure of the flinty framework may be veiled by the delicate gelatinous enveloping organic tissue.

The specimen of the *Euplectella Cucumer* here described, Dr. Farre writes, "was given, together with other presents, by the King of the Seychelle Islands to Captain Etheridge, R.N., in acknowledgment of some friendly services, and with an intimation that this was one of the rarest products of those regions. From Captain Etheridge it passed into the hands of Dr. Richard Payne Cotton, of Clarges Street, by whom it was recently presented to me."—(A. F.)

With regard to the first-described species, *Euplectella Aspergillum*, Mr. Hugh Cuming writes to me:—"The *Euplectella* brought home by me from the Philippines was taken by a fisherman, in ten fathoms, rocky ground, off the island of Bohol, one of the southern islands of the Philippine group. The fisherman was employed in catching a species of cod which abounds in those islands, and finding, after some time, the fish did not take his bait, he drew it up, when to his surprise he found the above specimen attached to his hook, near the orifice; and fearing to injure it by disentangling the hook from such a fragile substance, he cut out that portion to which the hook was attached. On his arrival on shore at St. Nicholas di Zebu, he made a present of it to the governor of the town. On my arrival a few days after, I was introduced to the governor, who, upon knowing the object of my visit to the island, presented me with it as the greatest curiosity he had to offer me, as he had never seen the like before. On my showing it to the bishop of that city, and the principal inhabitants, they confirmed the opinion of its rarity expressed by the governor."—(H. C.)

In conclusion, I beg to state, that although this paper is communicated to the Society as from one author, it is properly the work of two: many of the observations were originally made by Dr. Arthur Farre, which afterwards were confirmed by my own eyes; and every recorded observation of my own has been repeated by, and received the sanction of my friend. In returning these acknowledgments for the considerate call which he pressed upon the describer of the original species to bring the second before the notice of naturalists, and for his generous relegation of this pleasing task to me, I desire, at the same time, to offer my best thanks to Mr. Cuming, who, with his own hands, transported his frail and unique specimen of *Euplectella Aspergillum* to the residence of Dr. A. Farre, in order to afford every facility of comparing the two species: and I have again to express, as at the close of my former memoir, my obligations to Mr. G. B. Sowerby, for his zealous devotion of much time and peculiar artistic skill to a faithful representation of this second species of the rare genus *Euplectella*.

DESCRIPTION OF THE PLATE.

TAB. XXI.

Fig. 1. *Euplectella Cucumer*, nat. size; with the foreign sponge and other bodies to which it is attached:—A. wall of the cylindroid, or parietal portion; B. terminal grating or lid; *a.* parietal orifices; *c.* confluence of longitudinal fibres; *d. ibid.* prior to forming the network of the lid; *e. ibid.* as the cylindroid contracts towards its attached end; *h.* resolved filaments, reflected from the attached body; *o, o'.* oblique fibres; *p.* prominent lines from the oblique fibres, chiefly due to the multiradiate accessory spicula; *r.* rim or thickened transverse line at the attached border of the lid; *t.* transverse fibres.

Fig. 2. The opposite side of the attached end of the *Euplectella Cucumer*, with the substance to which it adheres:—*h.* the free ends of the resolved filaments: nat. size.

Fig. 3. The reticulate grating or soldered lid of the *Euplectella Cucumer*: nat. size.

Fig. 4. A closed and an open interspace of the meshwork, magnified four diameters:—*a.* the open space; *b.* longitudinal fibres; *t.* transverse fibres; *k.* superficial oblique fibres closing an interspace; *o.* deep-seated fibres; *o'.* intermediate fibres.

Fig. 5. A multiradiate spiculum, from the place of intersection of the superficial oblique fibres, magnified eight diameters.

Fig. 6. Portion of a barbed filament with its terminal anchor, magnified twenty diameters.

Fig. 7. Transition of the barbed to the smooth structure in one of the filaments, similarly magnified.

Fig. 8. A portion of a sponge from the mass to which the *Euplectella* adheres; natural size, and magnified ten diameters.

Fig. 9. Another portion of sponge from the same mass; natural size, and magnified ten diameters:—*9a.* one of the squares of the harrow-like structure, magnified twenty diameters.

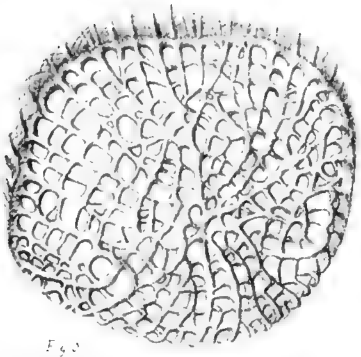

Fig 3

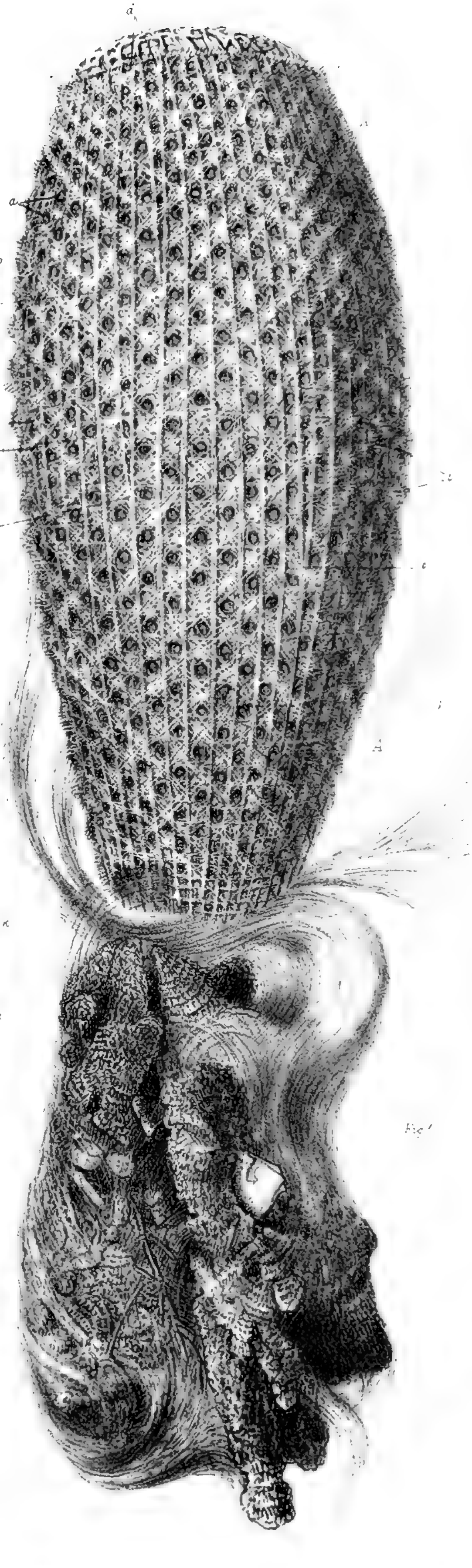

Fig 1

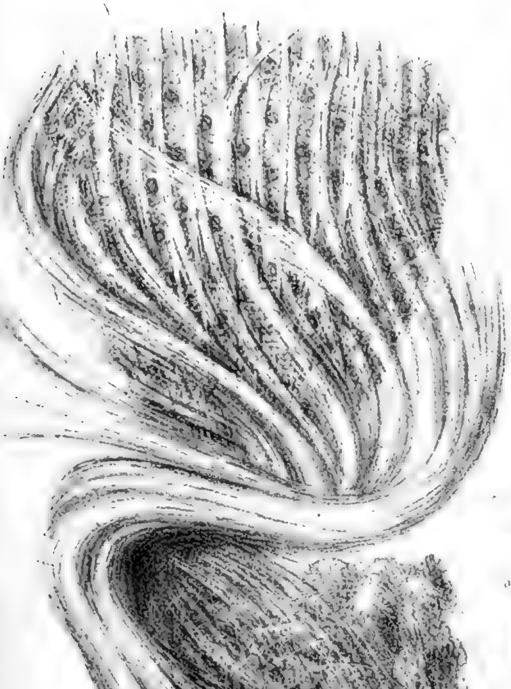

Fig 2

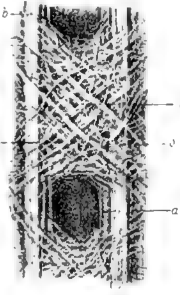

Fig 4

9a

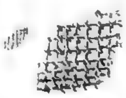

Fig 9

G.B.Sowerby lith ad nat

EUPLECTELLA CUCUMER, Owen.

VII. *On* Brachynema *and* Phoxanthus, *two new Genera of Brazilian Plants.*

By GEORGE BENTHAM, *Esq., F.L.S.*

Read May 5th, 1857.

AMONG the North Brazilian plants collected by Mr. Spruce, are two, which have appeared to me to present some interesting anomalies, preventing their being referred absolutely to any of our Natural Orders as at present defined. I therefore beg to lay before the Linnean Society the following descriptions, accompanied by drawings carefully executed by Mr. Fitch, in the hope that their publication may be the means of further elucidating the immediate affinities of these plants.

1. BRACHYNEMA RAMIFLORUM. (TAB. XXII.)

This plant, to which I have given the name of *Brachynema,* in allusion to the short filaments of the stamens, has a foliage which reminds one of the simple-leaved *Galipeas* or *Ticoreas,* whilst the structure of the flowers is nearer that of *Ebenaceæ.* I should indeed have had little hesitation in considering it as a true *Ebenacea,* slightly anomalous in inflorescence, in the shape of the corolla, and in the hermaphrodite flowers, were it not for the leaves. These have the general form and appearance, the unequal petioles, and the evident tendency to articulation at the summit of the petioles, of several unifoliolate *Rutaceæ.* The surface of the leaf is not however covered with the minute resinous dots of most *Diosmeæ,* but the principal nerves when they approach the margin often emit a small lateral branch terminating in a gland on the margin itself, as is the case in some *Diosmeæ.* The same circumstance may however be observed in some *Euphorbiaceæ,* in a few of the Malvoid families, and in some other Orders. The inflorescence of *Brachynema,* the shape of the corolla, the almost valvate slightly contorted æstivation of its thick lobes, have nothing in them incompatible with the gamopetalous *Diosmeæ,* but here all affinity ceases. The insertion of the stamens, the structure of the ovary, the fruit with its enlarged calyx, are nearly those of *Ebenaceæ.* The only seed which I could examine was probably not quite ripe. Within a striated closely adherent coating, it only presented a uniform cartilaginous mass with a slight discoloration in the interior, in which however I failed in detecting the embryo. Outside, the longitudinal furrows of the seed show an approach to the ruminated albumen of some *Ebenaceæ*; although, on the other hand, there is nothing to preclude the supposition that the whole may be an exalbuminous embryo. The coarse fibres more or less cohering to the external furrows, appear to be detached from the endocarp of the fruit.

For the present, therefore, *Brachynema* must be considered as a doubtful *Ebenacea,* anomalous in its foliage, in its hermaphrodite flowers, in its long-tubed corolla, and in the number of stamens equal to and alternate with the lobes of the corolla.

I should add, that the flowers appearing only on the older branches of the tree, the portions of branch bearing them are in my specimens detached from those which have the leaves. But besides that Mr. Spruce is far too careful a collector for me to suspect any accidental mismatching, the bark and wood of the flowering portions perfectly correspond with those of the leafy ones.

BRACHYNEMA.

CHAR. GEN.—*Calyx* cupuliformis, subinteger, post anthesin accrescens. *Corolla* infundibularis, tubo elongato, laciniis 5 crassis lanceolatis patentibus, æstivatione valvato-subcontorta. *Stamina* 5, brevia, ima basi corollæ v. cum corolla toro inserta, laciniis corollæ alternantia; filamento brevi dilatato; anthera extrorsa, biloculari, connectivo apiculata, loculis longitudinaliter dehiscentibus. *Ovarium* sessile, 5-loculare. *Stigma* subsessile, 5-lobulatum. *Ovula* in loculis solitaria, pendula. *Fructus* (drupaceus?), pericarpio tenui, endocarpio crustaceo intus fibroso, unilocularis, monospermus. *Semen* lata basi affixum, sulcato-striatum, testa tenui arcte adnata. *Albumen* cartilagineum. *Embryo* ignotus (v. embryo crasso-carnosus exalbuminosus indivisus?).

Species unica B. RAMIFLORUM. Arbor, teste R. Spruce, gracilis, 30-pedalis. Rami subteretes, ligno duro, cortice scabriusculo. Folia sparsa, exstipulata, inæqualia, ovato-oblonga, anguste acuminata, integra v. obsolete sinuata, basi cuneata, membranacea, glabra, utrinque viridia, penninervia et transverse venosa, costa nervisque subtus prominentibus. Petioli majorum 4–6-pollicares, apice leviter inflexi et quasi articulati, minorum vix pollicares. Lamina majorum fere pedalis, 5 poll. lata, minorum vix 4-pollicaris. Nervi primarii a costa utrinque 6–8, versus marginem arcuate et irregulariter confluentes, hinc inde juxta marginem ramulum emittentes in margine ipso glandula parva terminantem; duo infimi oppositi, margini paralleli. Flores in ramos annotinos v. vetustiores ex axillis foliorum delapsorum nascentes, fasciculis subcymosis, 5–15-floris, sessilibus, ebracteatis. Pedicelli crassiusculi, vix lineam longi. Calyx per anthesin cupuliformis, 1½ lin. latus. Corollæ tubus 7–8 lin. longus, extus zonis transversis intensius coloratis variegatus; limbi laciniæ crasso-triquetræ, patentes v. recurvæ, intus linea longitudinali pilorum intra tubum plus minus decurrente notatæ. Staminum filamenta antheris breviora; pollen e granulis minutis globosis compositum. Ovarium crassum, subglobosum, vertice depresso-umbilicatum. Stigma pulviniforme, lobulis brevissimis subemarginatis. Fructus in specimine depresso-globosus, 6–8 lin. diametro.

Hab. In Brasilia boreali ad cataractas fluminis Aripecurù, in fl. Amazonum juxta Obidos fluentis (*R. Spruce*).

2. PHOXANTHUS HETEROPHYLLUS. (TAB. XXIII., XXIV.)

Of the other genus, for which I propose the name of *Phoxanthus*, in allusion to the long pointed petals giving a tapering conical form to the bud, Mr. Spruce's specimens afford ample materials for a full illustration. In the first hasty determination for the purposes of distribution, struck by the linear petals with stamens opposite to their dilated base, and some other points of resemblance with Aublet's figure of *Mayepea*, I had thought it probably a second species of that genus (which had already been referred to *Linociera*), and I accordingly labelled it *Linociera* (*Mayepea*) *heterophylla*. But a closer examination showed that I was in error. In the first place, Aublet's figure is incorrect. His specimen in the British Museum has opposite, not alternate, leaves, and from Dr. Solander's notes it appears that there are two, not four, stamens, and that it is altogether a true *Linociera*. If therefore Aublet's dissections, especially fig. 4 of his Plate (t. 31), represent what he really saw, he must have had some flowers of *Phoxanthus* mixed up with those of his *Mayepea*, and have confounded the two plants. Further, I find that Mr. Spruce's plant has not generally four petals, as was accidentally the case in a flower I first examined, but five, although very unequal in size. There are really five stamens, of which three are reduced to mere barren scales; all are opposite to the petals and inserted with them under a small five-lobed disk, and our plant must be sought for among the disk-bearing polypetalous families with compound leaves. The form and structure of the ovary remind at once of some *Simarubaceæ*, and if that family be extended as proposed by Planchon, it may well include *Phoxanthus* also. The stamens opposite the linear petals occur in *Picramnia* (whose place among *Simarubaceæ* is however doubted by Tulasne), and in the still more anomalous *Alvaradoa*; the contortuplicate cotyledons, so remarkable in *Phoxanthus*, are also described in *Picrodendron*. The stamens, however, are very different in form from those which prevail in *Simarubaceæ*, and I have been unable to detect in our plant any of the bitter principle so universal in that family. The absence however cannot be absolutely ascertained from a dried specimen. The succulent pericarp is evidently very oily.

Mr. Spruce describes *Phoxanthus* as a slender woody plant with a stem as thick as the arm, threading among trees to a great height, or, when standing alone, forming a small tortuous tree. The branches are distant, nearly simple, the lower ones near the ground alone flowering, and these have mostly simple leaves, whilst the upper barren branches have large pinnate leaves with three to nine leaflets often near a foot long. The flowers are small and numerous in large red panicles, the petals themselves being of a pale flesh colour. He gathered it in October 1852, in the forests of the Rio Uaupès, especially near the Falls of Panuré.

PHOXANTHUS.

CHAR. GEN.—*Calyx* brevis 5-fidus; laciniis ovatis æstivatione imbricatis, 2 exterioribus vulgo minoribus, una interdum deficiente. *Petala* linearia, acutissima, basi dilatata, hypogyna. *Stamina* petalis opposita et cum iis sub disco hypogyno 5-lobo inserta; 2 fertilia filamento brevissimo crasso, anthera biloculari, loculis connectivo crasso disjunctis rima transversali dehiscentibus; 3 sterilia squamæformia. *Ovarium* subsessile, apice brevissime bilobum, lobis vertice stigmatosis, intus biloculare. *Ovula* in loculis gemina, versus apicem anguli interioris superposita pendula. *Fructus* drupaceus, abortu unilocularis, monospermus. *Semen* unicum, hilo lato juxta basin fructus affixum; testa membranacea. *Embryo* exalbuminosus; radicula crasso-carnosa incurva ad hilum spectans; cotyledones insigniter contortuplicatæ.

Species unica PHOXANTHUS HETEROPHYLLUS. Frutex alte scandens vel arbor parva tortuosa. Rami subsimplices; inferiores floriferi juxta terram breves foliis plerisque simplicibus (unifoliolatis petiolo brevissimo); superiores steriles foliis imparipinnatis 3–9-foliolatis, petiolo 1–2-pedali. Stipulas non vidi. Foliola elliptico-oblonga, abrupte et anguste acuminata, basi rotundata v. acutiuscula, 6–12 poll. longa, 3–4 poll. lata, coriacea, glabra, penninervia, impunctata. Paniculæ axillares, amplæ, laxæ, ramis divaricatis in vivo rubris, in sicco pube minuta rufescentibus. Flores parvi in ramulos ultimos thyrsoidei. Pedicelli vix semilineam longi, bractea minima suffulti. Calyx pedicello brevior, campanulatus, laciniis membranaceis margine denticulatis. Petala valde inæqualia, majora $1\frac{1}{2}$–2 lin. longa. Æstivatio subvalvata videtur, Stamina fertilia petalis minoribus, sterilia majoribus opposita; filamenta fertilium obovoidea; anthera biglobosa, per anthesin introrsum incumbens, post pollinem ejectum ascendenti-erecta. Drupa 9–12 lin. diametro compressa subglobosa v. leviter incurva, ad insertionem sæpe depressa. Pericarpium tenue, carnoso-oleosum. Putamen lignosum. Semen pericarpio subconforme.

Hab. In sylvis ad Rio Uaupès juxta fines Brasiliæ borealis (*R. Spruce*).

DESCRIPTION OF THE PLATES.

Tab. XXII.

Brachynema ramiflorum, a leafy and a flowering specimen: natural size.

Fig. 1. Flower.
Fig. 2. Corolla, cut open.
Fig. 3. Stamen.
Fig. 4. Calyx and ovary.
Fig. 5. The same, vertical section.
Fig. 6. Ovary, transverse section:—all magnified.
Fig. 7. Enlarged calyx and fruit: natural size.
Fig. 8. Fruit.
Fig. 9. The same, transverse section.
Fig. 10. Seed.

Tab. XXIII.

Phoxanthus heterophyllus, a flowering specimen: natural size.

Fig. 1. Flower.
Fig. 2. Petal.
Fig. 3. Stamens and ovary, showing the largest staminodium or abortive stamen.
Fig. 4. The same, seen from the other side, showing the two smaller staminodia and one of the lobes of the disk seen between them.
Fig. 5. A single stamen.
Fig. 6. Ovary and hypogynous disk.
Fig. 7. Ovary, vertical section.
Fig. 8. Diagram of the flower:—all magnified.

Tab. XXIV.

Phoxanthus heterophyllus, a fruiting specimen, and a pinnate leaf from a sterile branch: both natural size.

Fig. 1. Fruit: natural size.
Fig. 2. The same, vertical section: somewhat magnified, as well as the three following.
Fig. 3. Embryo, end view, showing the large ascending radicle.
Fig. 4. The same, side view.
Fig. 5. The same, vertical section.

Trans Linn. Soc Vol. XXII tab 22 p.123

W. Fitch del.

G. Jarman sc.

Trans Linn Soc Vol XXII tab 23 p.128

W Fitch del

G Jarman sc

W. Fitch del.

[illegible] sc.

VIII. *On some new Fungi.* *By the Rev.* M. J. Berkeley, *M.A., F.L.S.*

Read May 5th, 1857.

A VERY valuable collection of Fungi has been lately made by Fendler in Venezuela, which are now in the hands of the Rev. M. A. Curtis of South Carolina, and will shortly be offered for sale. The collection abounds in new species, of which I have selected three as peculiarly interesting, with the intention of bringing one or two more under the notice of the Society at some future meeting. To these I have added a description of a new species of *Mitremyces* from South Carolina, and of a very curious genus of Hypogæous Fungi lately received from Tasmania, with many other good things, through the kindness of Mr. Archer. The Tasmanian collection will shortly be described in Dr. Hooker's Tasmanian Flora, but this genus is so curious that it deserves previously a more especial notice.

1. Hydnum brunneoleucum, Berk. & Curt. Pileo flabelliformi arcuato tenui luteobrunneo glabro; hymenio pallido setulis validis consperso.

On dead wood. Venezuela (*Fendler*).

Pileus thin, flabelliform, vaulted, 1½ inch long, nearly as much broad, yellowish-brown, smooth, slightly streaked behind. Hymenium whitish, sprinkled with many scattered strong bristles.

This species is closely allied to *Hydnum flavum*, Berk. (*Peziza flava*, Swartz), a figure of which was published in the Annals of Nat. Hist. vol. x., from an original specimen in the British Museum. It occurs in Venezuela as well as Jamaica, and is no. 129 of Fendler's collection. It differs from the present species not only in colour, but in the bristles being divided above. Both belong to Fries' genus *Kneiffia*, but its characters scarcely separate it with sufficient precision from *Hydnum*. *H. brunneoleucum* is exactly a *Kneiffia*, but then *Hydnum luteum*, which is clearly congeneric, approaches so closely to *Hydnum*, that I know not how to separate it. The two species have a peculiar, Peziza-like habit which at once distinguishes them from all others.

2. Craterellus papyraceus, Berk. & Curt. Pileo centrali tenuissimo umbilicato coccineo glabro; stipite gracili subæquali fusco; hymenio lævi ochraceo.

Venezuéla (*Fendler*).

Pileus 3½ inches across, extremely thin, umbilicate or very broadly infundibuliform, smooth, slightly fissured at the margin which is arched, bright scarlet, with a few vein-like pencilings in the umbilicus; stem 4 inches high, not a line thick, smooth, reddish-brown, equal except at the very base, where it is slightly dilated as it springs from the matted mycelium. Hymenium quite smooth, ochraceous.

This very beautiful Fungus, which is remarkable in the genus *Craterellus* for its elegant habit and extremely thin pileus, is conspicuous from the beautiful red of the pileus, resembling that of fading leaves of *Ampelopsis quinquefolia*. It is altogether one of the most charming species with which I am acquainted.

3. SKEPPERIA, nov. gen. (TAB. XXV. A.)

Stipes brevis, lateralis, in pileum tenuem utrinque arcte convolutum clavulamque obtusam referentem abrupte transiens; pileus externe cellulosus intus filamentosus.—Genus *Stereo* affine, Edmundo Skeppero plantarum Cryptogamicarum solerti indagatori dicatum.

S. CONVOLUTA, Berk. & Curt.

On dead sticks, Venezuela (*Fendler*, no. 286).

About 1 line high. Stem rising from a little orbicular disk $\frac{1}{3}$ of a line high, but confluent for some distance with the pileus and rather paler; pileus $\frac{2}{3}$ of a line high, of a deep vinous brown, sprinkled with little heaps of granules arising from the breaking up of the outer coat, strongly convolute on either side, so as to form a little compact clavate body with a deep groove on one side like that of a grain of wheat, composed externally of cells, internally of filaments which give rise to the hymenium. Hymenium pale, studded with cystidia.

This singular Fungus looks at first sight like a little *Mitrula*, with which genus it may be confounded if the microscopical structure is neglected. The outer surface, however, is covered with little heaps of granules consisting of a number of deeply coloured cells, beneath which smaller cells occur, which pass into branched threads, and these into an even hymenium consisting of closely packed sporophores with projecting cystidia.

Few genera are more singular in their characters. Notwithstanding the resemblance of *Pistillaria*, there is no close affinity. *Skepperia* will come next to *Stereum*, without however passing into it by any intermediate forms.

4. MITREMYCES RAVENELII, Berk. (TAB. XXV. B.) Pusillus; peridio exteriori in verrucas parvas liberas vel cohærentes dehiscente; interiori glabro; intimo conformi, nec spatio magno vacuo circumdato; sporis ellipticis; ostiolo miniato.

On the ground. Cæsar's Head, Mountains of South Carolina (*H. W. Ravenel, Esq.*).

Rather more than $\frac{1}{2}$ an inch high, including the stem. Stem short, consisting of intricate mucedinous threads. Outer peridium cracking up into warts of various sizes, which are sometimes scattered, but sometimes adhere together so as to form a little lid. Inner peridium smooth, pale, terminated with a few triangular vermilion-coloured teeth; inmost delicate, entirely filling the cavity of the second peridium; flocci abundant, white, terminated with little racemes of obtuse processes; spores ovate, $\frac{1}{2000}$ inch long, not granulated.

Very distinct from all the other species in the larger size of the inmost peridium. The nearest ally is *Mitremyces Junghuhnii*, figured in the 'Botanische Zeitung' for 1844, which has the teeth of the ostiolum pale, and the spores globose.

5. Mesophellia, nov. gen. (Tab. XXV. C.)

Peridium crassum, coriaceum, substratosum; capillitium fasciculato-anastomosans, ad columellam centralem suberosam liberam radians; flocci subflexuosi; sporæ breviter fusiformes utrinque obtusiusculæ.—Genus *Cyclodermati*, Klotzsch, affine; species hypogææ.

M. arenaria, Berk.

From $\frac{3}{4}$–1 inch across, elliptic, somewhat depressed, subterraneous, clothed externally with white flocci which attach themselves to little grains of sand. After the external down has become exolete, dark branched veins are seen to run over the peridium, without however giving off free threads, as in *Hysteromyces*. Peridium single, coriaceous, apparently consisting of several compacted strata like wasp pasteboard; flocci pinkish-grey, radiating in little fascicles from the peridium to the large central corky columella, which is either entirely free, or attached by one or more tendinous threads; spores fusiform, short, slightly obtuse at either end, $\frac{1}{2250}$ of an inch long, of the same colour as the flocci.

This genus approaches close to *Cycloderma*, Klotzsch, which appears to have been seen by no other botanist; but there is no inner peridium, the columella is not a prolongation of a stem, and the spores are not globose. It is a most interesting addition to the Hypogæous Fungi, and, like *Cycloderma*, connects *Trichogastres* with *Myxogastres* through *Lycogale*. The early condition of the plant is, however, quite unknown. The colour of the spores reminds one of *Lycogale*, and the veins of *Hysteromyces*. A Fungus was found by Mr. Drummond on the Swan River, resembling a large cocoon, which is undoubtedly congeneric with this, if not identical. The specimens were, however, very imperfect.

EXPLANATION OF THE PLATE.

Tab. XXV. A.

Fig. 1. *Skepperia convoluta*, nat. size.
Fig. 2. Single plant, magnified.
Fig. 3. Section of pileus before the stem completely vanishes.
Fig. 4. Section of ditto more highly magnified.
Fig. 5. Hymenium.

Tab. XXV. B.

Fig. 1. *Mitremyces Ravenelii*, nat. size.
Fig. 2. Section slightly magnified.
Fig. 3. Flocci from young peridium and spores.
Fig. 4. Flocci from old peridium.

TAB. XXV. C.

Fig. 1. *Mesophellia arenaria*, nat. size.
Fig. 2. Section of ditto.
Fig. 3. Veins on the peridium, magnified.
Fig. 4. Tissue of veins.
Fig. 5. Flocci of capillitium.
Fig. 6. Spores magnified.

A

B

C

Rev.d M. J. Berkeley del.

G. Jarman sc.

IX. *On the Growth and Composition of the Ovarium of* Siphonodon celastrineus, *Griffith, especially with reference to the subject of its Placentation. By* JOSEPH DALTON HOOKER, *Esq., M.D., F.R.S. & L.S.* (With a Plate, TAB. XXVI.)

Read June 16th, 1857.

IN a learned memoir upon some remarkable plants in the Hon. E.I.C.'s Botanic Gardens, Calcutta*, Mr. Griffith established the genus *Siphonodon* upon a very curious Malacca tree of doubtful affinity and singular structure, and accompanied his description with many observations of the highest interest and importance to the student of structural and morphological botany. Amongst these observations is one, which, though published for now nearly fifteen years, has never attracted the attention of botanists, owing to the limited circulation of the Calcutta Journal, but which, from its bearing on the subject of placentation, has a peculiar interest to myself; for it appears to me to be, if correct, the strongest proof hitherto adduced in favour of the theory which regards the placenta as terminating the axis, and not as being referable to the carpellary leaf. To this theory my own experience is opposed, and as I believed I had proofs of the invalidity of what appeared to me to be the most cogent arguments previously adduced in favour of it, I more particularly wished for an opportunity of testing the accuracy of Griffith's statement with regard to *Siphonodon*. Mr. Griffith's conclusion is, "I beg to propose this plant to botanists, as an instance in which the placenta is the termination of the axis, bearing around its base a verticillus of ovula, and produced upwards into a stigma, a single organ, surrounded for the most part by a style with which it has no connexion." (*loc. cit.* p. 255.)

The foundation for this proposition is Griffith's conviction that the ovules, of which there are many in one horizontal series, are developed on an axis in the centre of the flower, independently of the carpellary leaves, and not enclosed by them or by any other organs except the perianth; and that the subsequently developed carpellary leaves form a verticillus externally to the ovules, and rising upwards and inwards, finally enclose them. These conclusions appear to me to be founded on erroneous observations, and the chief object of the present communication is to lay before the Society my reasons for supposing them to be so.

I am indebted to my friend Dr. Thomson, who was well-aware of the interest attached to this plant, for specimens of *Siphonodon* flowers preserved in spirits, gathered from the same tree, I believe, in the Hon. E.I.C.'s Botanic Gardens, which was described by Griffith. These flowers are in all stages of growth, from buds scarcely perceptible to the naked eye, to fully expanded flowers, which measure about $\frac{1}{3}$ inch in diameter: I find, however (as is usual in flower-buds), that there is little relation between the size of the bud and the development of its reproductive organs. In all, I invariably find both whorls of the perianth to be fully formed in two closely imbricated series, before any traces of the

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* Calcutta Journal of Natural History, vol. iv. no. xiv. July 1843, p. 231, t. 14.

ovules or carpellary organs are differentiated, and I shall therefore commence with the bud at this stage, as the first in which the structure and composition of the ovary can be studied.

1. In the first stage (Pl. XXVI. fig. 2) the bud is a minute turbinate body, about $\frac{1}{4}$ line in diameter, with little external distinction between the flower and peduncle. On a vertical section (fig. 3), the double perianth is found to be wholly superior, the sepals placed highest, then the petals, then the stamens, whose anthers (*s*) form minute clavate bodies, sessile at the very base of the petals. All these organs are placed considerably above the plane of the centre of the flower, which presents a depressed area with a very low broad central mamilla, whose vertex scarcely rises to the level of the plane of the base of the stamina. At this period the ovary is manifestly plunged into the apex of the peduncle, and can by no means be regarded as invested by the true calyx, the bases of the sepals being obviously inserted in the margin of the broad obconic apex of the peduncle. In some buds at this period, the central mamilla of the axis (the future style of Griffith) is surrounded by a low broad ridge, or annulus, correctly described by Griffith as belonging to the carpellary leaves.

This is Griffith's earliest stage; he, however, regards the central mamilla as the pistillum itself, a view which is irreconcileable with the fact that the ovarian cells are in the next stage developed below the plane passing through its base, and removed from the circumference of its base.

2. The next marked stage (fig. 4) is that in which the anthers are fully formed and their polliniferous cavities defined, and hence well distinguishable. At this period the central mamilla has risen, and presents the appearance of a style consisting of a short column with a depressed conical hemispherical base; it is more or less invested by the annulus (*a*), which was obscurely seen in the first stage; this annulus has five notches at its mouth, is very thick, and points upwards and inwards towards the apex of the column, being usually applied to its base. The relative position of the stamens and perianth to the plane of the ovarium is the same as in the first stage; vascular bundles are developed in the petals, and are traceable continuously downwards into the peduncle, and branches from these bundles supply the stamens also. The stamens arch over the annulus, and the conniving apices of the anthers almost reach the central column; they are opposite the five notches in the annulus, and five slight ridges on the annulus correspond with its teeth and with the interstices between the anthers.

At this period the ovules are first developed. A whorl of about twenty minute cavities are traceable in a plane below the point of junction of the annulus and conico-hemispherical base of the column; the ovarian cavities (*o*) point downwards and outwards. The ovules appear as minute papillæ, occupying the base of each cavity towards the axis; they present no distinction of parts whatsoever. No vascular bundles are discernible in the ovarium.

In this stage I have included the second and third stages of growth described by Griffith, because, after examining an extensive series of buds, I find very great irregularities in the time of appearance of the ovarian cavities, relatively to the development of the annulus. In some buds I find the ovules formed before the annulus has reached the rounded shoulders of the column, in others not till after it has enveloped that organ. It is at this period, however, that the important difference between my observations and Mr. Griffith's occurs, and as it is upon this that the whole question of the placentation turns, I have taken every means of endeavouring to arrive at the truth. Griffith says, that at the period when the base of the central column becomes concealed by the growth of the annulus, very young ovula may be detected, apparently attached around the whole base of the column, and not presenting any manifest relations with the carpellary leaves. He adds, that at this time a double long section had not shown him any solution of continuity resulting from forcibly pulling back the carpellary leaves (annulus) and thus exposing the ovula. On the other hand, I, at no period, find the ovules to be developed freely at the base of the column; I have sought in vain between the annulus and column for any such appearance, removing the annulus piecemeal with the utmost caution; and in every double vertical section that I have made, I have found the ovarian cavities to be developed even at a much earlier period than that indicated by Griffith, below the junction of the annulus and column, manifestly within the substance of the ovary. The cavities containing the ovules cannot at any period be exposed without tearing the annulus, which, however, owing to the delicacy of the tissues and the excessive minuteness of the organs, it is sometimes difficult to avoid doing.

3. In the succeeding stage (fig. 5), the anthers are fully formed, and, arching inwards, conceal the whole vertex of the ovary, leaving the apex of the column alone exposed between their apices (fig. 8). The cylindrical portion of the column has lengthened, and is terminated by a capitate stigma-like head; its conical base is proportionally smaller and more depressed. The annulus is very much thickened and grown in all dimensions; it has advanced up the column, and presents on a double vertical section two broad shoulders embracing the column, which it thus sheaths in a tube; its upper surface is moulded by the pressure of the anthers which lie between the five radiating ridges accurately described by Griffith. The five teeth (figs. 8 *t* & 6 *t*) terminating the ridges are now more prominent, turn upwards, and are very cellular and fimbriated; and a distinct groove is formed on the surface of the annulus, close to its orifice and concentric with it. The ovarian cavities are fully formed, linear-oblong, and all point outwards, but some upwards and some downwards. The ovules are horizontal with an obscure lateral raphe, and each is conformable to its cell. The column has an evident cuticle, as has also the contiguous wall of the annulus. At this period vascular bundles appear in the ovary, and are traceable downwards from each ovular insertion, and transparent lines are continued from each ovule upwards into the annulus, to whose inner face these ascending lines are parallel and contiguous. The tissues of the sheath of the annulus are pale and translucent. Mr. Griffith says, that at this period the stigmatic surfaces will be found at the conical base of the central column, at the point of its junction with the base of the annulus; he says, "the lines of communication, by which each isolated ovulum is placed in the usual conditions to receive the male influence, will be found to terminate on the circumference of the conical base of the central column." On the contrary, I find the cuticle to be uniformly extended over the points indicated; but its tissue is there rather looser, the cells which form it being elongated inwards, giving when torn the appearance of stigmatic

tissue, and causing that fragility of that part of the ovarium which led to Griffith's supposing that the ovarian cells were formed subsequently to the freely developed ovules. The true stigmatic canals I find terminating in the papillose fimbriated teeth of the annulus.

4. Towards the period of expansion of the flower (fig. 6), a considerable change is found to have taken place in the relative proportions and positions of the ovary and perianth. Owing to the upward direction of the development of the ovary, it is now half-superior, in the usual acceptation of that term. The *stamens* (fig. 9) form a closely imbricating whorl, appressed to the surface of the annulus, the stigma-like head of the central column appearing in the space between their apices, and the five cellular fringed teeth of the annulus also projecting.

On removing the stamina, the protuberant surface of the annulus is more strongly 5-ridged, and the groove round its orifice is deeper. A double vertical section shows that the column is much elongated, and its surface covered with a more evident cuticle, as are its capitate stigma-like apex and the adjacent walls of the annulus. The external surface of the annulus is also covered with a similar cuticle, except at the groove surrounding its orifice, and on the fimbriated teeth, which are manifestly the true stigmata, and are formed of loose papillose tissue (fig. 13). The ovarian cavities are at this period found to be considerably displaced, some being carried a little upwards and others downwards, so that two or three are often exposed at one vertical cut. Unrollable spiral vessels are now found in the vascular cord that passes downwards from the ovules, but none in the transparent line that passes upwards from the ovules parallel to the inner walls of the annulus, these lines being formed of loose conducting tissue, terminating in the stigmatic teeth at the orifice of the annulus. A transverse section of the annulus (fig. 10) now shows five pale spots of loose cellular tissue; these are the stigmatic canals, placed very close to the inner walls of the annulus.

5. At the period of expansion (fig. 7) the stamens are found to have risen from the surface of the annulus, and the stigmatic teeth are sphacelated and covered with pollen-grains, which adhere to its surface and to the surface of the mouth of the tube; but I have not succeeded in tracing the pollen-tubes into the stigmatic canals, probably owing to the excessive minuteness of the pollen in this plant.

The differences between my own and Mr. Griffith's observations are, first, in the ovules being developed in cavities of the ovarium, and not free at the base of the conical central body, which he has mistaken for a placental development; secondly, in the presence of a cuticle over the whole surface of the said body and on the contiguous walls of the annulus; thirdly, in the absence of any vascular bundles passing from the ovules upwards into the annulus; and fourthly, in the absence of any stigmatic puncta at the base of the central column, and of stigmatic lines passing from these inwards to the ovules. The groove round the mouth of the annulus, the absence of cuticle over it, and the structure and consequently the stigmatic nature of the teeth of the annulus, seem further to have escaped Mr. Griffith's notice.

If my observations are correct, the composition of this very remarkable ovarium is reducible to the known modifications of carpellary structure, and may be regarded as consisting of a whorl of five connate carpels adnate to a central fleshy axis or torus;

this torus being produced, as in *Nymphæa*, *Victoria*, &c., into a styliform and stigma-like body. Each carpel bears two ovules on each of the ten marginal placentæ, making twenty ovules in all. The annulus is the free upper portion of the five confluent carpellary leaves; the five ridges are the lines of junction of these; the five stigmata are each double, formed by the terminations of the confluent placental margins of the adjacent carpels, as in *Papaveraceæ* and many other Orders.

There is one point, however, to which further allusion is necessary, as possibly in part explaining Mr. Griffith's views; and this is, the above-mentioned line of loose cellular tissue that extends from the base of the central column to the ovarian cavities, and which is met at the ovarian cavity by the true stigmatic tissue. It is very possible that this line indicates the existence of a stage in the early state of the ovarium in which the carpellary leaves were not completely closed; for though I feel satisfied that the ovules of this plant are at no period independent of the carpellary leaves, and are indeed formed in cavities of those leaves and from their margins, it does not follow that there may not have been a free opening to these cavities, or one closed only by a very lax tissue. It is indeed held by some botanists, that all carpellary leaves are congenitally open, and close more or less completely afterwards; an opinion which is not as yet absolutely proven, though I cannot but think that the open ovary of *Coniferæ** and its allies is a strong argument in its favour. This however, if true, by no means reconciles Mr. Griffith's observations, or his theoretical view of the structure of the ovary of *Siphonodon*, with my own.

The structure I have described in *Siphonodon* suggests a different view of the affinities of this obscure genus than those which have been doubtfully adopted by Griffith, though in the absence of ripe seeds it will be difficult to establish these, and I shall not therefore attempt to do so now.

In submitting this very singular plant, then, as a strong proof of the validity of those laws of carpellary placentation which it has been supposed to have subverted, I cannot refrain from expressing my admiration of the learning which Mr. Griffith has displayed in his discussion of the view he somewhat hastily adopted;—of the guarded manner in which he expresses his opinion;—of the full weight he gives to every structural point that seems to him to militate against it, and of the candour with which he states every adverse argument that suggests itself to him. Though I believe his observations and conclusions to be erroneous, it must be recollected that the plant is a very anomalous one, its parts exceedingly small, and that my experience assures me that specimens preserved in spirits, such as I examined, are in many respects much better for determining structural points from than living ones are. Mr. Griffith's paper further abounds in acute observations on many other points in the structure of *Siphonodon*, to which I have not alluded; and it contains, in a note, a short abstract of the only accurate account hitherto published, so far as I know, of the development and true nature of the ascidia of *Nepenthes*†.

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* It appears more consonant with the known laws of vegetable morphology to regard the Coniferous ovary as an arrest of the usual tendency of ovaries to close, than to suppose the ovaries of most Phænogams to be congenitally closed, and that of Conifers open.

† Some years ago I prepared drawings of the development of the pitchers of *Nepenthes*, from plants in the Royal Garden at Kew. These confirm Griffith's observations in every particular, and prove the pitchers to be modifications of excurrent midribs. Each pitcher commences as a gland at the anterior apex of the conical mamilla, which represents

Before dismissing the subject of carpellary placentation, I would state that the other arguments in favour of free axile placentation, to which I have alluded at the beginning of this communication, are, the free central placenta of *Primula*, and the position of the ovule of *Taxus*. I am not aware of any deviation from the free central placentation having been observed in *Primulaceæ* except by Prof. Henslow, who kindly placed in my hands for examination a monstrous flower of *Primula vulgaris*, in which two ovaria presented ovules developed on the confluent margins of some of the carpellary leaves, far removed from the base of the ovary, and wholly unconnected with the central placenta, which still existed, but in a reduced form, and bore ovules.

The other case is that of *Taxus*, adduced I believe originally by M. Schleiden, who considers the ovule as terminating the bracteate peduncle or rachis which bears it. That this view is not tenable appears to me to be proved by the fact that I have found two and even three ovules at the apparent apex of the peduncle. I further cannot but consider the bracteate peduncle of the female flower of *Taxus** as a genuine cone, the majority of the bracteæ of which bear no ovarian scale and ovule. When more than two ovules are developed in this cone, these almost invariably wither and disappear at a very early period; but I have examined partially diseased cones of *Taxus*, in which the second ovule had enlarged and persisted in a scale below the terminal one.

With such a preponderating mass of evidence in favour of carpellary placentation, derived from the normal condition of both simple and compound pistilla, in which the relation of the parts cannot be misinterpreted, and from monstrous states of ovaries whose composition is more obscure, it does seem to me unphilosophical to call for the operation of a second law to explain the comparatively few exceptional examples of placentation that are not at once referable to the carpellary. Of these exceptional cases, *Primulaceæ*, *Caryophylleæ*, and their immediate allies have always been supposed to be the most difficult to explain away, but *Caryophylleæ*, both in their normal state and as monsters, present many cases of carpellary placentation, and Professor Henslow's *Primula* demands a double law for one flower, if the free axile placentation be not considered a modification of the carpellary.

If it be admitted that the floral whorls are formed from leaves, even when appearances

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a leaf in the earliest stage of its development. A contraction below the gland separates it from the lamina of the leaf, which is independently developed with a convolute vernation.

While upon this subject, I may further mention, that the bilobed lamina of *Dionæa* is unquestionably the true lamina of the leaf of that plant; and that it is inflexed in early vernation, as in *Drosera*, to which it is so closely allied, and to which it is further united by means of *Aldrovandra*.

Of *Aldrovandra* I may remark, that this very rare and singular plant has been rediscovered by Dr. Thomson in the immediate vicinity of Calcutta. It was originally found there by Dr. Roxburgh, but unsuccessfully sought for by Dr. Wallich, Griffith, Voigt, and indeed every Calcutta botanist. Though unknown in any intermediate spot between Europe and Calcutta, I can find no difference whatsoever amongst the specimens from these widely-sundered localities.

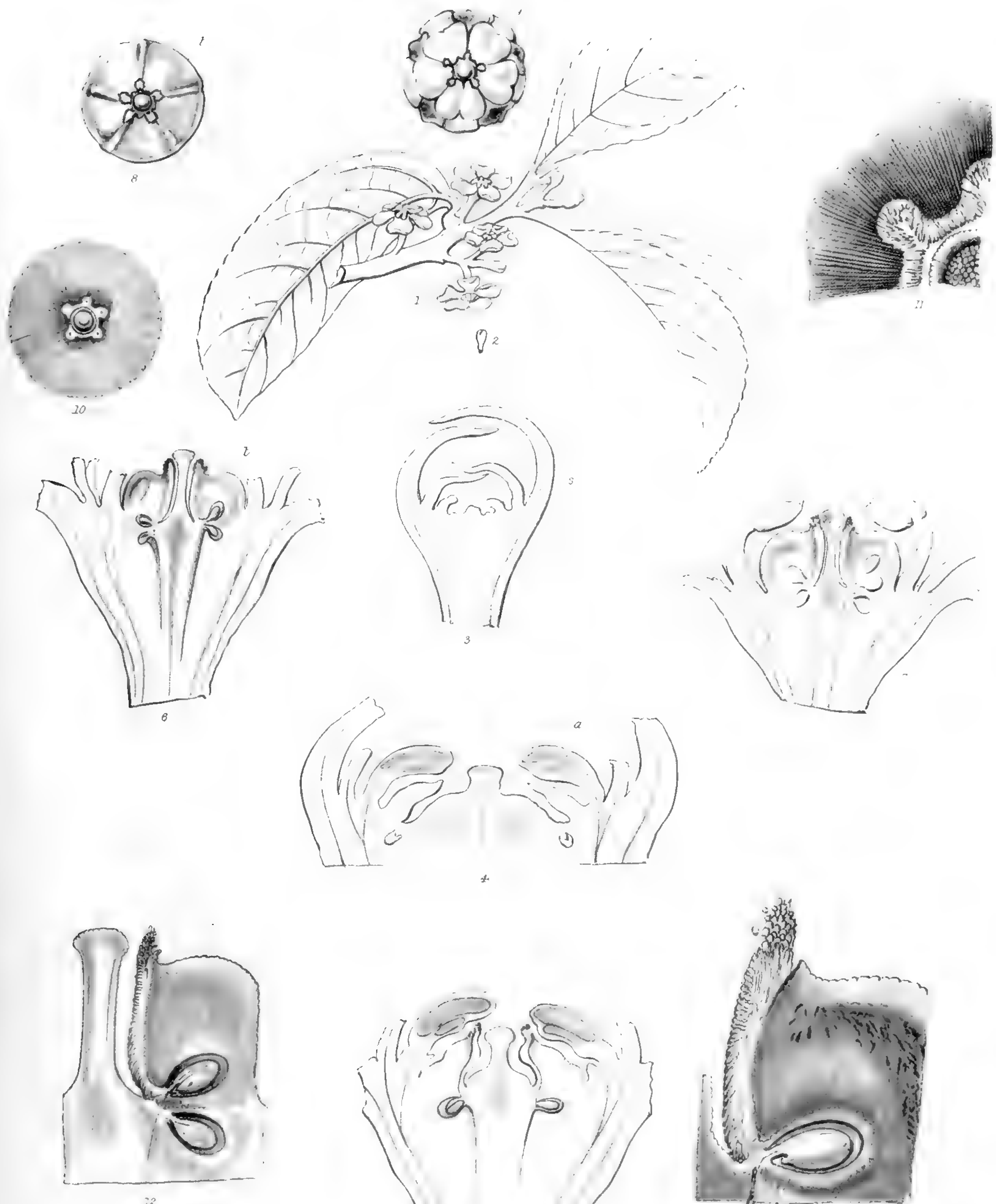
* The fleshy cup of *Taxus*, which is usually called a disk in botanical works, but which is regarded as an arillus by Schleiden, is undoubtedly the outer coat (primine) of the ovule; it is developed at an early stage as an annulus in immediate contiguity with the second coat (secundine): this second coat in *Taxus*, as in many other Conifers, becomes the outermost covering of the seed, or tegmen. I have ventured to allude to this here, as I am not aware that the true nature of the integuments of the seed and ovule of *Coniferæ* has been correctly stated in any general systematic work.

are against this view, and when it may be impossible to demonstrate it; and that this law allows of no exception,—it seems natural to suppose that the law of the formation of ovules in one of these whorls should be regarded as no less absolute, and that any explanation that does no violence to nature should be accepted to account for apparent exceptions, in preference to abandoning the general law and adopting a particular one for those exceptions. Under this point of view I should prefer agreeing with those botanists who consider that all placentation is axial, and that carpellary insertion is to be explained by supposing axes to be produced upon the carpellary leaves, rather than conclude that nature resorts to two totally distinct and opposite principles in effecting the same purpose with the same organs. The instances, however, of the ovules being normally developed on the margin of the carpels, are so extremely numerous and convincing, and the cases of insertion which are not at once reducible to this relation of parts are so few and so scattered through different Natural Orders, that I cannot but regard the latter as insufficient to invalidate the law in question, and to demand the operation of another.

EXPLANATION OF THE PLATE.

Tab. XXVI.

Fig. 1. Flowering branch of *Siphonodon celastrineus*:—of the natural size, from Mr. Griffith's drawing.
Fig. 2. Bud at the earliest period of the appearance of the parts described:—of the natural size.
Fig. 3. Vertical section of ditto; *s.* stamens.
Fig. 4. Vertical section of upper portion of more advanced bud, the ovular cavities having just appeared.
Fig. 5. Another bud further advanced, the stigmata formed, and vascular cords to the ovules.
Fig. 6. Flower about to expand, cut vertically. The ovules are displaced, and the annulus swollen.
Fig. 7. Flower after impregnation, with the stamens still attached.
Fig. 8. Annulus from fig. 5, seen from above; *t.* the stigmatic teeth.
Fig. 9. Stamens seen from above, concealing the annulus.
Fig. 10. Transverse section of annulus, showing the five stigmatic cords or passages.
Fig. 11. Portion of ditto much more highly magnified.
Fig. 12. Portion of annulus, with stigma, conducting tissue, ovules, and vascular cords.
Fig. 13. Portion of another annulus with stigmata, an ovule and its vascular cord.
All but figs. 1 & 2 more or less highly magnified.



J. D. Hooker M.D. del.

[illegible] sc.

X. *Further Remarks on the Organs found on the bases of the Halteres and Wings of Insects.* *By* J. B. Hicks, *Esq., M.D. Lond., F.L.S.*

Read June 2nd, 1857.

In a former paper, published in the Journal of the Linnean Society*, I endeavoured to describe a curious and beautiful structure to be observed at the base of the halteres of the *Diptera*, and a similar but less elaborate condition on the subcostal nervures of the wings of both *Diptera* and other insects, and stated that generally the organs in question on the posterior wings of the 4-winged tribes were the more numerous. I also proceeded to show, that into the halteres, as also into each of the wings of insects in general, could be traced a nerve of considerable size, varying in the different tribes and genera in that particular, and that the nerve proceeding to the posterior wings was generally the larger, and also that the one supplying the halteres of the Blow- and Drone-fly was the largest nerve in the insect, except the optic. I may here repeat, that each of these structures consists of very thin and transparent, hemispherical, or more nearly spherical projections from the cuticular surface, beneath which the wall of the nervure is deficient, so as to allow a free communication with its interior; these organs are arranged in rows on the halteres, and in variously shaped groups in the wings. I concluded that the nerve proceeded to these structures, inasmuch as there was no muscle in the wing or halteres, and that consequently the nerve must be one of sensation; and looking at the elaborate and regular disposition of the structures composing it, I was induced to think the organ was one of special sensation, and that, situated as it was near the great thoracic spiracle, as well as exposed to constant and rapid currents of air, it seemed not improbable that it was connected with the olfactory sense.

At that time I had not been able to prove the actual connexion between the nerve and these vesicles, but I have now the pleasure of exhibiting a drawing (Tab. XXVII. fig. 1) made from a specimen which I have preserved, showing most distinctly the nerve in its whole course, giving off in its passage by the groups of vesicles, numerous branches which can be traced into their bases. This may be seen by any one taking due care in the preparation of the specimen. The drawing is from the second wing of a Longicorn beetle (*Strangalia elongata*); though perhaps every wing will not show it well, on account of the position of the nervures. I may here mention the method employed, which is one, I believe, frequently in use:—After cutting off the wing and washing it well in water or spirits of wine, and draining off the major part by blotting-paper, I immerse it in spirits of turpentine for a week or two, after which it is placed in Canada balsam between glass in the usual way, taking care not to heat it, as that renders the nerve too transparent. In those parts which are too dark for observation, I have been enabled to render them colourless by chlorine: a little chlorate of potash, and a few drops of hydrochloric acid,

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* Vol. i. p. 136, Nov. 1, 1856.

mixed in a small bottle, with the addition of a little water when the effervescence is brisk, will in a short time remove sufficiently the colour of most insects. Some parts which are quite black, as the elytra of beetles, wings of bees, &c., require a day or two, and some even a week. The hydrochloric acid has also a valuable property in rendering the nerve-tubes more perceptible. This plan of bleaching will be found invaluable in examining the structure of antennæ, which are often quite black, as I shall hereafter show.

I have also shown the distribution of the nerve in the wing of *Tenthredo viridis*: the bundle of nerves going to the vesicles was well marked in the specimen from which the drawing was taken.

These examples will, I think, serve to point out the intimate connexion between the vesicles and the nerves. Whether the whole nerve be distributed, in all instances, to these organs, I am inclined to doubt, since a small branch seems to pass beyond the point where they cease.

I shall now endeavour to trace these organs through the different tribes, so far as I have been able.

In the *Hymenoptera* I find that they exist far more extensively than I supposed when my former paper was read; their detection has been mainly owing to the use of chlorine, so few of this Order having light-coloured nervures in the wings. The figures here given represent these organs in *Ophion luteus* (Tab. XXVIII. fig. 2) and *Tenthredo viridis* (Tab. XXVIII. fig. 3), two species which are good examples of the tribe, and in which the nervures are the most transparent. These organs in the Wasp (*Vespa vulgaris*), Honey-bee (*Apis mellifica*), *Andrena fulvicans*, and *Tenthredo lucorum*, having a great resemblance to the above, I have not thought it worth while to figure them.

They consist of two groups on the upper, and one scattered group on the under side of the subcostal nervure, amounting in *Ophion* to 200–300 above, and perhaps 100 beneath, with a smaller group at the end of the nervure.

With regard to the *Diptera* I have nothing to add to my former remarks, excepting that I have found the vesicles in *Hippobosca equina* distinctly marked both in the halteres and wings. The diameter of each vesicle is $\frac{1}{2300}$ inch.

In *Tipula oleracea* they are also well shown on the wings.

In the *Hemiptera* they are very scanty; I have observed and drawn those on the second wing of the Tree Bug, a species of *Pentatoma*.

In *Notonecta glauca*, or the Water-boatman, they are even more simple.

In *Corysus* I have been unable to find them. I have carefully examined the elytra of the common Bed-Bug (*Cimex lectularius*), but cannot find anything definite; some papillæ occur on them, but they do not seem to be arranged in any distinctive manner.

In the Coleopterous group we find them highly developed, as may be observed in the drawing of these organs in *Strangalia elongata* in Plate XXVII. fig. 1.

They occur in numerous groups on the subcostal nervure, mostly at the widest part, but are also scattered along it to the joint of the wing, where we find about ten or twelve large vesicles in a group, after which they cease.

In the Carrion Beetles (*Necrophorus*) they are very well developed, as also in *Silpha*, where they are remarkably large, considering the size of the insect.

In *Lucanus Cervus, Melolontha vulgaris*, and *Cetonia aurata* they are not so large, but still are numerous.

In *Carabus granulatus* they are found in the rudimentary second wing, more diffused over it than in some other genera, inasmuch as other nervures than the subcostal are furnished with them, though not to the same extent.

In an apterous Beetle which I examined, I did not find any similar organs on the part of the side corresponding to the position of the wings.

With regard to the distribution of the nerve in the elytron of the *Coleoptera*, there are some curious facts, which, I think, have not been hitherto noticed. If the elytron be treated in the way above mentioned, and first bleached if it be dark-coloured, the branching tracheæ will at once be recognized, accompanied by the nerve, which gives out branches as it proceeds. Now, in all the elytra of beetles I have examined, there is a number of distinct projections from the whole dorsal surface, in many hemispherical, in some like small papillæ just raised above the cuticular surface; these eminences are arranged in a tolerably regular manner, and are quite distinct from other irregularities of surface. The hemispherical forms are very transparent, the wall of the elytron being deficient beneath them, as in those before described. There are two or three papillæ at the highest point of the vesicle. Some, when viewed by polarized light, exhibit a dark cross, something after the manner of starch-cells; those of *Melolontha* show it well.

In many beetles the vesicle or papilla is accompanied by a hair, which always, I believe, when so situated, overarches it, as if for the purpose of affording protection.

Now, into each of these vesicles and papillæ a branch of the nerve can be distinctly traced, as I have shown in the two drawings taken from *Melolontha* (Tab. XXVII. fig. 2) and *Carabus* (Tab. XXVIII. fig. 1). In the case of *Melolontha* the hair may be seen overarching the vesicle.

With regard to the *Lepidoptera* I have found nothing new, except that the organs are well developed in the female Vapourer Moth (*Orgyia*) on the rudimentary wing.

In none of the Orthopterous specimens hitherto examined have I been able to find any structure like that described in the other groups. A nerve, small in some, but large in *Mantis religiosa*, is to be found entering the wings, yet I have been unable to make out anything satisfactory, except a few scattered vesicles on one or two of the nervures.

In the *Neuroptera* these organs can be distinctly found, though not quite so fully developed as in most of the preceding groups. In *Libellula depressa* they are not, relatively to the size of the insect, by any means so numerous as in the *Coleoptera*. I have drawn those of *Agrion*, where they are but few; and those of *Phryganea*, which are rather more simple. In the Flea (*Pulex irritans*), I have been unable to detect anything connected with this subject.

I have not been able to distinguish any difference between the sexes in reference to these structures, their relative size corresponding to that of the individual, which is generally larger in the female. The species of a given genus, especially of the Dipterous group, exhibit a marked similarity in the appearance of these organs; so that it is possible, by examining them, to tell to what genus any Fly, whose halteres are presented to you, belongs.

In regard to their relative development in the various Orders, so far as I have already gone, I am enabled to say, that they are most perfect in the *Diptera*, next so in the *Coleoptera*, rather less so in the *Lepidoptera*, but slightly developed in the *Neuroptera*, scarcely at all in the *Orthoptera* (though this assertion may be hereafter modified), and that only a trace of them exists in the *Hemiptera*.

I have found in each of those divisions the most numerous and largest organs in those insects which are notorious for their acute scent, *ex. gr.* in the Carrion Beetles, Blow-flies, and *Bombycidæ*, and the smallest and fewest in those that are either very sluggish in habit, as the Bugs; or in those that hunt their prey by sight, as the *Libellulæ*; or those having a large development of the eye, as *Tabanus*, &c.

Note.—Since the above paper was read, I have been favoured, through the kindness of Mr. J. O. Westwood, with the following extracts from Keller's 'Geschichte der gemeinen Stubenfliege' (pp. 22, 23), taken from copies of the two versions in the Hopeian Library at Oxford. The original version in German, dated 1764, is Mr. Westwood's copy, and the French, dated 1766, is Mr. Hope's.

"Les baguettes sont placées derrière les stigmates. La couleur jaune de l'une de ces baguettes (très grossie, pl. 4. fig. 3) est bien de beaucoup plus vive que celle des vésicules résonnantes [alulets], cependant elle paroit pourtant être faite de la même matière, du moins la tête de la baguette, *g*, et ne consiste qu'en une simple membrane, bordée d'un chassi, d'une matière un peu plus solide, qui les divise dans la même proportion en deux hémisphères. L'on voit encore mieux ces parties dans les Cousins qui de même que tous les insectes à deux ailes sont pourvûs de ces baguettes et qui ont aussi deux vésicules résonnantes très petites, que dans les mouches, puisque les tiges des vessies presque transparentes sont plus longues. Aussitôt que nous examinons la vessie antérieure au travers d'une loupe nous ne pouvons faire aucune autre conclusion, si non, qu'elle soit creuse, ou pour mieux dire que ce soit une vessie enflée. Nous pouvons conjecturer la même chose ici par comparaison. Mais cette conjecture devient d'autant plus certaine, si nous examinons la baguette d'une mouche morte, où nous trouvons sa tête affaissée et contractée comme une vessie vuide d'air (pl. 3. fig. 27 *c*).

"Nous verrons dans la suite que cette cavité des baguettes est faite dans des desseins très importants. La verge [peduncle] garnie de poils très courts, ou la tige a le plus d'épaisseur près du corps; elle est inflexible, et *presque garroté par en haut de plusieurs nerfs* [*oben mit vielen nerven als wie mit Schnüren umwickelt*; mit einem worte, so beschaffen, dass man ihm gleichsam seine Stärke ansicht]; en un mot, elle est faite de manière que l'on peut juger de sa force par les dehors."

The plates in both versions of the work are from the same coppers. In the figures of the *halteres* a rough view is given of the groups of vesicular projections at the base of those organs. The individual vesicles, however, are not represented as distinct from each other. By the "nerves," described as being outside, and as giving an idea of strength, I presume the author means "nervures," which he considers the rows of vesicles to be, and not nerves derived from the ganglionic centres.—J. B. H.

EXPLANATION OF THE PLATES.

(All the figures are magnified.)

Tab. XXVII.

Fig. 1. Preparation from the wing of a Longicorn Beetle (*Strangalia elongata*), showing the subcostal nervure giving off branches passing to the vesicles: *t*, trachea; *n*, subcostal nervure.

Fig. 2. Elytron of *Melolontha vulgaris*: *t*, trachea; *n*, nervure; *b*, portion more highly magnified, showing the termination of the nerves.

Tab. XXVIII.

Fig. 1. Portion of the elytron of a species of *Carabus*: *a a*, trachea; *b b*, nerves proceeding to papillæ; *c c*, markings in elytron, probably solid between upper and under wall.

Fig. 2. Portion of anterior wing of *Ophion luteus*: *a*, base of subcostal nervure, upper side; *b*, end of nervure; *c*, under side of nervure.

Fig. 3. *Tenthredo viridis*. A, portion of anterior wing; *a*, upper, *b*, under side. B, portion of posterior wing; *a*, upper, *b*, under side. C, section of wall of nervure through the organs; diameter at surface $\frac{1}{6000}$th of an inch.

Fig. 1

continuation of trachea and nerve

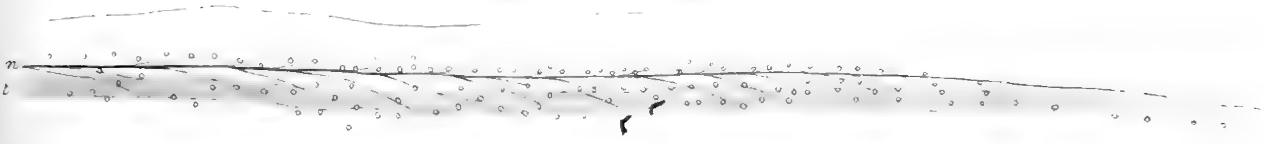
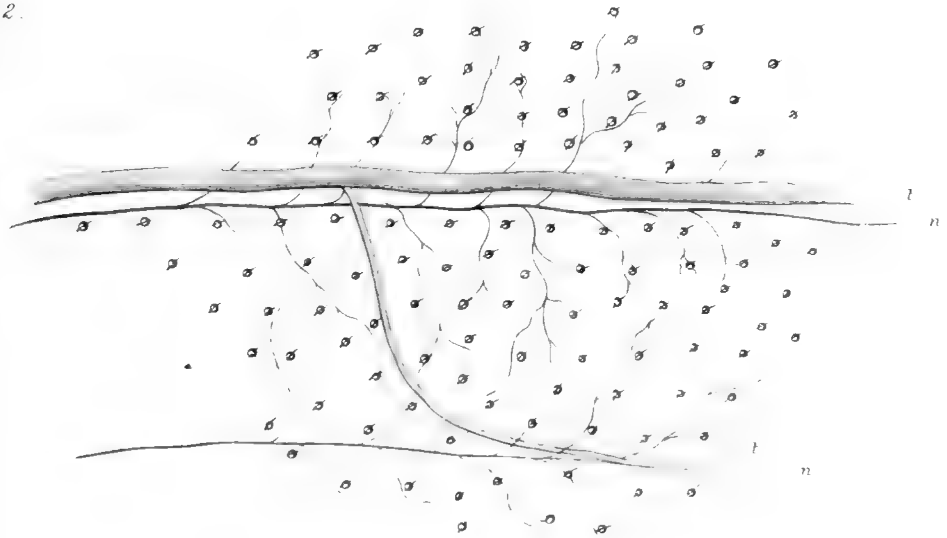
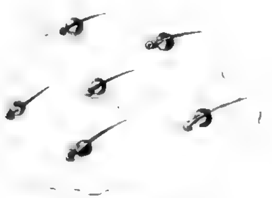


Fig 2.





J. B. Hicks, M.D. del.

G. Jarman sc.

Fig 1

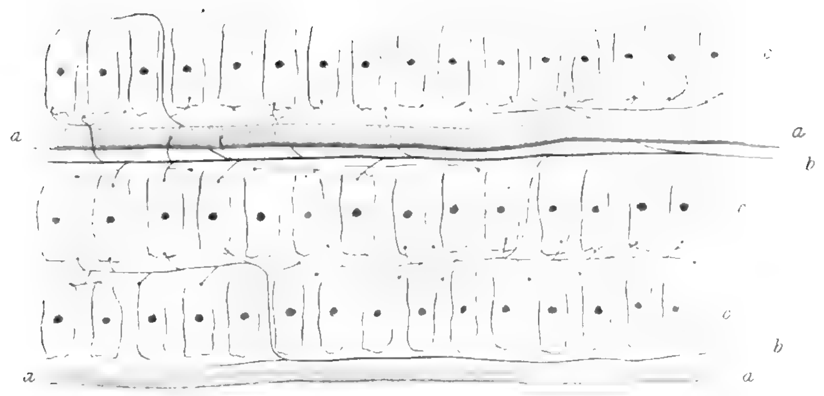


Fig 2

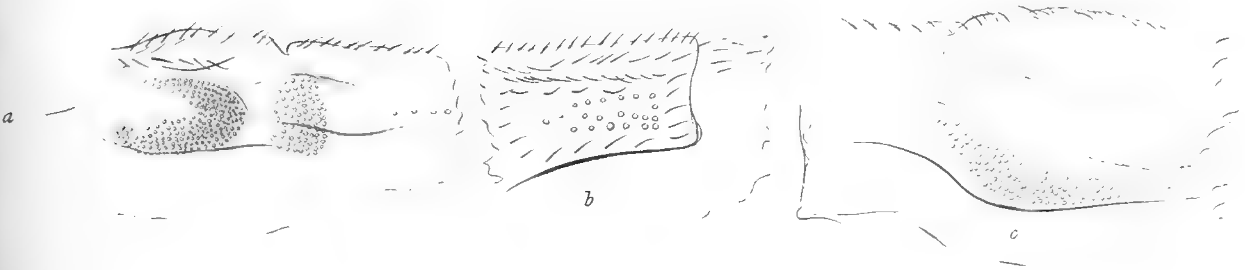
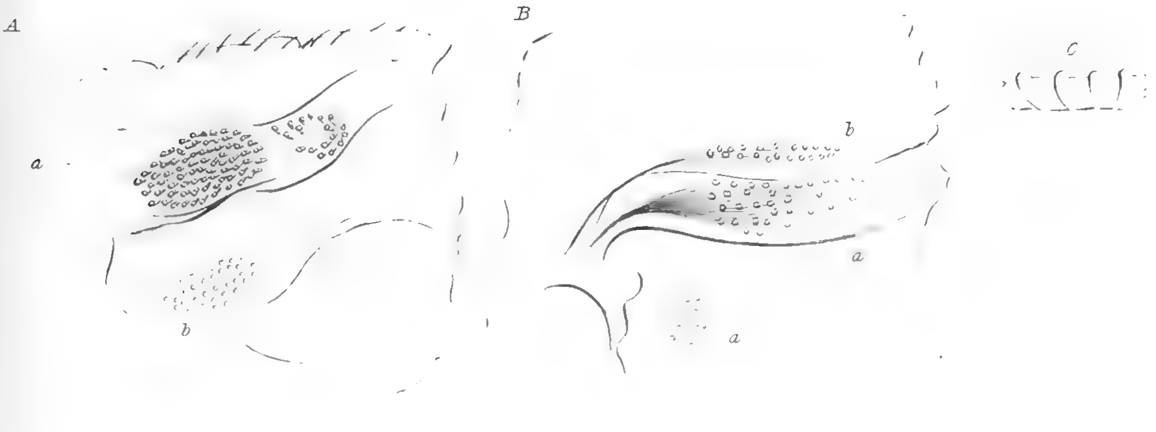


Fig 3



J.B.Hicks M.D del

G Jarman sc

XI. *On a new Structure in the Antennæ of Insects.*

By J. B. Hicks, *Esq., M.D. Lond., F.L.S.*

Read June 2nd, 1857.

THE object of this paper is to call attention to some peculiar structures to be found in the antennæ of insects, which have not been hitherto noticed. If we submit the antennæ to the bleaching process which I have before described (see pp. 141–2), these structures will be well brought into view; they vary somewhat in form in the different genera, but all, I believe, possess the same elements, and are formed on the same principle.

I shall first describe those of the *Diptera*.

The antenna of the common Blow-fly (*Musca vomitoria*) is usually described as consisting of three joints, the terminal one being dilated and elongate, having a plumose *seta* or *bristle* on one side. There are many genera of *Diptera* which possess a similar antenna, and it is on this third dilated joint that the structures about to be described are found. When the antenna is not so constructed, although many of the joints present similar appearances, yet I believe they will not be found on the first and second joints, but almost invariably, if not always, to commence on the third, as may be seen in the accompanying figures.

First, of the Blow-fly (*Musca vomitoria*) (Tab. XXIX. fig. 1). Over the whole surface of the elongated third joint may be noticed at first sight, a multitude of transparent dots, apparently vesicles, but on closer examination and in profile, they will be found to be level with, if not rather below the general surface (fig. 1, *b* 1). These dots after a careful investigation prove to be perforations of the inner coat of the wall of the antenna, closed in externally by a very thin membrane, which can be seen, when the antenna is crushed, on the lines of fracture.

Behind this closed perforation is a sac, rather larger than the perforation itself, which, when the antenna is broken up, may be found floating about in the balsam (fig. 1, *d* 1). The diameter of these perforations of the inner wall of the antenna is about $\frac{1}{5000}$ inch. They are placed very close together. The area on each half of the antenna covered by these structures, has a surface-measurement of $\frac{1}{90}$ inch by $\frac{1}{30}$ inch, and as each square of $\frac{1}{90}$ inch has within it 3025 (that is, a square having 55 on each of its sides), the total number embraced within the space occupied by them will be about 9075; and the total for both sides will therefore be about 18,150. But it will be proper to deduct from this number about 1000 for the space occupied by the apertures (presently to be described), and some possible irregularities in the disposition of these organs; we may therefore assign 17,000 for the whole surface of each antenna.

But besides this multitude of peculiar structures, there are numerous apertures leading into cavities, which may be either simple or composed of one to five chambers, all communicating with the common aperture. These apertures are protected slightly by hairs which arise from the edges, and also a little way within them (fig. 1, *b* 2, *c*, *d* 2). There are about eighty of these cavities on one side of the antenna, and probably about the same number on the other; their diameter varies from $\frac{1}{3000}$ to $\frac{1}{1420}$ inch. The largest sacculated chamber is about $\frac{1}{660}$ inch. By focusing down to the floor of this cavity, papillæ may be seen, each in the centre of an hexagonal area. On viewing these structures in profile, as at fig. 1, *d*, there may be seen beyond, and adherent on all sides to their walls, a firm granulated mass of considerable thickness, and which appears to be tubulated nearest the walls of the sac. This latter investigation is attended with some difficulty, and requires much care, but I think I am not far wrong in stating that the hexagonal areas correspond to the tubes which extend inwards from the walls of the chambers. This is shown at fig. 2, *d* 2.

In *Helophilus pendulus* (Tab. XXIX. fig. 2), the smaller organs first described are not so numerous as in *Musca vomitoria*, while the cavities are more frequent, though less chambered. Hairs also arise from the interior of the cavity, as is shown at fig. 2, *d* 2.

In many antennæ of this shape, there are one or two openings very much larger than the rest, in the lower part opposite the origin of the seta; these are well shown in *Mesembryum meridianum*. They possess the same structure as the cavities before described. These cavities, and their chambers or sacculi, will, I think, be found to consist of the same elements as the smaller organs; the chambers being compounded of groups of these, and seeming to be formed by the infolding of the external surface, as is shown by the presence of hairs inside them.

The above structures I have found in all antennæ of this form, varying in relative numbers in the different genera.

Before I take leave of this form of antenna, I would throw out a suggestion with regard to its true structure. The seta or bristle (Tab. XXIX. figs. 1 & 2) is 3-jointed, the last one plumose or not, as the case may be. Now it seems to me that these are the last three joints of a 6-jointed antenna, the third joint of which is more or less dilated on one side, thereby throwing aside the last three. This I think will be seen to be the true explanation of the seta, when it is considered what peculiar and important structures are developed on the third joint, which is probably dilated for their reception.

In *Tabanus* (Tab. XXIX. fig. 3) the third joint is much dilated, but unequally, so that the four other joints, although continued in the general direction of the antenna, are on one side of the axis. On all the five joints from the third to the apex, organs are found exactly like the smaller closed perforations in the Blow-fly, their diameter varying from $\frac{1}{7000}$ to $\frac{1}{3000}$ inch. Between each is a tooth-like projection of the cuticle, like a hair. The largest are scanty, and chiefly found on the lower part of the third joint.

In *Bombylius* the antenna is 5-jointed, the third joint only possessing these closed perforations, and being much elongated and slightly dilated; the diameter of the pores varies from $\frac{1}{8700}$ to $\frac{1}{3300}$ inch.

In *Hippobosca equina*, the antenna is 5-jointed; the third, fourth and fifth joints being devoted to the reception of the same structures. They are depressed beneath the general surface, in the form of a saucer, at the bottom of which is seen the thin membrane across the perforation of the inner wall. The last joint is plumose, exactly resembling the third joint of the seta in *Musca*, *Mesembryum*, *Eristalis*, *Volucella*, and other similar forms.

In *Tipula* (Tab. XXIX. fig. 4) these organs (precisely like those in *Hippobosca*, *Bombylius*, &c.) are to be found on the third joint of the antenna, which is more elongated and dilated than the rest, as is seen in fig. 4, *a*. Their diameter is $\frac{1}{2400}$ inch.

In *Ctenophora* the third joint is much more dilated, as at fig. 4, *b*, *c*. In *Ctenophora bimaculata* (fig. 4, *c*) this dilatation is well marked on one side, and on this part these organs are readily observed, and the nerve distinctly seen to proceed to them, as in fig. 4, *e* 1.

In *Bibio Marci* the antenna is composed of nine joints; the first two are free from any of the above appearances; but the last seven all possess them on one side, and a nerve can be traced distinctly to them. But the most remarkable condition of this antenna is, that from the third to the eighth inclusive, on the outer aspect of each joint is a cavity of considerable size, similar to those described in *Mesembryum*, the appearance of the floor being the same. The aperture leading to this cavity is about $\frac{1}{370}$ inch diameter, and around its wall is a layer, apparently of tubuli, as around the chambered cavity of the Blow-fly, and to each of these a nerve can be very plainly seen to be given off from the antennal nerve as it passes by them.

In this insect the advantages of the use of chlorine are strongly shown, the whole of it being of a jet-black, which in a day or two becomes quite colourless.

The antenna of *Asilus cristatus* is very like that of *Bombylius* in shape and arrangement; the organs are, however, larger and more scanty.

The club-shaped antenna of the Butterfly approaches that of the Blow-fly very closely, in possessing both the small transparent dots as well as the chambered cavities. I have figured the antenna of *Argynnis paphia* (Tab. XXIX. fig. 5). Both the above structures extend nearly to the base of the antenna, but more sparingly towards the lower end. The small organs are surrounded by various cuticular markings, and vary from $\frac{1}{5000}$ to $\frac{1}{3000}$ inch (fig. 5, *b* 1). The openings into the chambers are in diameter from $\frac{1}{2300}$ to $\frac{1}{1500}$ inch (fig. 5, *b* 2, 2). The chambers of the cavity vary from two to six; in the centre of their base is a projection or papilla, and the floor viewed from above presents the same appearances as in the Blow-fly.

I may remark that the small organs can be in no way mistaken for the roots of the scales, their form being very dissimilar.

I have not carried out the examination in the antennæ of Moths, but have found these small organs in the dilated extremity of the divisions of the antenna of the Drinker Moth.

In the Hymenopterous group we find these organs very extensively spread over the antenna, the external form varying somewhat in aspect; that of the Hive-bee (*Apis mellifica*) being a beautiful illustration, showing as it does the structure on a larger scale than any I have as yet described; and as the antenna is very free from cuticular markings, the nerve is very distinctly seen to give off a branch to the groups, which in this insect only occupy one side of the antenna (Tab. XXX. fig. 6).

Each structure consists (viewed from above) of round transparent spots, about $\frac{1}{1760}$ inch diameter, but on a side view they are seen to be depressions of the surface, the internal wall being perforated, with a very thin membrane closing in the perforation, which is probably the external layer of the antennal wall continued over it; and this is perhaps the condition in every variety of these structures (fig. 6, *a* 2).

In fig. 7 is represented the antenna of *Eucera longicornis*; the whole surface is occupied by a number of saucer-like depressions, which are arranged so close that they touch each other on all sides. In the centre of these is clearly seen the tubular perforation of the internal wall, closed in by the very thin membrane. The diameter of the perforation is about $\frac{1}{1700}$ inch; the whole saucer-like depression is $\frac{1}{1120}$ inch. If a fracture be made in the antenna, the above thin membrane will become detached and float about in the balsam. Beneath the perforation will be found, by very careful examination, a membranous sac (fig. 7, *c*). These sacs touch each other all round, the whole forming a thick layer on the internal surface of the wall of the antenna. The number of these structures in this insect is about 2000 for each of the ten joints furnished with them; the total will therefore be about 20,000.

In fig. 8 is shown the antenna of another Hymenopterous insect (*Andrena fulva*). It has the same construction as the last-mentioned, except that there are hairs between the saucer-like depressions; and each hair as well as the depressions being surrounded by a ring of very minute tubercles, the whole has a pretty appearance.

In the Ichneumons which I have examined, I find the appearance different, though the real structure is not so. The perforation remains the same, but the thin transparent membrane closing it in, is elevated above the general surface, and extends lengthwise beyond the perforation, while it is generally not so wide. The shape of this membrane is not unlike that of an inverted canoe, and a keel-like ridge extending longitudinally through its centre adds to the similitude. The perforation beneath it is oval. I have endeavoured to show this at fig. 9, *a*, *b*, *c*.

The extreme length of the external arched membrane I have found in one specimen to be $\frac{1}{640}$ inch; the longest diameter of the subjacent perforation is $\frac{1}{1360}$, the shortest $\frac{1}{2100}$ inch.

The antenna of *Vespa vulgaris* and of *V. crabro* is arranged on the same principle, but the organs are more numerous and not quite so regularly disposed. They are well shown in the pupa state.

In *Nomada* the appearance is much the same as in *Apis mellifica*.

But the most beautiful of all the structures I have as yet met with is that presented in the antenna of *Libellula depressa* (Tab. XXX. fig. 10). This antenna has six joints. The third, fourth and fifth have on one side the following organs. 1st, a simple, nearly round sac, formed in the internal membrane and projecting inwards; the external opening being closed in by the delicate thin membrane, as noticed in the other insects (fig. 10, *a* & *b* 2). 2nd, a sac as above, but opening inwardly into another convoluted membranous sac, which is shown at fig. 10, *b* 1. These are more simple towards the upper joints; and in some of the simpler sacs there seems to be a small cavity at the back. Whether there be any membrane separating the outer and inner sac, it is difficult to say; but I fancy there is no separation of the kind.

The nerve may be distinctly seen to pass to these structures, and as the cuticle has scarcely any marking, the whole is plainly visible, and forms a very interesting object.

The diameter of the simple sacs is about $\frac{1}{2000}$ inch, that of the largest from $\frac{1}{2000}$ to $\frac{1}{1500}$ inch; the length of the longest sac $\frac{1}{840}$ inch.

In the Grasshoppers (*Tetrix*) (Tab. XXX. fig. 11) I find a structure very similar to that of the simple sacs of *Libellula*, and formed in the same manner; but there is a distinct papilla (of which there is some trace in *Libellula*) in the centre of the floor of the sac (probably where the nerve is connected with it), and from this papilla a small chain of minute bodies extends to the centre of the membrane which closes the aperture. This connexion is well seen in profile (fig. 11, *c* 1), and, when viewed from above, the point of contact with the external membrane is seen in the centre, as is indicated in fig. 11, B.

The diameter of those represented in fig. 15, is about $\frac{1}{1200}$ inch. There are about twenty-two joints in this antenna, the lower of which possess about twelve sacs; the number increases towards the apex, till about from the fourteenth to the last there are 100 on each, so that we may estimate the total number on each antenna to be at least 1000.

In *Gryllus*, *Gryllotalpa*, and *Blatta*, I have found these structures in each joint of the filiform antenna, generally from two to four in number, and commonly occupying the same position and aspect of the joint. I have drawn those of *Gryllus domesticus* at Tab. XXX. fig. 12.

In the *Coleoptera*, so far as I have examined, similar organs are to be met with.

In the attenuated antenna of the Longicorns, they are placed near the upper end of each joint, where they form groups of eight to ten, one group on each side.

In *Silpha clavicornis* they are scattered mostly on one side of the thickened joints, the membrane by which the aperture is closed projecting hemispherically.

In *Melolontha vulgaris* the whole surface of the lamella is thickly covered by organs which are apparently of similar structure; these are figured in Tab. XXX. fig. 12. They consist of an irregularly-round cup-like depression, the centre of which rises up nearly to the external surface of the antenna. From this projection a tube runs inwards quite through the internal layer of the wall of the antenna, while the external end which forms the central projection is closed by a delicate membrane.

The diameter of the cup is about $\frac{1}{1100}$, while that of the central projection is $\frac{1}{2700}$ inch. The external layer of the cuticle is marked by hexagonal lines so disposed that each of the cups occupies one of the areas considerably enlarged.

The nerve entering the antenna is large, and at the base of each lamella sends into it a branch, which dividing into four or five smaller branches, spreads out over the whole internal surface.

The number of these organs on each antenna is as follows. The area of one side of each lamella is about $\frac{1}{11}$ inch by $\frac{1}{44}$ inch; each square of $\frac{1}{44}$ inch has on each side 45 of these structures; the square would therefore hold 2025. As there are four of these areas in the entire side of the lamella, the number would be 8180. The sum for both sides will be 16,360, and as there are seven lamellæ on each antenna, the total number of these organs on the whole antenna will be 114,520. A deduction of 2000 or 3000 may be made for irregularities, difference of size, &c.; still, making the most liberal deduction, we may say there are at least 100,000 on each antenna.

As in some of the *Diptera* and *Lepidoptera*, so in this species, the antenna has cavities in which we can detect from three to ten organs similar to those on the outside.

With regard to the physiological relations of these organs, I think we may perceive in them a structure analogous to that of the reputed auditory organs at the base of the antennules in certain Crustacea; but whether the resemblance be sufficient to allow us to conclude that they have a similar function, it is perhaps premature to assume. Their essential parts seem to be, a cavity in the antenna-wall, filled with fluid, closed in from the outer air by a very delicate membrane, and to the back of which a nerve certainly proceeds. There seems to be some correspondence between the chain of minute bodies passing through the cavity in the Grasshoppers, and the otolithes in the Crustacea; but at present it is only in this tribe I have found such an arrangement, though subsequent observations may extend the number in which it exists. If these organs are connected with the auditory sense, the opinion, held by Carus, Straus-Dürckheim, Oken, Burmeister, and Rennie and Kirby, that the antennæ are organs of hearing, will not be without foundation. In considering the function of these structures, we must bear in mind that all the auditory organs hitherto discovered in the Invertebrata have been in aquatic animals, and consequently, when the elements of an auditory organ are found in an air-breathing animal, it will be necessary to consider the difference between the force with which sound is transmitted from water to water through a membrane, and through the same from air to water. If we assign an olfactory function to these organs, one difficulty presents itself, viz. that for the odorous particles to affect the nerve, they must reach it through a membrane and a stratum of fluid.

The careful anatomical examination of the antennæ in all the genera of Insects would be a work demanding much time and many labourers, but productive of a rich harvest. If the method of proceeding I have recommended be adopted, viz. the bleaching of the parts before they are placed in Canada balsam, I have no doubt many interesting varieties of these organs would be met with. The comparison of the habits of the insect with the structure of the antennal organs would afford a further confirmation of their nature. At the same time a comparison should be instituted between these organs and those I have before described in the base of the halteres and wings, especially with reference to their relation to the sense of smell.

I may add, that the magnifying powers required to show the structures in question best, are the $\frac{1}{4}$th and $\frac{1}{8}$th-inch objectives.

Note.—Since the reading of the above paper, I have seen (through the kindness of Mr. J. O. Westwood) a copy of the rare work of Erichson, "Dissertatio de Fabrica et Usu Antennarum in Insectis," 1847, in which he mentions the existence of "pores," which are shut by a thin membrane from the interior part of the antenna, and that their disposition varied in different insects; but their peculiar form in Ichneumons, Wasps, &c., also the sacs, cavities, and nerves proceeding to them, he has failed to notice.—J. B. H.

EXPLANATION OF THE PLATES.

(All the figures are magnified.)

TAB. XXIX.

Fig. 1. Antenna of the Blowfly, *Musca vomitoria*:—*a*, antenna, showing both the smaller organs and the chambers; *b* 1, the smaller organs, having a diameter of $\frac{1}{5000}$ of an inch; *b* 2, the apertures to the chambers, having a diameter of $\frac{1}{3000}$ to $\frac{1}{1420}$ of an inch; *c*, aperture of chambers; *c′*, ditto as seen focused lower down; *d*, section of wall of antenna, showing 1, the smaller organs, and 2, the chambers and their sacculi, the diameter of the largest being $\frac{1}{660}$ of an inch.

Fig. 2. Antenna of *Helophilus pendulus*:—*a*, antenna; *b* 1, the smaller organs, having a diameter of $\frac{1}{4700}$ of an inch; *c* 1, do. do.; *c* 2, apertures to chambers, diameter $\frac{1}{1500}$ of an inch; *c* 2^a, do. do. focused lower down; *c* 2^b, focused still lower; *d*, section showing the smaller organs at 1, and the chambers with their sacculi at 2.

Fig. 3. Antenna of *Tabanus bovinus*:—*a*, antenna, with the third to the eighth joints furnished with the organs; *b*, enlarged view of the organs of various sizes.

Fig. 4. *a*, Antenna of *Tipula oleracea*; *b*, antenna of *Ctenophora* ——?; *c*, antenna of *Ctenophora bimaculata*; *d*, section of organs; *d*, organs as seen from above, diameter $\frac{1}{2400}$ of an inch.

Fig. 5. Antenna of *Argynnis paphia*:—*a*, antenna showing the position of the organs; *b* 1, small closed perforations of various sizes, the smallest $\frac{1}{5000}$, the largest $\frac{1}{3000}$ of an inch; *b* 2, openings to cavities, from $\frac{1}{2300}$ to $\frac{1}{1500}$ of an inch; *c*, last joint of the antenna, showing the openings to the cavities; *d*, section of chambered cavities, with a projection or papilla in the centre of each.

TAB. XXX.

Fig. 6. *a*, Part of antenna of *Apis mellifica*; *a* 1, groups of organs; *a* 2, nerve giving off branches; *b*, view of organs, more highly magnified.

Fig. 7. *a*, One joint of antenna of *Eucera longicornis*; *b*, saucer-shaped depressions, diameter from edge to edge $\frac{1}{1120}$ of an inch; *c*, section of wall of antenna, showing sacs or cells beneath; *c* 1, membrane closing in the openings in internal membrane, diameter $\frac{1}{1700}$ of an inch.

Fig. 8. *a*, One joint of antenna of *Andrena fulva*; *b* 1, saucer-like depressions, with membrane in centre closing in the perforations; *b* 2, hairs; 1 and 2 are both surrounded by a ring of very minute tubercles; *c*, section of wall of antenna.

Fig 9. *a*, One joint of antenna of a species of *Ichneumon*; *b*, section of wall of antenna, showing the transparent membrane overarching and extending beyond the perforation of the internal wall; *c*, enlarged view of organs; membrane as seen from above, very transparent, stretching over like an inverted canoe; the opening beneath is the perforation of the internal membrane.

Fig. 10. *a*, Antenna of *Libellula depressa*, showing the 3rd to the 5th joints with organs placed on one side of the nerve; *b*, portion of wall of the 3rd joint; *b* 1, large sacs with plicated walls, closed externally by a delicate membrane; *b* 2, small simple sacs, also closed by membrane; *b* 3, nerve proceeding to sacs; *c*, sacs of 5th joint.

Fig. 11. *a*, Antenna of *Tetrix* ——?, showing about 100 sacs to each joint; *b*, enlarged view of two organs from above; *b* 1, central spot where the connexion with papilla takes place; *c*, profile view of sacs, closed from the external air by a membrane, the centre of which is in connexion with the papilla by means of the delicate line *c* 1.

Fig. 12. Antenna of *Melolontha vulgaris*:—*a*, enlarged view of surface from above; *b*, profile view of organs; *c*, a lamella showing the nerves. Diameter of cups about $\frac{1}{1100}$, of centre projection $\frac{1}{2700}$ of an inch.

Fig 1

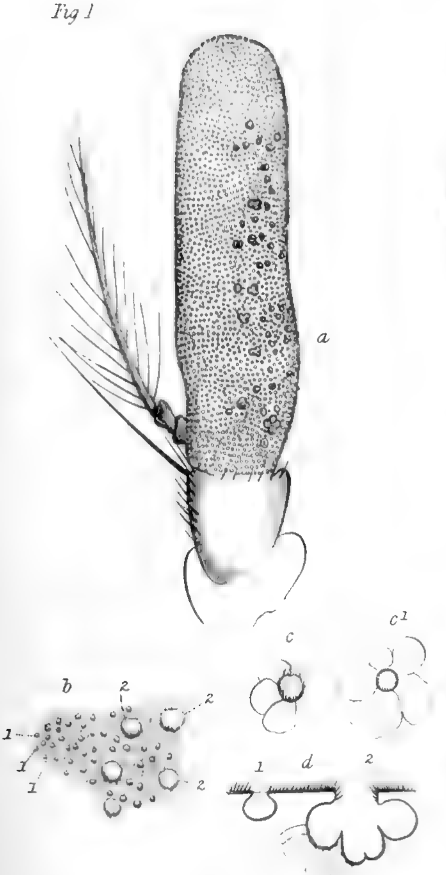
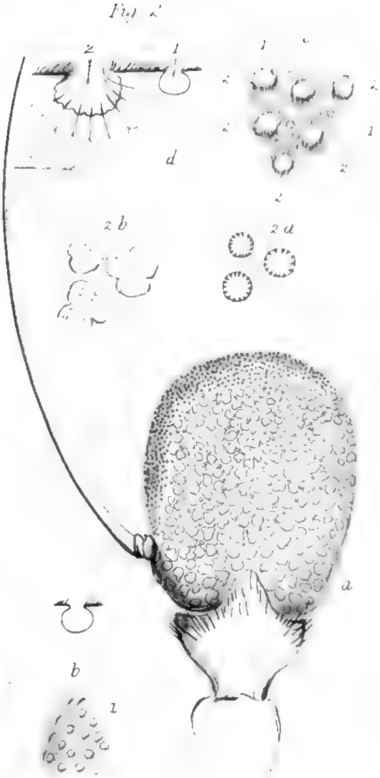


Fig 2



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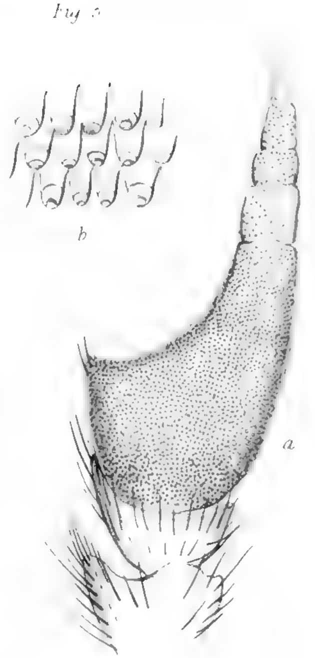

Fig 4

Fig 5

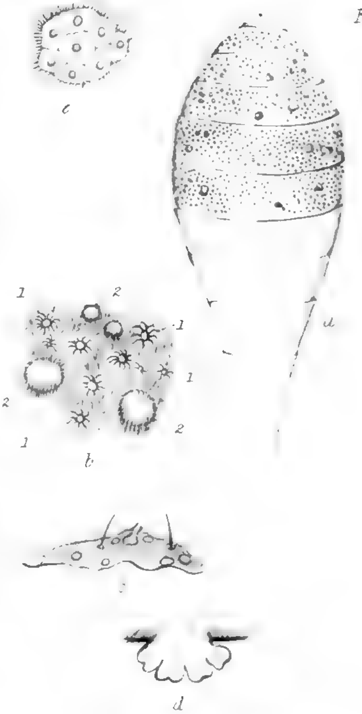

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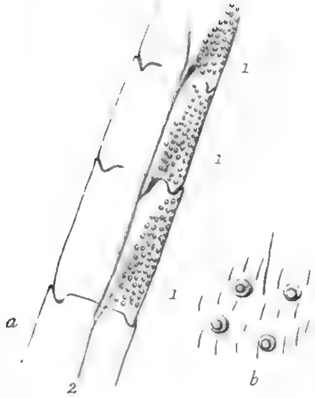
Fig 6



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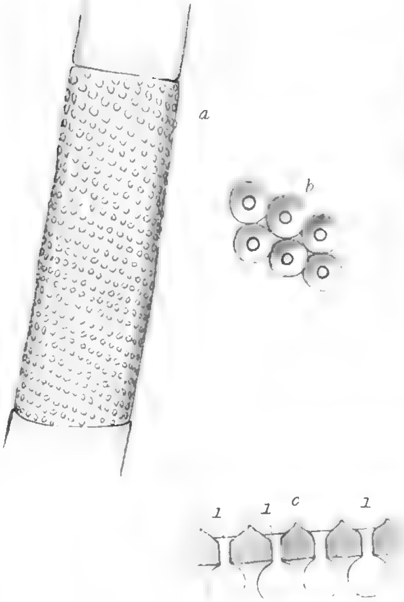

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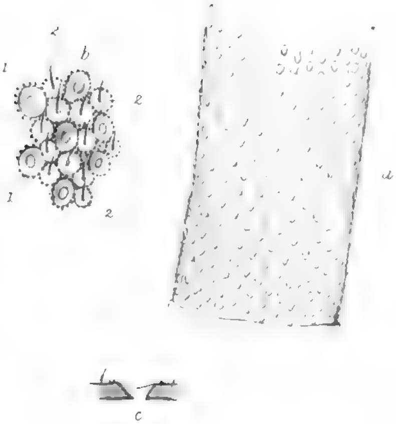

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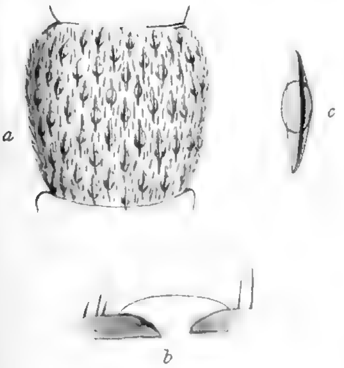

Fig 10

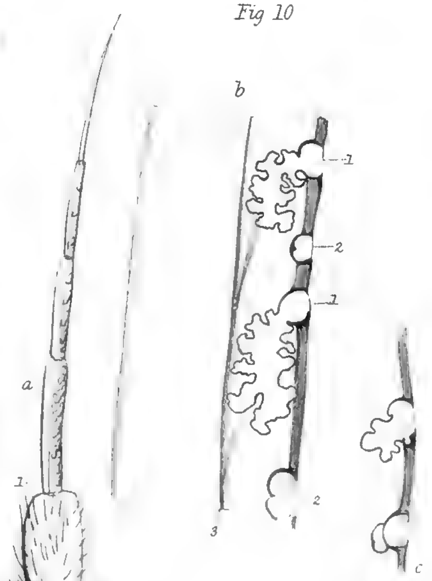

Fig. 11.

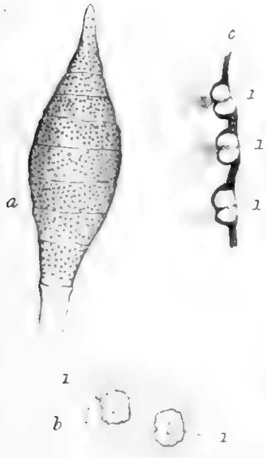

Fig 12

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THE

TRANSACTIONS

OF

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M.DCCC.LVIII.

CONTENTS.

PART III.—1858.

XII. *Observations on* Entozoa, *with notices of several new species, including an account of two experiments in regard to the breeding of* Tænia serrata *and* T. cucumerina.

By T. SPENCER COBBOLD, *M.D., F.L.S.*

Read December 3rd, 1857.

IN the month of February 1856, I commenced some experiments with the view of confirming the statements of continental helminthologists in regard to the development and habits of the cestoid Entozoa. Unforeseen circumstances prevented my carrying out these investigations to any great extent; nevertheless, as I have, during my past connexion with the Anatomical Museum of the University of Edinburgh, collected and examined numerous forms of Entozoa, I desire to lay before the Society the result of these casual searchings, at the same time offering an apology for the necessarily incomplete and fragmentary character of my remarks.

Excluding Man, the number of vertebrate species examined by me, with especial reference to the presence or absence of Entozoa, amounts to seventy, in forty-five of which worms were detected. This proportion, however, must not be regarded as a fair criterion of the frequency with which these higher orders of animals are infested; for although a great number of individuals—from twenty to forty—of the common species were examined, only one or sometimes two of the species more difficult to procure came under notice. In a statistical point of view, certain particulars in regard to the age of the animal, the time that had elapsed after death before it was examined, and other conditions materially lessening the chances of the detection of Entozoa, would have to be taken into consideration. The forty-five species found to contain worms may be arranged as follows:—

Common Stickleback, *Gasterosteus aculeatus.*
Fifteen-spined Stickleback, *G. spinachia.*
Minnow, *Leuciscus phoxinus.*
Rockling, *Motella quinquecirrata.*
Viviparous Blenny, *Zoarcus viviparus.*
Smooth Blenny, *Blennius pholis.*
Lucky Proach, *Cottus bubalis.*
Haddock, *Morrhua æglefinus.*
Coal-fish, *Merlangus carbonarius.*
Cod, *Morrhua vulgaris.*
Ling, *Lota molva.*
Holibut, *Hippoglossus vulgaris.*
Skate, *Raia batis.*
Pipe-fish, *Syngnathus acus.*
Angler, *Lophius piscatorius.*
Sun-fish, *Orthagoriscus mola.*
Sturgeon, *Acipenser sturio.*

Toad, *Bufo vulgaris.*
Frog, *Rana temporaria.*
Lesser Newt, *Lissotriton punctatus.*
Serpent, *Bothrops* ———?

Kite, *Falco milvus.*
Kestrel, *F. tinnunculus.*
Peregrine, *F. peregrinus.*
Sparrow-hawk, *Accipiter nisus.*
Honey Buzzard, *Pernis apivorus.*
Long-eared Owl, *Strix otus.*
Redshank, *Totanus calidris.*
Curlew, *Numenius arcuata.*
Grey Gull, *Larus glaucus.*
Kittiwake, *L. tridactylus.*
Guillemot, *Uria troile.*

Auk, *Alca torda.*
Red-throated Diver, *Colymbus septentrionalis.*
Golden Pheasant, *Phasianus pictus.*
Capercailzie, *Tetrao urogallus.*

Mouse, *Mus musculus.*
Cat, *Felis catus.*
Rabbit, *Lepus cuniculus.*
Dog, *Canis familiaris.*
Lion, *Felis leo.*
Ox, *Bos taurus.*
Sheep, *Ovis aries.*
Giraffe, *Camelopardalis giraffa.*
Porpoise, *Delphinus phocæna.*

In this list, notwithstanding the unfavourable circumstances above alluded to, I have found no less than sixty forms of Entozoa infesting forty-five vertebrate species; and there cannot be the slightest doubt, as subsequent observations will show, that this figure affords but a very low estimate of the liability of invasion to which these creatures are exposed. It is also worthy of remark, that out of those species in which Entozoa were not found, only one belonged to the fish tribe; whereas a very careful examination failed to detect any worms in several kinds of birds and mammals. Among those species not harbouring Entozoa, but in which their presence might have been anticipated, were the following:—Wild Duck, Swan, Woodpecker, Starling, Pheasant, Tawny Owl, large Water Newt, Water Rat, Squirrel, Stoat, Otter, Badger, Fox, and common Brown Bear.

Six or eight species of Entozoa have been described as inhabiting *Gasterosteus aculeatus*, but I have only met with three; namely the *Tænia filicollis* (Pl. XXXI. fig. 1); an imperfect specimen of cestoid worm corresponding in some respects with the *Schistocephalus dimorphus* of Creplin, and a small trematode presumed to be the *Monostoma caryophyllinum* in a very young state (figs. 2, 3). The head of *T. filicollis*, according to the descriptions of Dujardin and others, is simple, globular, unarmed with the usual proboscidiform retractile tubercle, and unprovided with lateral suckers. In those which have come under my notice, a very distinct proboscis was to be seen while the specimens remained fresh, but there was no indication of hooks; these may have fallen off. Four well-developed suckers surrounded the head, and the water-vascular canals were unusually conspicuous throughout the entire segmental series. In an adult individual, these tubes, four in number, terminated superiorly so close to the cup-shaped *bothria*, that it was difficult to divest oneself of the notion that they communicated with the latter.

After a fruitless search for Entozoa in many specimens of *Gasterosteus spinachia*, one example at last yielded an extremely minute trematode (figs. 4, 5), enclosed in a cyst of cellular tissue and attached to the subperitoneal surface of one of the ovaries. While under microscopic examination it was accidentally swept off the slide, but an outline of its structure has been preserved. A feature in this specimen consists in the presence of an unusually large ventral appendage, the free extremity of which is bifid and each division apparently perforated. The hermaphroditic signification of this organ is evident; but the circumstance of the ends of the male and female reproductive tubes being thus greatly extended, may in some measure be regarded as accidental. Traces of a bifurcate stomach were plainly discernible, the canals being slightly sinuous. As I am unable to refer this worm to any known species, I recognize it provisionally under the signification of *Monostoma dubium.*

In *Motella quinquecirrata*—the *Gadus mustela* of Linnæus—Rudolphi mentions the occurrence of a cestoid entozoon. This species of *Bothriocephalus* I have not seen; but in a specimen of the above-named fish its place was supplied, as it were, by two other worms—the *Distoma fulvum* (figs. 6, 7, 8), hitherto observed in the Ling and *Gadus mediterraneus*, and the common *Filaria piscium*, which is especially abundant in the Cod-tribe. So far as I am aware, the *Distoma fulvum* has not yet been figured under that name, but after a careful investigation I am satisfied that it is identical with the *D. simplex* of Rudolphi and *Fasciola Bramæ* of Müller*. Dujardin, after giving the specific characters of *D. simplex*, appends an account of two unnamed trematodes which he found in a specimen of *Gadus quinquecirratus* from the coast of Brittany; these also appear to me to be one and the same species, and I think he would have been justified in considering them as merely altered forms of *D. simplex* or *D. fulvum*. Dujardin moreover makes *D. simplex* synonymous with the *Fasciola Æglefini* of Müller and the *D. Wachniæ*, first described by Tilesius†. After consulting the figures and descriptions of these authors, I consider *D. Wachniæ* to be the original representative both of *D. simplex* and *D. fulvum*, but I believe *F. Æglefini* may be properly regarded as a distinct species. The living specimens of *D. fulvum* examined by me alternately elongated and contracted themselves very vigorously, thus varying the length of the body between the twelfth and fortieth part of an inch. In this way the neck sometimes became extremely attenuated, contrasting strongly with the large and prominent ventral sucker. Under a half-inch lens, the largest specimen, as now preserved, exhibits the intromittent organ everted and the convoluted uterine tube crowded with ova.

The only entozoon I have observed in the viviparous Blenny is a single specimen of *Ascaris aucta*, R. It was coiled in a cyst beneath the peritoneal surface of the liver, the gland being otherwise diseased. In an example of *Blennius pholis*, four specimens of *Echinorhynchus tereticollis*, R., were obtained from the intestine, in different stages of development. The largest exhibited a bulging of the cuticle near the middle of the body, probably the result of injury.

Cottus bubalis.—Several were examined and only one found infested—*that* by a single tape-worm, which occupied the intestine immediately below the pancreatic cæca. This entozoon, long known to inhabit *Cottus scorpius*, and by Müller termed *Tænia Scorpii*, has been more fully described by Leuckart, Eschricht, and Van Beneden, under the better title of *Bothriocephalus punctatus*. The extreme transparency of this worm, when alive, produced, during its active movements, very puzzling appearances, and had I not previously entertained the persuasion that all tape-worms were destitute of a true digestive tube and buccal cavity, I should have felt entitled to affirm, that this species at least was provided with a continuous alimentary canal. The anterior cephalic segment, while extended, greatly exceeded in length each of the ten or twelve succeeding segments, and when contracted appeared rather broader. Müller's figure gives an idea of considerable disparity in this respect, but in other particulars the specific resemblances were at once recognized. Toward the lower part of the so-called neck, the joints exhibited at the lateral margins indications of division, which became gradually more defined towards the tail.

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* Zoologia Danica, tom. i. p. 33. pl. 30. fig. 6.

† Mém. de l'Acad. des Sciences de St. Pétersb. tom. ii. p. 363. tab. 19. figs. 8–10.

In the Haddock and others of the Cod-family we meet with many kinds of Entozoa and the worms found in one species seem liable to occur in all members of the group. Most of the *Trematoda* infesting fishes are exceedingly minute, and it is absolutely necessary for their identification that specific descriptions should be accompanied with accurate figures. I am led to this remark from the difficulty of making out the identity of a Distoma found associated with *Echinorhynchus acus*, R., and *Bothriocephalus rugosus*, R., in the intestine of a Haddock. The trematode in question agrees in some respects with *D. scabrum* and *D. appendiculatum*, especially the latter, but differs in a few essentials; moreover, *D. appendiculatum* is not mentioned as infesting the Gadidæ. Provisionally therefore I propose to regard it as a distinct species, and shall briefly describe it under the title of *D. rachion* (ῥαχιαῖος), as follows (figs. 9, 10):—Body of a faint pink colour; length 3 lines; flat, covered with minute spines; obtuse at either extremity; posterior half of the body rather broader than the front; oral sucker large, not quite terminal; ventral sucker comparatively small, near the centre of the body; œsophagus narrow, twisted, bifurcating immediately above the ventral sucker; gastric canals very capacious; genital pore large and conspicuous; internal seminal vesicle, uterine tube, ovary, testes, and contractile vesicle particularly distinct. Some other details in regard to the structure of this trematode will be found indicated in the explanation of the accompanying figures. In regard to *Bothriocephalus rugosus* I have only to observe, that in consequence of the head being found in all instances firmly rooted within one of the pancreatic cæca, it was impossible to ascertain the precise form of the cephalic segment. Dujardin remarks the same peculiarity in specimens obtained by him from *Gadus pollachius* and *G. merlucius*. The single Echinorhynchus, obtained from the same Haddock, exhibited when alive an organ lying near the proboscideal sheath—the so-called lemniscus, concerning the use of which we are still ignorant. In common with others, I have observed, in another acanthocephalous species, two of these organs, one on each side of the sheath. They have no connexion with the retractor muscles; but the latter, in the example under consideration, could not be recognized through the semi-opake integument. A Haddock examined by me on the 8th of May, 1854, contained, in addition to two specimens of the above-mentioned Bothriocephalus, several small cysts enclosing *Filariæ*, and a larger solitary cyst occupied by a *Tetrarhynchus* (figs. 11 to 19 inclusive). These require a passing notice. The minute sacs were imbedded in the submucous tissue of the alimentary canal, and scarcely exceeded half a line in breadth. The single large cyst, situated beneath the peritoneum outside the intestine, measured about a quarter of an inch long, and one-eighth of an inch broad. It was oval, semitransparent throughout, and on division of the peritoneal investment, easily removed. When detached, the fibro-cellular investing capsule or ectocyst offered a pyriform outline, and from its narrow extremity there proceeded a stalk-like prolongation. The ectocyst on being torn open disclosed the tetrarhynchoïd *Scolex*, the head and body of which were invaginated, but became readily evolved by gentle pressure applied to the bulky caudal vesicle or endocyst. Amplified forty diameters, the internal structures were well seen, the proboscidiform tentacula and "sclerous particles" being especially conspicuous. I have here, with due consideration, applied the term "sclerous" to the subcutaneous corpuscles so abundant in the caudal vesicle, in order to signify my adhesion to the view of Siebold and others as to their earthy nature. Helminthologists express various opinions in regard to their structure and function. All the older writers speak of them as "ova;" whilst other, more recent observers, following Eschricht, ascribe to them a nutritive function. The late Prof. William Smith of Cork apparently adhered to this latter view, for in his interesting paper on "Measled Pork," he designates these corpuscles "assimilating cellules*," whilst the distinguished Belgian entozoologist, Prof. Van Beneden, attributes to them a still higher organization, calling them cutaneous glands†. The ordinary cellules of the parenchyma were found to be comparatively small, requiring the aid of a quarter-inch lens for their satisfactory definition. The epidermic cells showed in profile very fine markings, indicating a columnar epithelium; and immediately beneath the corium there were outlines of anastomosing tubes, which appeared to represent a water-vascular system. The armature of the retractile proboscides is rather complicated; each proboscis being made up of numerous segments, and every joint supporting quadruple rows of four hooks, sixteen in all; the superior set being disproportionately large.

Having thus cursorily alluded to five different forms of Entozoa infesting the Haddock, I pass to the consideration of worms found in the Coal-fish, common Cod, and Ling.

Merlangus carbonarius. Morrhua vulgaris.—Numerous examples of *Ascaris clavata* (R.) occupied the intestinal canal of one individual. No other species of Entozoa were detected in the limited number of specimens examined. In a Cod examined on the 15th of March, 1855, two specimens of *Bothriocephalus rugosus* had severally attained a length of nearly fifteen inches, and their anterior segments, for an inch or more downwards, were so firmly impacted within the pancreatic cæca, that it was found impossible to dislodge them without injuring the filamentary head and neck. As if to make the anchorage doubly secure, the cartilaginoid thickening of the invaded pancreatic cæcum had degenerated into a calcareous and contracted cylinder, twisted upon itself in various ways.

Lota molva.—On the 31st of March, 1855, two kinds of nematoid worms, differing in relative size, were obtained from the intestinal tube. The smaller species, about half an inch in length, may be referred to an entozoon described by authors under a variety of names. It is the *Cucullanus marinus* of Zeder and Müller, the *C. foveolatus* of Rudolphi, and the *Dachnitis globosa* of Dujardin (figs. 20–23). The vaginal orifice of the female is situated near the middle of the body, being protected by two prominent folds of integument. The spicules of the male, two in number, are sabre-shaped, and there is a spacious sucker-like depression in front of the anal opening. The larger round-worms

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[*] Microscopical Journal, vol. v., description of pl. 2.

[†] Recherches sur les Vers cestoides, p. 23:—"ils consistent dans de courts cæcums légèrement ramifiés, et sécrètent un mucus destiné à lubrifier la surface du corps."

Since the above was written, a paper by M. E. Claparède has appeared in Siebold and Kölliker's Zeitsch. f. Wissensch. Zoologie, vol. ix. p. 99, on the subject of the calcareous corpuscles of the Trematoda, in which it is shown that these bodies are lodged in the dilated extremities of branches of the so-termed "water-vascular" or excretory system of vessels. This interesting fact seems to have been demonstrated to the satisfaction of Joh. Müller, Virchow, Lachmann, and others, and to have been previously known to, though not published by, Dr. G. Wagener. And with respect to it, it may be remarked that so far back as 1830, Laurer pointed out that the ultimate branches of this system of vessels terminated in minute vesicular dilatations in *Amphistomum conicum*, although a similar condition could not be detected by Nordmann in *Diplostomum volvens*.

above mentioned cannot, so far as I know, be satisfactorily referred to any species of *Ascaris* or other nematode at present described; and although unwilling to multiply species in a group of Entozoa already extended numerically far beyond the proper limits, there is in the present instance no alternative. *Ascaris acanthocaudata* (mihi) may be identified as follows:—Body 10 to 15 lines long, half a line broad; diameter slightly increased toward the head, suddenly narrowed at the tail; mouth trilobular; caudal extremity *armed with several minute spines* (figs. 24–26). A preserved specimen in my collection exhibits the transverse and longitudinal muscular layers with unusual clearness; but the most interesting structure, which can be seen with a half-inch lens, and its minute tissues with a quarter-inch objective, consists of a broad double band of partially disintegrated cellules, extending from head to tail on the under side of the body. The centre of this band is occupied by a well-defined canal apparently containing a delicate white thread. It does not give off any branches, but terminates superiorly in an abrupt manner immediately below the trilobular mouth. From this point there is a faint appearance of radiating lines towards the margin of the lobes, but I cannot positively say that they are nervous filaments. Notwithstanding this doubt, I am confident that the long-entertained opinions of Otto and Siebold, in regard to the existence of a nervous cord in the Nematoidea, are correct.

Hippoglossus vulgaris.—A specimen dissected on the 4th of May, 1854, yielded two forms of thread-worm—*Filaria piscium* and *Ascaris collaris**. Examples of the former were coiled within the mesenteric folds, while the latter were chiefly enclosed in cysts, in and upon the mucous membrane of the intestine. A fully-developed *Ascaris collaris* (Pl. XXXII. fig. 27) presented the following characters—here given on account of certain difficulties in the way of identification:—Body an inch in length, comparatively thick; head obtuse, trilobular valves of the mouth very small; œsophagus narrow, communicating with a broad intestine, bounded on either side by two slender cæcal appendages of unequal length and vesicular at the free ends†; caudal extremity rounded, rather narrower than the head; anal orifice in front, not far distant. In addition to these nematodes, the intestine contained numerous specimens of *Scolex polymorphus*, and there was also a minute trematode enclosed in a capsule beneath the peritoneal membrane. The anatomy of various Scolex-forms has been beautifully illustrated by Prof. Van Beneden and Wagener‡; nevertheless I remark upon one or two particulars in passing. In this Scolex (figs. 28, 29) the simple structure of the sclerous particles formerly alluded to is most satisfactorily seen, and it is difficult to understand why such discrepancy of opinion should prevail in regard to their nature. Siebold long ago recognized their dermo-skeletal character. The four presumed water-vascular canals take their origin by two single trunks, one on each side of the lower part of the proboscidiform sucker; there is no appearance of intercommunication, however, between them and the cavity of the cup. The encysted trematode corresponds in many respects with the *Fasciola Platessæ* of Müller, answering more closely, however, to the *Distoma atomon* found by Rudolphi in *Pleuronectes flesus*

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* According to Miescher, Steenstrup, Wagener, &c., the *Filariæ* are only young Nematoidea.

† In *Cheiracanthus robustus,* Diesing remarks the presence of four similar lemnisciform bodies.

‡ Die Entwickelung der Cestoden, &c. 1854.

(figs. 30–32). It is not unlikely that these are one and the same species, seeing that the principal difference, according to Dujardin, consists in the colour of the body and in the relative size of the ventral sucker. A living Distoma varies much in form during contraction, and the same worm will present appearances when preserved very unlike those seen when it was fresh. I have found this to be the case especially in the entozoon under consideration, the ventral sucker presenting, during life, a most unusual breadth. The oral sucker was comparatively small; the simple gastric cæca, uterine tubes and contractile vesicle being severally large and conspicuous.

Raia batis. Syngnathus acus.—Of Entozoa infesting the former, I have only to notice the extreme abundance of *Bothriocephalus coronatus* (R.) occupying the chambers of the spiral intestine. Under an amplification of 400 diameters, the advanced ova exhibit a well-developed Scolex, provided with rudimentary hooklets and sclerous particles. In the common Pipe-fish I have found several specimens of *Filaria piscium.*

Lophius piscatorius.—The voracious habits of the Angler guarantee the presence of a variety of worms, and, with the exception of *Orthagoriscus*, no fish is perhaps more copiously infested. A specimen, dissected May 12, 1854, yielded three species of Entozoa, namely *Ascaris rigida*, *Scolex polymorphus*, and *Distoma gracilescens.* Most of the nematode individuals were imbedded in folds of the peritoneum and mesentery, the other kinds occupying the intestinal canal. Published descriptions of *Distoma gracilescens* (figs. 33–37 inclusive) being few and imperfect, I offer the following notice of its more obvious characters:—Body of a pale brown colour, semitransparent, one-sixth of an inch long, flat, linear, beset all over with minute tubercular spines, those about the head being more cogently developed; anterior half somewhat narrower than the posterior; oral sucker oval, not quite terminal; ventral sucker circular; sheath of the penis large, and placed immediately below the ventral cup; uterine tube broad and tortuous, occupying the inferior half of the body; vitelline organs consisting of two elongated, botryoidal masses, commencing a little below the oral sucker and passing down on either side of the neck; testes bulky, transparent, placed toward the lower and back part; in front of these, two smaller vesicular bodies, corresponding to the ovary and seminal vesicle; contractile vesicle very large, with thick muscular walls.

Orthagoriscus mola.—I have dissected, in its entirety, but one specimen of this remarkable fish. It was a very young individual, and was captured off Anstruther, on the coast of Fife, September 6, 1856*. There were no Entozoa in the intestinal canal, but the liver and retractor muscles of the anal fin contained several examples of the *Gymnorhynchus reptans* of Rudolphi (figs. 38–46 inclusive). Professor Goodsir has given an accurate description of this cestode in the Edinburgh New Philosophical Journal for 1841, under the title of *G. horridus*, regarding it as a new species. If I may be allowed to differ, I do not think the circumstance of Bremser's having omitted to notice the two lowermost rows of exaggerated hooks on the proboscis, or his non-observance of the jointed condition of the body, as sufficient evidence that these characters were not present in his *G. reptans.*

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* Its dimensions were as follows:—Length from head to tail, 18 inches; between tips of dorsal and anal fins, 26 inches; greatest depth of the body, 12 inches; length of pectoral fins, 2 inches and a half; width of the gill-aperture, 1 inch. Two or three other individuals were taken a few weeks previously in the Firth of Forth.

It requires considerable enlargement and a good lens to render the comparatively large size of the hooks obvious, and the articulations of the body are but very faintly indicated toward the anterior part of the animal. Notwithstanding the fish in question had been dead several days and cast aside as refuse by the salesman of whom it was purchased, the Entozoa coiled within the muscles were alive, and on being removed to a tumbler of sea-water, they continued to live until the third day following, when they were placed in spirit. During the active movement of contraction and elongation, the proboscidiform tentacula were freely protruded and withdrawn. It was difficult to ascertain the exact number of hooklets upon these processes. I think every circular row carries sixteen, and there are about one hundred of these rings of hooklets on each proboscis; if this estimate be correct, the total number of hooklets is 6400. The form of the proboscis is clavate, and its free extremity more or less rounded; in relative size the hooklets are tolerably uniform, those towards the tip being rather larger; the two lowermost rows of the series are very highly developed.

Acipenser sturio.—On the 25th of April, 1855, I obtained a great many examples of *Dachnitis sphærocephala* of Dujardin (Pl. XXXIII. fig. 51) and *Distoma hispidum* (Abildgaard) from the spiral intestine. Contrary to the statements of Creplin, I find the hooks surrounding the head of the latter remarkably conspicuous and disposed in two rows, fourteen in each. I think it would be preferable to place this species in the subgenus *Echinostoma*. (Pl. XXXII. figs. 47, 48; Pl. XXXIII. figs. 49, 50.) Dujardin retained it among the true Distomata with hesitation. The integumentary spines in front are prominent, and directed outwards with a slight inclination backwards; those below the ventral sucker become gradually smaller, and finally degenerate into mere tubercles at the posterior extremity.

Rana temporaria.—From different individuals I have obtained *Filaria rubella* (?), *Ascaris nigro-venosa*, *A. acuminata*, *Oxyuris ornata*, *Distoma cylindraceum*, *D. clavigerum* (figs. 52, 53), and *Polystoma integerrimum*, the latter being fully half an inch in length*.

Bufo vulgaris.—With reference to parasites, I have only examined one or two examples of the common Toad, and in the intestine of an individual dissected on the 20th of April, 1855, found a single specimen of *Ascaris acuminata* associated with numerous small flukes. These trematodes are fully as large as the *Distoma cygnoides*, frequently infesting the urinary bladder of the Frog; nevertheless they may probably be referred to a smaller species—the *D. clavigerum* of Rudolphi, their length varying from one to two lines and a half. The vitelline ducts, the uterine canal with its crowded ova, and the long intromittent organ, are readily distinguishable in preserved specimens.

Lissotriton punctatus.—I here wish to call attention to a striking illustration of the predilection for a particular species which certain Entozoa exhibit in selecting their habitation. A careful dissection of some thirty or forty Water-newts—consisting of our two most common species, the large black and the lesser speckled Salamanders in nearly equal proportions—has shown, that while in almost every instance worms were present

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* The anatomy and development of these and other forms of Frog's flukes have recently been illustrated by Dr. H. A. Pagenstecher in his attractive monograph, entitled "Trematodenlarven und Trematoden," Heidelberg, 1857. Also in Dr. Wagener's "Entwickelungsgeschichte von *Distoma cygnoides*."

in *Lissotriton punctatus*, not a single entozoon of any kind could be obtained from *Triton cristatus*; a fact rendered more significant inasmuch as the specimens were all obtained from the same locality, namely from ponds at the summit of the Braid Hills near Edinburgh. In the stomach of one of the large species there was a small trematode-like body, but on microscopic examination it proved to be a young horse-leech. From specimens of the lesser Newt, procured at intervals during the months of April, May and June, 1855, there were obtained in the first place numerous examples of *Ascaris acuminata*, the presence of which was by no means invariable; secondly, an abundance of *Echinorhynchus anthuris*; thirdly, multitudes of *Opalina intestinalis*, a ciliated infusorial animalcule believed by Agassiz to be in reality only a larval planarian; and fourthly, a considerable number of *Trichodinæ*. The first three groups were found in the stomach and duodenal portion of the intestinal canal; the fourth occupying the cloaca and ducts in its immediate neighbourhood. The only remark I have to offer respecting *Ascaris acuminata* has reference to its size, which is variously estimated by different authors; my specimens average about 8 lines in length, which accords with Mr. Bellingham's statement in his Catalogue of Irish Entozoa. This leads me further to observe, concerning the definition of species, that much unnecessary stress is laid upon the relative size of individuals, bulk alone, it would appear, being frequently regarded as a criterion of specific distinction. In very many instances at any rate it cannot be denied that this is the case. I believe the error is so prevalent in the older lists, that for every new species now added, two old ones might with propriety be expunged. In the present communication, it is not my intention to show how the truth of this assertion may be sustained by an appeal to facts; nevertheless, if it were desired, sufficient illustration might be afforded from the materials in hand. The second group, represented by *Echinorhynchus anthuris* (figs. 54–62 inclusive), deserves attention, forming as that species does, on account of its small size and extreme transparency, an excellent subject for microscopic investigation; but a minute description is not needed, in consequence of the admirable manner in which it was originally described by its discoverer, M. Dujardin. General details being given in the description of the figures, attention in this place is only invited to a brief notice of the peculiar ova. These characteristic bodies in their early state are perfectly round, appearing simply as nucleated cellules in the interior of the so-called ovaries, which are also spherical, and float loose in the cavity of the body; the nucleus may be taken to represent the germinal vesicle, but it cannot be recognized in the fully developed ovum. In this latter condition each ovum encloses a perfectly transparent cell, lobed at both ends after the fashion of *Trichina*, and an irregular but very distinctly granular yelk-like mass; these are placed side by side; and from the granular body proceeds at either end a coiled thread or chalaza advancing to the extremity of the external envelope and becoming blended with it; the wall of the transparent cell exhibits in profile very delicate undulations. In regard to the infusorial *Trichodinæ*, which may yet turn out to be larval forms of some higher group, I have only to observe that some were in the encysted condition.

Bothrops.—For an opportunity of dissecting a species of this genus I am indebted to Mr. Edwards, Demonstrator of Anatomy in the University of Edinburgh. Several examples of *Pentastoma proboscideum* occupied the mesenteric folds, but with reference to their structure I am unable to add any new or otherwise interesting facts.

Passing to the consideration of Entozoa in birds and mammals, my remarks under the former head will be very short, as they are designed to indicate little more than a record of worms found in particular species.

Falco milvus.—In the duodenum of a Kite opened on the 16th April, 1855, there were present five or six specimens of *Ascaris depressa*, several examples of *Trichosoma Falconum*, and multitudes of *Hemistomum spathula* (Diesing). The latter—better known as the *Amphistoma macrocephalum* of Rudolphi—presented a bright grass-green colour, owing to the quantity of bile in the intestine. Outside the gut there was a minute botryoidal fatty mass, consisting of four unequal lobules united together and attached by two filamentary stalks; each of these lobes contained an encysted nematode.

Falco tinnunculus; *F. peregrinus*; *Accipiter nisus*; *Pernis apivorus*; *Strix otus.*—Specimens of *Ascaris depressa* were obtained from a Kestrel on the 21st of January, 1856, and being very numerous they completely choked that part of the intestine in which they were lodged; a solitary individual was also procured from the duodenum of a Honey Buzzard on the 30th of May of the previous year. From the cellular aponeurosis at the back of the abdominal cavity of a Peregrine, I also obtained in April of the same year a single specimen of *Filaria attenuata*, measuring nearly 10½ inches; and from the stomach of a Sparrow Hawk dissected in January 1856, an example of *Spiroptera leptoptera*. This last entozoon I have also found associated with *Hemistomum spathula* in the small intestine of the Long-eared Owl in the month of January.

Totanus calidris; *Numenius arcuata.*—I have taken *Tænia variabilis* from the small intestine of the former of these allied species in January, and also *T. sphærophora* (figs. 63–67 inclusive) from the Curlew at the same period in great abundance, the latter entozoon being situated midway between the gizzard and cloaca. As this cestode is only imperfectly known, some additional facts in regard to it may prove acceptable. The head is correctly described by Diesing as obcordate, but no mention is made of the armature of hooks surrounding the *rostellum*; this is not to be wondered at, considering the facility with which they drop off after death, or during life, on even the most gentle handling. One cannot judge how many it carries from the number found in the *proscoleces*, where there appear to be six hooks arranged as usual in three pairs on the proboscis; and in no case have I seen the adult cestode with its full complement. The anterior segments are extremely narrow, but well defined immediately below the head, the sucker-bearing and proboscideal divisions appearing to represent very distinctly two rings of the segmental series, or in other words, the first two modified individuals of the colony, if we can suppose with Van Beneden each *proglottis* to represent an independent animal. The middle and succeeding segments become gradually broader and deeper toward the caudal extremity, the lateral margins showing a bilobular outline; the intromittent organs are placed consecutively on one side only, their bulk being comparatively large; and the external wall of the sheaths is closely beset with minute spines directed backwards when the organs are protruded. The segments near the tail seemed ready to burst from the volume of the contained ova, most of which latter, when withdrawn and examined separately, displayed internally that advanced condition of the embryo termed *proscolex* by Van Beneden.

Larus glaucus; *L. tridactylus*; *Uria troile*; *Alca torda*; *Colymbus septentrionalis.*—In the months of December and January, 1854–55, I obtained from the common Grey Gull abundance of *Tetrabothrium cylindraceum* (the *Bothriocephalus macrocephalus* of Dujardin) and *Echinostomum spinulosum.* The latter (figs. 68–72) is usually described as a *Distoma,* but ought certainly to be generically separated. I find the disc surrounding the head capable of being elevated so as to form a kind of hood; and the hooks being connected together by an extension of the integument, the coronet resembles the fin of a fish. The vitelline organs have a peculiar zigzag conformation, the cæca alternating in parallel rows. In the small intestine of the Kittiwake I have also constantly found *Tetrabothrium cylindraceum,* and from the same situation in the Red-throated Diver quantities of *T. macrocephalum,* which Diesing—correctly, I think—regards as distinct from the former. From the œsophagus and proventriculus of the Auk and common Guillemot I have procured, during spring, numerous examples of *Ascaris spiculigera*; one dissection in the case of *Uria troile* exposing two of these nematodes lodged in the auricle of the heart. The intestines of another specimen of this bird contained several individuals of a cestode, which has been vaguely indicated by Abildgaard under the title of *Tænia Colymbi Troiles*; I have not been able to satisfy myself, however, that this species is distinct from *Tetrabothrium macrocephalum.*

Phasianus pictus; *Tetrao urogallus.*—Both cæca of a Gold Pheasant, dissected on the 7th of January, 1856, were found enlarged to three or four times their natural width, owing to the presence of a multitude of dark-coloured tubercles, about the size of peas, the interior of each of which contained a coiled nematode, the *Ascaris vesicularis* of Frölich. From the intestine of a Capercailzie, examined in the spring of the previous year, were procured numerous specimens of *Trichosoma longicolle*; and also from the subcutaneous areolar tissue overlying the great pectoral muscle, a solitary entozoon resembling *Ligula reptans.*

Mus musculus; *Felis catus.*—Fresh experiments are not required to determine the now well-established fact in regard to the *Cysticercus fasciolaris* of the Mouse being the imperfectly developed *Tænia crassicollis* of the Cat; indeed, long before their actual identity was demonstrated, the frequent occurrence of a cestoid condition of the Scolex within the liver suggested an hypothesis which has since proved correct. In my collection there is a specimen of this helminth in the tænioid condition taken from the liver of a White Mouse, which is nearly as long as that figured by Bremser. Such examples are by no means uncommon. In addition to *Ascaris mystax* and *Dochmius tubæformis,* the only other worm I have seen in the domestic Cat is the *Tænia elliptica,* but, like Dujardin, I have been unable to obtain its head.

Lepus cuniculus; *Canis familiaris.*—The experimental researches of Von Siebold, Küchenmeister, Leuckart, and other continental helminthologists, have sufficiently established a mutual relation between *Cysticercus pisiformis* and *Tænia serrata,* hereby affording an additional instance of the truth of Steenstrup's law of alternate generation. I am not aware if any entozoologist in this country has attempted to repeat their experiments, and I therefore regret that circumstances have prevented my carrying out more fully an intention of verifying some of those particulars which have recently attracted our notice. Two of a few experiments, however, having been completed and attended with partially satisfactory results, I take this opportunity of placing them on record:—

On the 5th of February, 1856, I administered to a Dog three minute *Cysticerci*, obtained from the fresh livers of two wild Rabbits. These cysts were perfectly round and measured only the twelfth of an inch in diameter, and were evidently not to be referred to the common *C. pisiformis*. A fortnight after (19th) six similar cysts were obtained from the liver of another wild Rabbit and given to the same Dog. Ten days subsequently the canine animal was destroyed by chloroform, when, on laying open the small intestines, six specimens of *Tænia cucumerina* were detected. Three of these individuals were severally about 12 inches in length, the others measuring only 3 inches. Thus far, therefore, but for the circumstance of three of the nine cysts administered being undeveloped or lost, no doubt whatever could be entertained as to the complete success of this experiment. As it is, we have the interesting result of three nearly completely developed tape-worms, the growth and number of which exactly correspond with the circumstances that apparently led to their presence in the viscera of the Dog; and in addition we have three other individuals, only one-fourth of the bulk of the former, which may legitimately be regarded as the partially developed representatives of three of the six *Cysticerci* that were subsequently administered. It would appear, in consequence of the *C. pisiformis* being frequently present in the liver of the Rabbit, as well as in the mesentery, that our minute Cysticercus has not hitherto been recognized as distinct; at least, I find no notice of it in foreign works, and shall therefore in future speak of it as *C. cucumerinus*. In order to impart additional value to the above experiment, a young tame Rabbit was next procured, and the three larger Tænias (whose caudal proglottides contained multitudes of imperfectly formed ova) were given to it, the living worms being greedily devoured with portions of a cabbage-leaf. Eleven days after, the Rabbit was destroyed, and the liver found to contain numerous minute cysts corresponding to those of *C. cucumerinus*, the great omentum likewise containing four specimens of *C. pisiformis*. No inference of any value can be deduced from the presence of both kinds of *Cysticerci* in this case, for they are almost always present in tame Rabbits, young or old, whether they have eaten tape-worms or not. On the same day, 11th March, portions of the liver were given to a young Dog, and on the 17th many examples of *C. pisiformis* from the omentum of another tame Rabbit were given to the same animal. Two or three days before the second worm-feeding, this dog had commenced ejecting its ordinary food, and I have no doubt that by far the greater part of the more recently introduced worm-feedings shared the same fate. This throwing up of the stomachal contents was followed by total abstinence; and as the dog appeared weak, it was accordingly destroyed on the 20th, thus allowing only three days for the development of any pisiform *Cysticerci* that might chance to be retained, and but nine days for the small liver-cysts. The result was as follows:—Seven tape-worms were present in the intestine; of these, four were specimens of *Tænia cucumerina*, varying from 3 to 10 inches in length, and the remaining three were examples of *T. serrata*, the segmentation of which was scarcely manifested, the longest individual measuring less than an inch. On the whole, therefore, it is reasonable to conclude that the latter experiment confirms the statements of Leuckart and others as to *C. pisiformis* being the young of *T. serrata*, whilst both experiments satisfactorily demonstrate the breeding of *T. cucumerina* from a minute Cysticercus, probably hitherto unnoticed (figs. 73–79)*.

The other species of Entozoa casually observed by me in *Lepus cuniculus* and *Canis familiaris*, are *Fasciola hepatica* and *Oxyuris ambigua* in the former, and *Ascaris marginata* in the latter.

Felis leo; *Bos taurus*; *Ovis aries*; *Camelopardalis giraffa*.—From a partial examination of the viscera of two Lions, the only entozoon detected was *Ascaris leptoptera*. I have carefully dissected specimens of *Fasciola hepatica* and *Cœnurus cerebralis*, but have no new facts to offer in respect of their organization or development. From a Giraffe I have obtained two forms of Cercariæ and numerous specimens of a very large fluke (*Fasciola gigantica*, mihi), details of which with coloured figures have already been published†.

Delphinus phocæna.—I have dissected, either in whole or in part, several individuals without detecting Entozoa; but from a specimen shot in the Firth of Forth, and kindly forwarded to me by J. Jardine Murray, Esq., in the month of April 1855, several interesting forms were obtained. The pulmonary vessels, both arteries and veins, and likewise the smaller bronchial ramifications on the left side of the thorax more especially, were extensively occupied by two species of *Strongylus*, or in other words, by the *Prosthecosacter inflexus* and *convolutus* of Diesing; two examples of the former being likewise found in the ventricles of the heart. The small intestine of this Porpoise was completely choked for the space of 8 or 9 feet by five very large tape-worms so closely impacted together that the gut presented all the appearance and firmness of a solid cylinder. Four of the worms measured severally between 7 and 10 feet in length, and the fifth about 18 inches. This worm constitutes a fresh addition to our sterelminthoid fauna. Accepting Prof. Van Beneden's classification of the cestoid Entozoa, the name now proposed will place this new genus between his diphylloid *Echinobothrium* and the pseudophylloid *Bothriocephalus*. *Diphyllobothrium stemmacephalum* (mihi) may be briefly characterized as follows:—Length upwards of 100 inches, greatest breadth $\frac{5}{8}$ths of an inch; head arched, supported by a narrow neck, the latter rapidly increasing in breadth; bothria two in number, compressed, shallow, subsessile, together forming a semicircular festooned crown; segments $\frac{1}{12}$th to $\frac{1}{6}$th of an inch broad from above downwards, marked by 10 or 12 longitudinal furrows, the lower border of each slightly overlapping the succeeding segment; reproductive orifices conspicuous, widely separated, both placed in the mesial line (figs. 79–83 inclusive).

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* It is highly important that the cysticercal condition of every real species of Tape-worm be indicated, otherwise the value of our breeding experiments is lost. Von Siebold (Band- und Blasenwürmer, p. 98 *et seq.*) actually denies the hitherto recognized specific distinctions of five well-marked cestodes. His view, if proved correct, would almost sanction a revival of the transmutation theory.

† Description of a new Trematode infesting the Giraffe, &c. Edin. New Phil. Journ. for 1855. See also Reports of the British Association for 1856. The fluke discovered by Professor Busk in the duodenum of a Lascar (*D. Buskii*, Lankester) exceeds in size not only the *Distoma gigas* of Nardo, but this species also in a slight degree, from which it is generically distinct.

Another still more interesting entozoon, and one which was only discovered after a very careful dissection, is a small fluke, from the gall-ducts of the liver. This minute trematode is furnished with intestinal cæca of a zigzag form, and it is of especial interest as establishing the clear-sightedness of those Entozoologists who have insisted upon a generic distinction between the organization of the common fluke (*Fasciola*) and of the Distomata properly so called; we have here, in short, an intermediate condition between the complex alimentary cæca of the one genus and the simple bifariously divided tube of the other. For the generic and specific recognition of this species I offer the following nomenclature and characters:—*Campula oblonga*. Length $\frac{1}{8}$th to $\frac{1}{4}$th of an inch; breadth $\frac{1}{15}$th; oral and ventral suckers conspicuous; reproductive pores immediately in front of the latter; integument everywhere clothed with minute spines; vitelline organs largely developed; gastric cæca of a zigzag form, somewhat irregular (figs. 84, 85). This entozoon occupies the peripheral branches of the hepatic cæca, which are very much enlarged and thickened at the infested points, sometimes enclosing from fifteen to twenty individuals at one spot. In the stomach of the Porpoise there were also specimens of the crustacean *Lerneonema* and a *Filaria*, evidently belonging however to the partially digested fish-remains within that viscus.

To facilitate reference, the following is a list of the worms noticed in this paper:—

LARVAL ENTOZOA.

Cœnurus cerebralis.
Cysticercus cucumerinus.
—— Giraffæ.
—— fasciolaris.
—— pisiformis.
Scolex polymorphus.
—— tetrarhynchus.

NEMATOIDEA.

Filaria attenuata, *R.*
—— piscium, *R.*
—— rubella ?, *R.*
Trichosomum falconum, *R.*
—— longicolle, *R.*
Spiroptera leptoptera, *R.*
Prosthecosacter convolutus, *Dies.*
—— inflexus, *Dies.*
Oxyuris ambigua, *R.*
—— ornata, *Duj.*
Ascaris acanthocaudata, *T. S. C.*
—— acuminata, *Schrank.*
—— aucta, *R.*
—— clavata, *R.*
—— collaris, *R.*
—— depressa, *R.*
—— leptoptera, *R.*
—— marginata, *R.*
—— mystax, *R.*
—— nigrovenosa, *R.*
Ascaris rigida, *R.*
—— spiculigera, *R.*
—— vesicularis, *Fröl.*
Dachnitis globosa, *Duj.*
—— sphærocephala, *Duj.*
Dochmius tubæformis, *Duj.*

ACANTHOCEPHALA.

Echinorhynchus acus, *R.*
—— anthuris, *Duj.*
—— tereticollis, *R.*
Pentastoma proboscideum, *Brem.*

CESTOIDEA.

Bothriocephalus coronatus, *R.*
—— punctatus, *R.*
—— rugosus, *R.*
Ligula reptans ?, *Dies.*
Gymnorhynchus reptans, *R.*
Diphyllobothrium stemmacephalum, *T. S. C.*
Tetrabothrium cylindraceum, *R.*
—— macrocephalum, *R.*
Schistocephalus dimorphus ?, *Crep.*
Tænia crassicollis, *R.*
—— elliptica, *Batsch.*
—— filicollis, *R.*
—— serrata, *Goeze.*
—— sphærophora, *R.*
—— variabilis, *R.*

TREMATODA.

Fasciola gigantica, *T. S. C.*
—— hepatica, *Linn.*
Campula oblonga, *T. S. C.*
Hemistomum spathula, *Dies.*
Echinostomum spinulosum, *R.*
Monostoma caryophyllinum ?, *Zed.*
—— dubium, *T. S. C.*
Distoma atomon, *R.*
Distoma clavigerum, *R.*
—— cylindraceum, *Zed.*
—— fulvum, *R.*
—— gracilescens, *R.*
—— hispidum, *Abildg.*
—— rachion, *T. S. C.*
Polystoma integerrimum, *R.*

The names here abbreviated are those of Rudolphi, Bremser, Dujardin, Diesing, Linneus, Zeder, Creplin, Frölich, and Abildgaard.

DESCRIPTION OF THE PLATES.

TAB. XXXI.

Fig. 1. *Tænia filicollis.* Natural size.
Fig. 2. *Monostoma caryophyllinum,* imperfectly developed. Natural size.
Fig. 3. The same, showing an oral sucker and cells in the interior. Magnified 300 diameters.
Fig. 4. *Monostoma dubium* (mihi). Natural size.
Fig. 5. The same, displaying the elongated ventral appendage and internal gastric cæca. Enlarged 200 diameters.
Fig. 6. Four examples of *Distoma fulvum.* Natural size.
Fig. 7. One of the above, showing the position of the suckers and the extremely attenuated neck during elongation. Enlarged 20 diameters.
Fig. 8. The same, during contraction; it also exhibits the intromittent organ and ova within the uterine tube. Magnified 60 diameters.
Fig. 9. Three specimens of *Distoma rachion* (mihi). Natural size.
Fig. 10. One of the above, enlarged 40 diameters. It exhibits the regularly arranged dermal spines investing the whole of the body; an oral and ventral sucker, the lining membrane of the former consisting of polygonal cells; a narrow œsophagus communicating with a broad, elongated, horse-shoe-shaped digestive cavity—in front of the latter a wide uterine tube symmetrically disposed in coils on either side and filled with ova; and an internal seminal vesicle. The ovary is placed immediately above the caudal vesicle, and is surmounted by the testes.
Fig. 11. Transparent cyst from the subperitoneal surface of the intestine of a Haddock. Natural size.
Fig. 12. The same, ruptured. Magnified 4 diameters.
Fig. 13. Scolex of *Tetrarhynchus,* escaped from the cyst. It shows the head and body enveloped by the large caudal vesicle, the surface of which is slightly segmented and dotted by the highly refracting sclerous particles. Magnified 4 diameters.
Fig. 14. The same with the body and proboscides evolved. Natural size.
Fig. 15. Part of the Scolex, enlarged 20 diameters. It exhibits the four narrow and pointed phylloid bothria, a portion of the transparent caudal vesicle with its sclerous particles, and more particularly the four proboscides, two of which are partially withdrawn from their sheaths.
Fig. 16. An oval sclerous particle, magnified 200 diameters.
Fig. 17. Section of a proboscis or tentacle, showing the peculiar arrangement of the hooks and hooklets. Magnified 200 diameters.

Fig. 18. Lower part of one of the proboscides, showing the retractor muscle within the sheath. Magnified 60 diameters.

Fig. 19. Anastomosing tubes seen beneath the skin, at the lower part of the body, in front of the proboscideal sheaths. Magnified 260 diameters.

Fig. 20. Two specimens of *Dachnitis globosa*; male and female. Natural size.

Fig. 21. Anterior extremity of the same (male), showing the position of the mouth and muscular œsophagus. Magnified 260 diameters.

Fig. 22. Tail of the same, showing the sabre-shaped spicules and a depression immediately in front. Magnified 260 diameters.

Fig. 23. Section from near the centre of the female, showing more particularly the vaginal sheath and prominent folds of the vulva. Magnified 200 diameters.

Fig. 24. *Ascaris acanthocaudata* (mihi). Natural size.

Fig. 25. Section of the same, magnified 260 diameters. It exhibits the longitudinal muscular fibres with their nuclei, and a broad band of partially disintegrated cells, in the centre of which is a canal occupied by an apparently nervous thread.

Fig. 26. Tail of the same, with numerous minute spines at the tip. Magnified 260 diameters.

TAB. XXXII.

Fig. 27. Anterior part of *Ascaris collaris*, exhibiting the small trilobular mouth, muscular œsophagus and broad intestine; also four cæcal appendages, two on either side of the digestive tube. Magnified 200 diameters.

Fig. 28. Several examples of *Scolex polymorphus*. Natural size.

Fig. 29. Head of *Scolex polymorphus*, showing the four suckers, the retracted proboscis, the so-called water-vascular canals, the sclerous particles, carmine pigment-cells, and columnar epithelium. Magnified 400 diameters.

Fig. 30. Cyst from the peritoneal cavity of a Halibut. Natural size.

Fig. 31. *Distoma atomon* removed from the cyst. Natural size.

Fig. 32. The same, showing the suckers, the simple gastric cæca, uterine tube, and contractile vesicle at the inferior extremity. Magnified 20 diameters.

Fig. 33. Four examples of *Distoma gracilescens*. Natural size.

Fig. 34. One of the same, magnified 60 diameters. It displays the spinose tubercles of the skin, the position of the suckers, the central penis-sheath, the botryoidal vitelline organs on each side of the neck, the two (or four?) testes, the uterine tube, the ovary and seminal reservoir, and the large muscular contractile vesicle*.

Fig. 35. Bunch of vitelline organs. Magnified 100 diameters.

Fig. 36. Section of the uterine tube, with its double row of contained ova. Magnified 100 diameters.

Fig. 37. Ovum. Magnified 260 diameters.

Fig. 38. Outline of a dissection of the Short Sun-fish, showing in particular several *Gymnorhynchi* enclosed in cysts within the retractor muscles of the anal fin. Reduced to $\frac{1}{6}$th of the natural size.

Fig. 39. Head, neck, and subcervical enlargement of *Gymnorhynchus reptans* enclosed within a transparent sheath. Enlarged $\frac{1}{3}$rd of the natural size.

Fig. 40. Anterior fourth of the body of *Gymnorhynchus reptans* removed from its investing capsule. Natural size.

Fig. 41. A few articulations from the posterior part of the body. Natural size.

Fig. 42. Club-shaped proboscis exhibiting a multitude of small hooklets serially disposed in rows of six-

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* Von Siebold, in his 'Lehrbuch der vergleich. Anat.,' speaks of three or four testes in *D. appendiculatum* and *D. cygnoides*.

teen to each circle; the hooks of the two lowermost rows being very large. Magnified 20 diameters.

Fig. 43. Diagram of one of the circlets showing the arrangement of the lesser hooks. Magnified 60 diameters.

Fig. 44. One of the large hooks, to show the blunt extremity directed diagonally outwards and downwards. Magnified 260 diameters.

Fig. 45. A small hook, showing its sharp and curved tip pointed vertically downwards. Magnified 260 diameters.

Fig. 46. Head, viewed from above, to illustrate the form and aspect of the two lateral bipartite suckers and the position of the closed orifices of the proboscideal sheaths. Enlarged 8 diameters.

Fig. 47. *Echinostomum hispidum.* Natural size.

Fig. 48. The same, enlarged 15 diameters. It exhibits the uterine tube, testes, ventral sucker and integumentary spines.

TAB. XXXIII.

Fig. 49. Another view of the head, showing the oral sucker.

Fig. 50. Cutaneous spines. The uppermost one is from the neck; the central, from the first row surrounding the head; the lowermost, from the second cephalic circle of spines. Magnified 200 diameters.

Fig. 51. *Dachnitis sphærocephala.* Natural size.

Fig. 52. *Distoma clavigerum.* Natural size.

Fig. 53. The same, enlarged 12 diameters.

Fig. 54. Section of the intestinal tube of the speckled Salamander, laid open to exhibit the mode of attachment of *Echinorhynchus anthuris* to the mucous surface. Natural size.

Fig. 55. One of the males, enlarged 8 diameters.

Fig. 56. Caudal extremity of a female, showing the artificially distended and transparent integument, the muscular sac enclosing the reproductive organs, the central oviduct, and certain peculiar accessory glands. Magnified 200 diameters.

Fig. 57. One of the loose globular ovaries containing ova in their nascent condition.

Fig. 58. Another ovary more advanced.

Fig. 59. A series of ova isolated from the above to exhibit their different stages of development.

Fig. 60. Fully developed ovum enclosed in a cyst.

Fig. 61. Front view of the same.

Fig. 62. Ovum detached from its enveloping cyst, showing the lateral position of the yelk and the peculiar Trichina-like form of the membrane enclosing the albumen. The last six figures are severally magnified 350 diameters.

Fig. 63. *Tænia sphærophora.* Natural size.

Fig. 64. Head of the same. Magnified 200 diameters.

Fig. 65. Section from three of the segments showing the external reproductive organs and imperfectly developed ova. Magnified 200 diameters.

Fig. 66. Proscolex removed from one of the caudal segments.

Fig. 67. Another still more advanced, showing the inverted rostellum with its three pairs of hooks. Magnified 500 diameters.

Fig. 68. *Echinostomum spinulosum.* Natural size.

Fig. 69. The same, enlarged 10 diameters.

Fig. 70. Posterior view of the head, showing the fin-like disposition of the cephalic spines.

Fig. 71. Diagram illustrating the arrangement of the vitelline cæca.

Fig. 72. Ovum. Magnified 300 diameters.

Fig. 73. Three examples of *Tænia serrata* of about seventy hours' growth. Natural size.
Fig. 74. Head of one of the above. Magnified 10 diameters.
Fig. 75. *Tænia cucumerina.* Natural size.
Fig. 76. Head of the same, enlarged 25 diameters.
Fig. 77. Joints of the same, showing the male reproductive organs opening at both of the lateral margins, also the ova and water-vascular canals. Magnified 25 diameters.
Fig. 78. Male organs, consisting of testes and vas deferens, and the penis retracted within its sheath. Magnified 60 diameters.
Fig. 79. Head and anterior segments of *Diphyllobothrium stemmacephalum.* Natural size.
Fig. 80. Section from near the centre of the body. Natural size.
Fig. 81. Head and neck, enlarged 100 diameters.
Fig. 82. Lateral or marginal view of the same.
Fig. 83. Appearance of the bothria when viewed from above.
Fig. 84. *Campula oblonga.* Natural size.
Fig. 85. The same enlarged 20 diameters, exhibiting more particularly the peculiar zigzag conformation of the digestive cæca.

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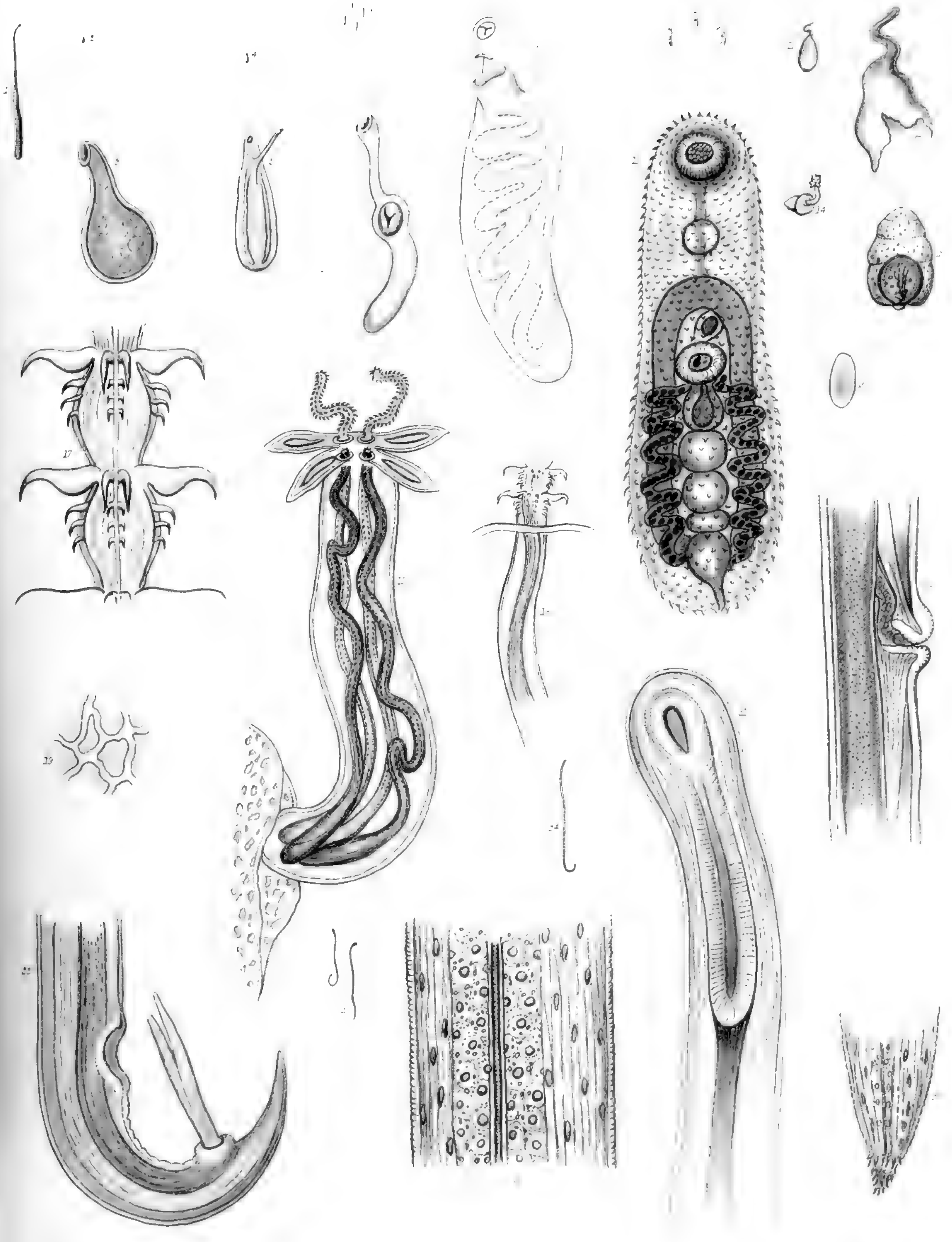

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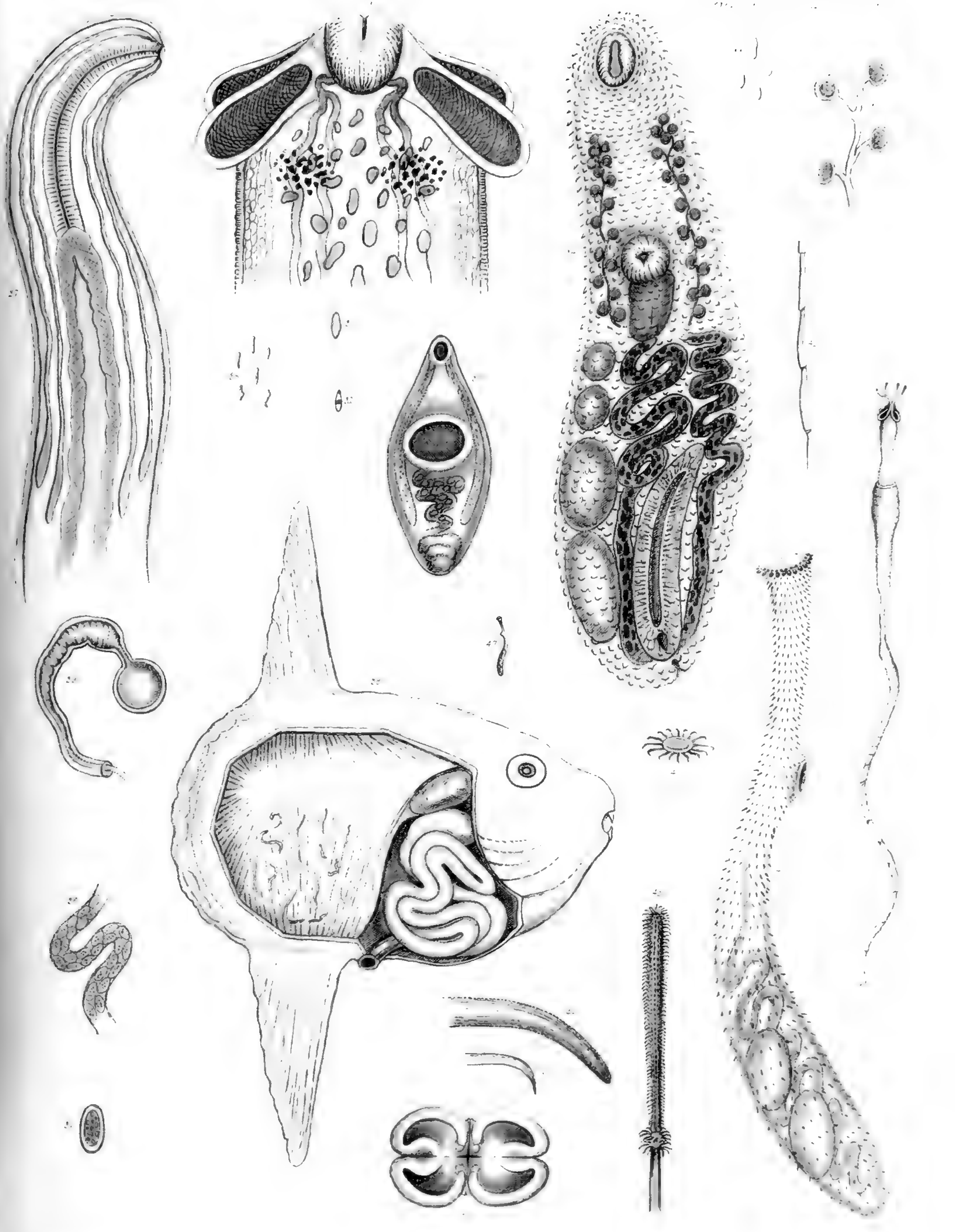

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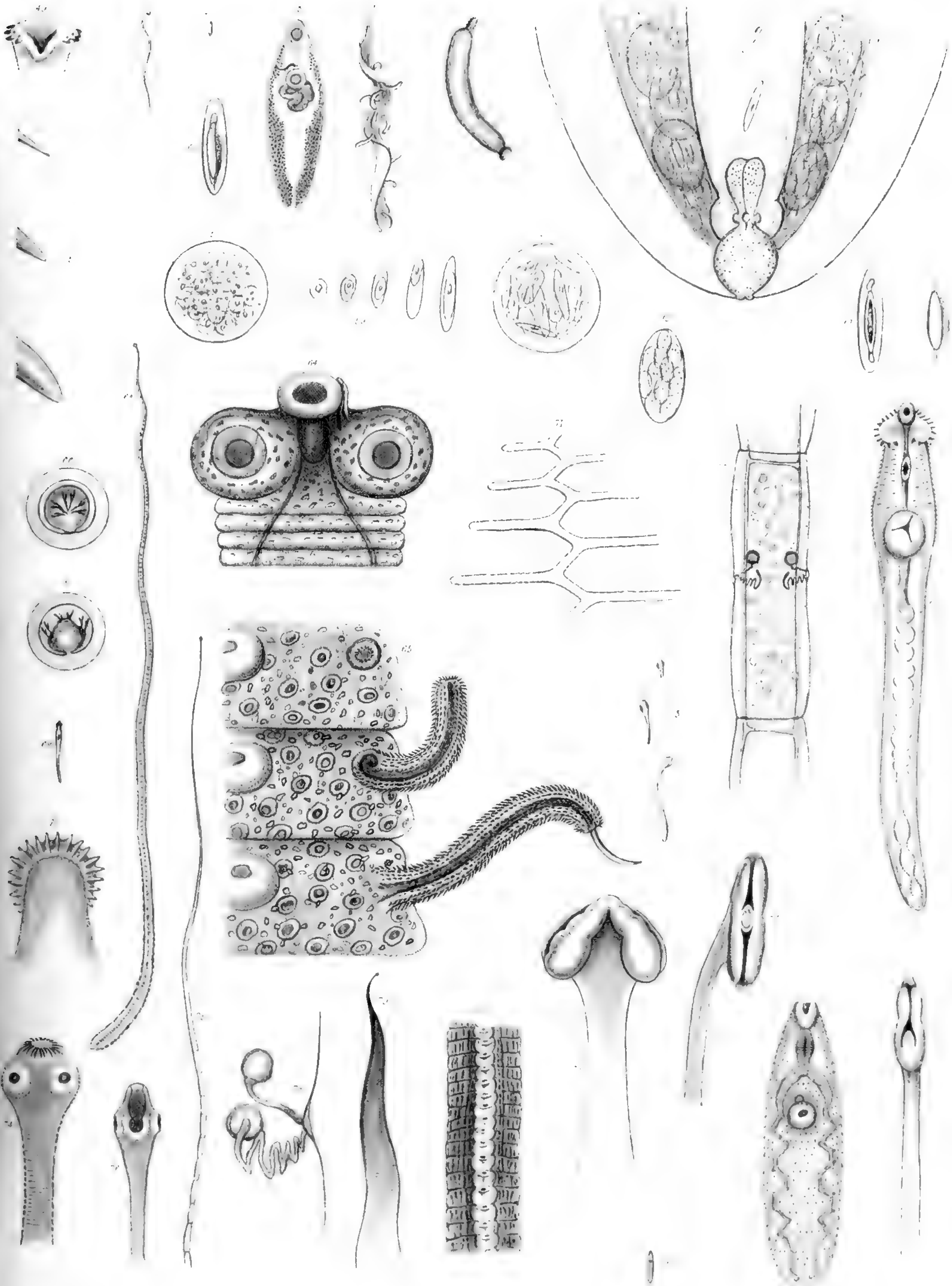

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XIII. *On the Arrangement of the Cutaneous Muscles of the Larva of* Pygæra bucephala.

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

Read February 18th, 1858.

LYONET'S celebrated memoir on the larva of *Cossus ligniperda*, and Straus-Dürckheim's still more beautiful work on *Melolontha vulgaris*, are the most perfect, and indeed the only monographs we have at all complete, on the general anatomy of any insects.

The very complicated arrangement of the cutaneous muscles in the caterpillar of *Cossus* inspired me with the wish to see how far the muscles of other larvæ would agree with, or differ from, this type.

With this view I dissected with great care some larvæ of *Tipula oleracea* and of *Ctenophora bimaculata*; but on comparing two or three specimens together, I found to my astonishment very considerable variations. It then occurred to me to compare several specimens together, in order to ascertain the nature and amount of these variations. The larvæ, however, of the different species of *Tipulidæ* so much resemble one another, that I could not feel certain that these supposed variations were not rather specific differences.

In order to remove this element of doubt, I selected the larvæ of *Pygæra bucephala*, which were obtainable in any numbers, and could not be confused with those of any other species. Moreover, as some of these caterpillars live on oak- and some on beech-leaves, I was curious to observe whether this difference in the food induced any alterations in the muscles. It did not, however, appear to have any such effect.

The full-grown caterpillars are about two inches long, and of a brown colour with dark longitudinal bars.

I have divided my paper into three sections:—

First, a description of the cutaneous muscles of the larva of *Pygæra*.

Secondly, a description of the variations observed in these muscles; and

Thirdly, a comparison, as complete as possible, of these muscles in *Pygæra* with the corresponding muscles of other larvæ.

In examining closely Lyonet's drawings, I have always found them inconveniently small: moreover he has represented alternately the two sides of the insect, so as to reverse the directions of many of the muscles; and as he has also figured the same muscle in different plates, it is difficult to ascertain the exact number of muscles in each segment.

In my drawings I have always represented the left side of the insect, and have never introduced the same muscle into two plates.

I propose to commence my description of the muscles at the third abdominal segment, and then, passing forward on the one hand and backward on the other, to point out the differences which exist in the muscles of the anterior and posterior segments.

No. 1 is a broad and strong muscle which is inserted into the skin near the front of the segment on one side of the dorsal vessel, and passes straight back to be inserted into the fore part of the following segment (fourth abdominal). This muscle is identical with that marked A by Lyonet.

No. 2 (B of Lyonet) is in fact treble, and consists of three muscles joined end to end; posteriorly it is inserted at the ventral side of the preceding, and passes forward parallel to it; but instead of being attached at the fore part of the third abdominal segment, it unites with the corresponding muscles of the two preceding muscles, and is inserted into the fore part of the first abdominal segment.

No. 3 is absent from this segment.

No. 4 (D of Lyonet) lies under No. 1, and is inserted in front, immediately under and behind it; posteriorly, however, it does not pass quite so far back, but is inserted at the line of separation of the third and fourth abdominal segments. It is not wholly straight in its direction, but inclines a little downward in front.

No. 5 (G of Lyonet) lies under the preceding, and is in some respects opposite to it; that is to say, the anterior insertion is on the dorsal side, and the posterior on the ventral, but on the same transverse lines.

These first five muscles must tend to contract the skin of the back.

No. 6 (E of Lyonet). This muscle lies at the ventral side of 2, and just at the dorsal side of the great lateral trachea. Its attachments are hidden by the transverse muscle 35, which will presently be described, and are on the same transverse lines as those of No. 1.

No. 7 (H of Lyonet). This muscle rises on the ventral side of No. 6 and on the same transverse line as the posterior insertions of Nos. 4 and 5, and passing forward and upward under Nos. 6 and 8, is attached on the dorsal side and near the anterior end of No. 6; this muscle and the next following bear the same relation to No. 6 that Nos. 4 and 5 do to No. 1.

No. 8 (F of Lyonet) rises posteriorly between 5 and 6, and passing forward and downward between 6 and 7, is inserted at the ventral side of the anterior end of 6.

No. 9 (I of Lyonet). This muscle is a little more than half as long as 5 and parallel to it, lying on the dorsal side of the posterior half.

Nos. 10 and 11 (L of Lyonet) are attached between the posterior insertions of 1 and 6, one on each side of the posterior end of 8, and pass straight forward for two-thirds of the length of the segment.

Nos. 12 to 15 (Q of Lyonet) rise almost on the same transverse line and underneath 4, and pass forward and downward, so as to cross under 9 and 5, for one-third of the length of the segment.

I have thus described all the longitudinal muscles in the upper half of the segment, and shall now pass to those in the lower half.

No. 16 (*d* of Lyonet) rises on the same transverse line as 4 and 5, and consequently on the line of division between the third and fourth abdominal segment, on the ventral side of the great lateral trachea, and passes straight forward to the front of the third abdominal segment.

Nos. 17 and 18 (*c* and *b* of Lyonet) are parallel, similar to, and on the ventral side of 16.

Nos. 19 and 20 (*ff* and *e* of Lyonet) arise under the posterior ends of 16 and 17, and are inserted in front under the anterior ends of 17 and 18. They are therefore not quite parallel to the axis of the body, but pass a little downward in their course forward, and are moreover nearer together in front. They appear to correspond to the two muscles marked *ff* and *e* by Lyonet; these two, however, are not parallel to and at the side of one another, but the latter overlaps the former in front.

No. 21 (*a* of Lyonet) is parallel to 16, 17 and 18, but is altogether rather further back, so that its attachments in some respect alternate with those of 16, 17 and 18, though they are not nearly midway.

No. 22 (*i* of Lyonet) lies under the preceding muscle, but inclines to the median line behind. It is generally bifid in front.

No. 23 (*f* of Lyonet) rises on the dorsal side of 24 and runs parallel with it, to be inserted under the fore end of 16.

No. 24 (part of *g* of Lyonet) rises just in front of the ganglion and on the same transverse line as 21, and passing forward and upward joins 23, and is inserted with it under the fore end of 17.

No. 25 (part of *g* of Lyonet) rises near the middle line of the body, and passing diagonally forward and upward joins 24, and is inserted with it under the fore end of 17.

No. 26 (*h* of Lyonet) rises on the same transverse line as 56 and 17, close to the dorsal side of the posterior end of 23, and under 25, and passes forward and upward parallel to that muscle, to be inserted under its anterior attachment.

No. 27 (part of *k* of Lyonet) is wanting in this segment.

No. 28 (part of *k* of Lyonet) rises on the ventral side of the hind end of 19, and passing forward and downward towards the ganglion is attached to a ridge, which commences near the middle line of the posterior end of the segment and is continued forward, at the same time curving upward. It is broadest in front, where also it is often divided into several heads.

Nos. 29 and 30 (*p* of Lyonet). These two muscles lie on the ventral side of, and parallel to, the preceding. These three muscles vary considerably in form and relative size.

No. 31 (part of ζ of Lyonet) rises under the posterior end of 18, and passing forward and upward at about one-third of the segment at an angle of 50°, is very much hidden by the fold of skin forming the boundary of the two segments.

No. 32 (part of ζ of Lyonet) lies parallel to, and on the dorsal side of, the preceding.

Nos. 33 and 34 (part of ζ of Lyonet) lie parallel to, and on the dorsal side of, the preceding.

I have now completed the description of the longitudinal muscles and come therefore to that of the transverse series.

The first two of this series pass over or rather inside the great lateral trachea and the muscle 6; the other transverse muscles lie between the longitudinal series and the skin.

No. 35 (part of θ of Lyonet), arising in part opposite and on the dorsal side of 16 of this segment, and partly opposite the hind part of the corresponding muscle of the preceding segment, passes upward, with a slight inclination backward, dividing at the same time into two heads, which are inserted on the ventral side of 2, and nearly opposite the anterior attachment of 1.

No. 36 (part of θ of Lyonet) is parallel to the preceding and has similar attachments, but lies rather further back.

No. 37 (part of α of Lyonet) rises under the fore end of 16, and running forward and upward is inserted under the middle part of 35.

No. 38 (part of α of Lyonet) bears the same relation to 36 that 37 does to 35.

No. 39 (part of *l* of Lyonet) is attached under the fore end of 19, and passes backward and upward to be inserted into the trachea close to the spiracle.

Nos. 40 and 41 (*m* of Lyonet). These two muscles rise anteriorly under 20, and pass diagonally backward and upward for about one-third of the length of the segment.

No. 42 (*n* of Lyonet) is parallel to and on the ventral side of the preceding.

Nos. 43 and 44 rise on the dorsal side of 28 and pass backward and upward along the posterior margin of 42, opposite to about the middle of which they are inserted.

No. 45 (part of *l* of Lyonet) may perhaps be regarded as a continuation of 39. It is inserted into the posterior and lower side of the trachea, close to the spiracle, and passes backward and upward to be inserted close to the upper end of 49.

Nos. 46, 47 and 48 (β of Lyonet). These three transverse muscles lie on the outer side of the following, and are therefore covered by it in the drawing: 46 and 47 are usually joined together at the upper end. With the two following they are concerned in the movements of the proleg.

No. 49 (γ of Lyonet) is attached below the proleg, and passing upward to the inner side of the preceding, is inserted just above it.

No. 50 also is attached at its lower extremity to the proleg, and, passing upward and backward, is inserted under the great lateral trachea.

No. 51 (δ of Lyonet) ought almost to be considered as two muscles, since, though it rises singly close to the anterior end of 34, it divides almost immediately. Both branches pass upward, inclining at the same time, and especially the posterior branch, backward, to be attached under 6.

No. 52 (ϵ of Lyonet) is a short transverse muscle which lies altogether on the outer side of the anterior branch of 51.

No. 53 (*r* of Lyonet) rises at the lower end of 48, and passing straight down, at the same time expanding in width, enters the proleg.

Under this muscle lie four other small ones, which also are attached to the proleg by their lower ends.

No. 54 (perhaps part of *t* of Lyonet) is a transverse muscle which lies on the outside of 31 and 32, and partly of 28 also. This muscle and the following are often difficult to find, from their being covered by the skin-fold.

No. 55 (perhaps part of *t* of Lyonet) is in this segment generally completely double, and lies parallel to and just behind the preceding.

No. 56 is a series of about eight transverse muscular fascicles which lie on the outside of 28, 29 and 30, and are much hidden in a fold which is bounded by the ridge already mentioned in connexion with those muscles. The fascicles of which this series is composed vary considerably in number and form in different specimens.

No. 57 (perhaps part of x of Lyonet) rises near the middle of the upper side of 56, and passes straight back to the posterior end of the segment.

No. 58 (perhaps part of x of Lyonet) rises close to 57, and passes backward and downward to the posterior end of the segment.

Besides these muscles, there are two small ones (86 and 87) which lie under and parallel to 53, and another (88) which runs under and transverse to 46, 47, 48 and 53.

Anterior Segments.—The first two abdominal segments are very similar to one another, and may therefore conveniently be considered together. The chief differences which exist between them and the third abdominal segment depend on the absence of prolegs.

It has been already mentioned that the muscle 2, belonging to the second abdominal segment, is quite free from the skin, being attached by its ends to the corresponding muscle of the preceding and succeeding segments. The other superior longitudinal muscles very closely resemble those of the third abdominal segment. In the first abdominal segment there are the two following variations:—First, Nos. 10 and 11 are either united together in front, or at least closely approach one another,—a tendency which is more developed in the two posterior thoracic segments, where they have completely coalesced; and secondly, No. 6 sends off a branch from the upper side of its anterior end.

Nos. 10 and 11 reach to the fore end of the first abdominal segment, and converge in front or sometimes unite.

In the ventral longitudinal series, No. 18 of the first abdominal segment is considerably swollen anteriorly, so as to overlap 21, which in this segment is inserted as nearly as possible on the same transverse line as 16, 17 and 18, and under the latter.

No. 22 of the same segment is single in front.

No. 27 was absent in the third abdominal segment; in the first two it rises on the dorsal side of 28 and passes forward parallel to that muscle.

Nos. 29 and 30 are small in the second abdominal segment, having the same attachment posteriorly, but not passing so far forward. In the first abdominal segment it is difficult to distinguish them from 31 and 32.

In the first abdominal segment, the four small muscles marked 29, 30, 57 and 58 appear to correspond with those so named in other segments; but it is difficult to determine which is which.

No. 35 is completely simple in the first abdominal segment, where also 36 is wanting. In this segment also there are only three muscles to represent 40, 41, 42, 43 and 44, though it is difficult to say which of the five have disappeared.

In both these segments 46 is inserted under or rather outside of 49 above, and in front of it below; the dorsal end of 49 is inserted just above 46, and above 51 below; and 48 is in general quite single.

Nos. 47, 48, 50, 52, 53 and 56 are completely absent in both segments.

Third Thoracic Segment.—The muscles in this segment differ so much from those that have been previously described, that in many cases I feel very doubtful whether I have used the right numbers to represent them. A careful examination of the thorax in different species would throw much light upon this question, but I have not at present the materials necessary for the investigation.

Nos. 2 and 3 are entirely absent.

No. 4 passes straight forward, but does not reach the front of the segment.

No. 5 is completely double. One branch rises at the side of 1, and passes diagonally forward and upward to be inserted under it. The other rises under the lower side of 1, and passes forward parallel with the other branch, to be inserted under its upper part.

No. 6 rises on the same transverse line and a little on the ventral side of 1, and passes back near the hind end of the segment, inclining at the same time downward.

No. 7 lies under or sometimes at the ventral side of, and more or less parallel to, the preceding.

No. 8 is double, and instead of passing straight forward as in the abdominal segments, inclines to the ventral side in front. Both branches rise at about the middle line of the front of the segment, and diverge gradually. The one is inserted under the hinder end of 1, and the other under and at the side of the lower branch of 5.

No. 9 rises under the posterior ends of No. 5′, and passes forward and upward, almost to the middle line of the back and for three-fourths of the length of the segment.

Nos. 10 and 11 have coalesced in this segment.

No. 16 is almost entirely covered by 17.

No. 18, instead of being parallel to 16 and 17, as in the abdominal muscles, rises under the posterior end of 17, and passing forward and downward, crosses the middle line of the segment between the two nervous chords, which are here at some distance from one another, and is attached to the fore margin of the segment on the ventral side of No. 21.

Nos. 19 and 20 lie under 17 and 21.

No. 21 rises on the fore margin of the segment and at the ventral side of 17, and passes back, under 18, to the same transverse line as 16 and 17.

No. 22 rises on the posterior margin of the segment under 16, and passing forward and downward, is attached to the skin under the fore end of 21.

No. 23 rises under the posterior end of 21, and passes forward and upward to the fore end of 17, where it is inserted.

Nos. 24 and 25 are attached in front as usual, but instead of extending the whole length of the segment to which they belong, are attached to the middle line of the ventral side, and are not above half the usual length.

No. 26 rises close to the ventral chord not very far from the posterior end of the segment, and passes forward and upward to be attached under the fore end of 20.

No. 27 is entirely absent.

No. 28 rises on the dorsal side of 30 and under 20, and passes forward parallel to 30 and under 26 to the middle ventral line.

No. 30 rises under 23, and passes downward and forward to the posterior end of 26.

Nos. 29, 31, 32 and 33 are altogether absent.

No. 34 is almost as in the first abdominal segment, but lies under instead of over 54 and 55.

No. 35 is as in the abdominal segment.

No. 36 is absent, as in the first abdominal segment.

Nos. 37 and 38 in the thoracic segments pass more forward, so that they are situated at the hinder end of a segment rather than at the front.

No. 39 is absent, as there are no spiracles in the two posterior thoracic segments.

No. 40 is double behind. No. 41 is parallel to 40, but not more than half as long.

No. 42 rises at the lower side of the fore end of 41, and passes upward and backward about as far as 40.

Nos. 43, 44 and 45 are absent.

No. 46 rises under 17, just behind 38, and passes straight upward, and divides at the same time into two diverging branches, both of which are attached to the skin under 7.

Nos. 47 and 48 are not present.

No. 49 much resembles 46, in front of which it is situated. It is however more deeply forked and is shorter, its lower end not passing so far down. It also passes inside 67, while 46 lies outside that muscle.

No. 50 rises under the posterior end of 7 by a double head, and passes forward and downward to be inserted under the middle of 16.

No. 51. This muscle rises immediately behind the upper end of the hinder branch of 46 and passes straight down, diverging however a little from 46, to be attached under the upper side of 16.

No. 52 is small; it rises at the lower end of 50 and passes to the hinder side of the lower end of 51.

No. 53 is absent.

No. 54 rises just behind the lower end of 51 and passes upward, going at the same time under 51, and being attached under the middle of 46.

No. 55 rises close to the lower end of the preceding, and passes upward and backward about as far as the posterior end of 7.

No. 56 differs very materially from the series of muscles so marked in the abdominal segments. It is here double. The two fascicles rise just in front of and rather above 57, and passing downward and forward, at the same time diverging from one another, are inserted opposite the posterior end of the muscles 23, 24 and 25, belonging to the opposite side.

Nos. 57 and 58 are represented by three small muscles which rise under 25 at a little distance apart and pass forward, converging at the same time, and are inserted into the legs. They frequently coalesce so as to form only one muscle.

We have now completed the muscles in the third thoracic segment which appear to represent those of the abdomen. There remain yet fifteen to be described.

Nos. 59 and 60 rise under the fore end of 1, and pass upward and backward to the dorsal line, where they are attached close to the anterior end of 9.

No. 61 rises at the lower side of 60 and passes back parallel to that muscle, but twice as far, and at the same time dividing into two, so that its lower branch is attached close to the fore end of 12.

No. 62 rises close to the posterior end of 60 and passes forward and downward to the fore end of 4. In some specimens I could not find this muscle.

No. 63 rises partly under the fore end of 7 and partly between 7 and 1, and passes backward and downward to the upper end of 49.

No. 64 rises under 7, and just on the lower side of 63, and runs parallel to that muscle. It does not however pass so far back. It is generally completely double.

No. 65, again, rises just below 64, and passes back parallel to it, but is about twice as long, and reaches to the upper end of 42.

No. 66 rises under the posterior end of 17, and passes forward and upward to the posterior end of 64.

No. 67 rises on the lower side of 42 and passes upward to the fore end of 66.

No. 68 rises under the lower end of 49 and passes forward and upward to the anterior end of 8.

No. 69 rises at the fore end of 68 and passes to the lower end of 50.

No. 70 rises at the hinder end of 68 and passes to the hinder end of 40.

No. 71 rises at the lower end of 70 and passes to the upper end of 54.

No. 72 rises at the hinder end of 63 and passes to the lower end of 50.

No. 73 rises under the middle of 17 and passes downward and forward to be inserted close to 24.

No. 74 rises at the upper end of 73 and diverges from it toward the upper side of the lower end of 56.

No. 75 is behind, and almost parallel to, the preceding.

No. 76, rising under the fore end of 8, passes backward and downward to be inserted under the middle of 17.

No. 77 rises at the posterior end of 76, under 17, and passes straight back to the hind end of the segment.

No. 78 also rises at the hind end of 76 and passes downward and backward. It is a short and small muscle, consisting generally of four distinct fascicles.

First and Second Thoracic Segments.—The muscles of the thoracic segments differ from one another, as might be expected, much more than do those of the abdomen. It is unnecessary here to mention the muscles which agree with those of the third thoracic segment, and I will therefore confine myself to pointing out the differences, using the third thoracic segment as the standard of comparison.

Second Thoracic Segment, however, does not differ very much from the third, and this agreement is even more striking in the small muscles than in the large ones.

Nos. 4 and 7 are thinner and weaker.

The single muscle representing 10 and 11, which are again distinct in the first thoracic segment, is here expanded in front, and usually double.

Nos. 16, 19 and 20 are represented by only two muscles.

No. 18 is double at the posterior end.

No. 22 rises at the upper end of 16, and passes backward and upward to the posterior end of 6.

No. 52 runs from the lower ends of 50 and 72 to those of 54 and 55.

Nos. 57 and 58 in most of my specimens had united together, and were smaller than in the third thoracic segment; but this is not, I presume, always the case.

Nos. 59 and 60 have united together.

No. 61 overlaps 60 at the fore end.

No. 63 is generally, if not always, double.

First Thoracic Segment.—In the posterior part of this segment several muscles are wanting, and in the anterior they differ widely from the usual type, being principally modified so as to effect rotations of the head.

The most striking alteration is the presence of the muscle marked 82 (C+of Lyonet), which is attached in front to the posterior border of the head, and passing through the present segment is attached by four heads along the middle dorsal line of the second thoracic segment; nor did it vary in any of the specimens examined by me. There does not seem to be any muscle comparable to it in the other segments. There are yet three other muscles which seem to be peculiar to this segment. No. 80 rises close to the fore end of 82, and passing over 19, 20 and 26, is attached by two heads near the middle ventral line, close to 56. No. 81 rises with the preceding and follows nearly the same course, but passes under 19, 20 and 26. No. 83 rises from the fore side of the spiracle and passes forward to the upper end of 46.

No. 1 is in this segment divided into two or three separate muscles, which are attached side by side behind, and fixed to the fore part of the segment, or rather into the membrane connecting the head with the thorax.

No. 4 is attached in front, close to 1.

No. 5 is double; in some cases however it is united in front. The one fascicle rises under or at the side of 1, the other rather further down, and both are inserted on the ventral side of 4.

No. 7 lies at the lower side of 6 and parallel to it.

No. 8 perhaps is wrongly identified, since it here lies under 10 and 11, rising close to the fore end of the latter and passing back to the hind end of the former. No. 9 is much broader than usual.

Nos. 10 and 11 are both present, and offer no peculiarity, except that 11 is expanded and sometimes double in front.

Nos. 12, 13 and 14 are absent.

No. 15 is a straight muscle, longer than, and lying at the side of, 9.

No. 16 is completely double; in front it lies at the upper side of 17, and under it behind.

No. 18 rises under the hinder end of 21, and passes forward with a slight inclination downward to be inserted at the lower side of the fore end of the same muscle.

Nos. 19, 20 and 26 are parallel to one another; they rise under 17 and 21, and pass forward and upward to be inserted at the anterior end of the segment, not far above 16.

No. 22 rises under the fore end of 16 and passes backward and upward to the hind end of 6.

Nos. 23, 28, 29 and 34 seem to be absent.

No. 31 is perhaps wrongly identified. It rises under 16 and passes upward and forward in front of the spiracle.

Nos. 37 and 38 appear to be absent.

No. 40 is longer than in the second thoracic. In one specimen it was single behind, and inserted between 51 and 66.

Nos. 46 and 49 are both quite single, and much larger than in the segments following.

No. 50 is wanting.

No. 51 rises at the posterior end of 40, and passes downward to be inserted under 17. This muscle may perhaps be rather the representative of 54.

No. 52 rises close to the lower end of 49 and passes downward and backward.

Nos. 54 and 55 are absent.

Nos. 59 and 60. There are three or four separate fascicles which apparently represent these two muscles. They lie in front of 9, and are parallel to the direction of the segment.

No. 61 is almost or sometimes completely double. It rises at the fore end of 82, and the two branches diverge slightly, both being inserted under 59 and 60.

No. 62 consists of three or four small oblique fascicles which rise along the front of the segment under the three preceding muscles and pass backward and upward.

Nos. 63 and 64 are absent.

No. 65 rises close to the lower end of 49 and passes upward and forward. It is very doubtful whether this muscle is homologous with that marked 65 in the other segments.

No. 66 is much less conspicuous than in the other thoracic segments.

No. 67 rises under the upper end of 49 and passes to the hinder end of 41.

Nos. 68 and 69 rise in front as usual, but pass back parallel with one another to the upper end of 51.

Nos. 70 and 71 are parallel with 65.

Nos. 72, 73, 74 and 75 are absent.

No. 79 lies under 77 as usual, and in this segment is hidden by it.

No. 80 rises close to the anterior end of 19 and passes downward, at the same time with a slight inclination backward, to the middle line of the segment, close to 56. At its lower end it is double.

No. 81 resembles 80, but is smaller; it lies also rather in front, and passes on the outer instead of on the inner side of 19, 20 and 26.

No. 82 has been already described.

No. 83 is devoted to the spiracle, from which it passes forward and upward to the upper end of 46.

Nos. 84 and 85 rise at the lower end and a little in front of 49, and diverging from one another, pass backward and downward; 85 is inserted near the posterior end of 57 and 58, and 84 on the ventral side of them, near their fore end.

Posterior Abdominal Segments.—Having thus described the thoracic segments, I now return to the abdomen. The fourth, fifth and sixth abdominal segments do not materially differ from the third. The muscles, however, become narrower and thus occupy less space.

No. 26 is double behind, thus indicating the more complete separation which is to take place in the following segment.

No. 28 is absent. In the fifth and sixth segments there is also a muscle which rises just above the upper end of 46, and passing downward is inserted just below the lower end of 53.

No. 52 is absent.

No. 55 is single in the sixth segment.

Nos. 16 and 17 approach nearer to one another, and separate a little from 18.

Nos. 47 and 48 are absent.

No. 49 in the fifth and sixth segments is completely double, and stronger than in the fourth segment, which indicates that the prolegs of these segments act in a somewhat different manner.

The gastric muscle ç rises, as in the larva of *Cossus*, on the upper side of 21.

Seventh Abdominal Segment.—Owing no doubt principally to the absence of prolegs, this segment differs much from those that immediately precede it. Thus 47, 48 and 56 are entirely absent. 49 and 50 also, though present and well-developed, are much shorter than usual.

On the other hand, in the specimens I examined there were two new muscles lying under 10 and 11, and inserted below them in front. 10 and 11 approach one another in front, and sometimes even unite together.

No. 25 has completely united with 24, and 26 lies on the lower side of these two muscles.

To represent 31, 32, 57 and 58, there are four small variable muscles which seem to be of little importance.

No. 46 also is very thin and weak, so that it is probably of little functional utility, and only present to fulfil the general law of arrangement of the muscles.

No. 51 is single and small. It rises at the lower end of 49 and passes to the front of 34, as in the anterior abdominal segments.

No. 52 is absent.

No. 53 is parallel and similar to 54, though a little shorter; these two muscles are very unlike in front, but become gradually more and more alike.

No. 56. As there are no prolegs to this segment, the series of muscles marked 56 is absent.

Nos. 57 and 58 are represented by two small muscles parallel and similar to 31 and 32.

Eighth Abdominal Segment.—In this segment the muscles have become much narrower and weaker, and 31, 32, 33, 34, 50, 53 and 56 are absent.

Nos. 12 and 13 have almost coalesced, so as to form one small muscle, and the same has taken place with 14 and 15.

No. 4 has entirely disappeared, while 3, on the other hand, is double; as also happens in the larva of *Cossus*.

Nos. 7, 8, 10 and 11 have become parallel, and seem to form one series.

In the *Ninth Abdominal Segment* the diminution of the muscles in size and number has proceeded still further; 3, however, is double, as in the preceding segment, and 4 makes its appearance again.

Indeed the number of missing muscles is much greater than of those which are present. These are, Nos. 1, 2, 3, 4, 5, 6, 7, 16, 17, 18, 21, 37, 38, 50 and 51.

The first six of them resemble the same muscles in the preceding segment.

No. 7 rises at the posterior end of 16, and passes forward and upward nearly to the upper end of 37.

Nos. 16 and 17 have coalesced.

Nos. 50 and 51 are even larger than usual, and pass quite back to the posterior end of the segment. 51 is double in front and attached under 16.

Besides these muscles, there are attached to the upright wall of the end of the body, and in a series along the lower middle line of the segment, a number of muscular fascicles which are distributed to the rectum and posterior parts of the alimentary canal; in the same place also are situated the muscles which move the posterior prolegs; I have not, however, examined these muscles with care enough to enable me to describe them satisfactorily.

Comparison of the Muscles in different Specimens.—Any one who has carefully examined Lyonet's drawings of the cutaneous muscles in the larva of *Cossus ligniperda*, or still better, has made himself acquainted with the organs themselves, must have been struck with amazement at their number and complicated arrangement.

The muscles in most animals are penetrated by the arteries and capillaries, and are supplied by them with blood; but this not being the case in insects, it is perhaps necessary that their muscles should be divided into numerous fascicles, in order that the blood may have free access to them. Whether for this or some other reason, they are in the shape of thin ribands, the thickness of which varies very much in different muscles and in different parts of the same muscle, but is in the largest about $\frac{1}{200}$th of an inch.

The largest muscular fibres in man, which are not penetrated by blood-vessels, are, I am informed by Professor Huxley, $\frac{1}{400}$th of an inch in diameter. We can, however, derive no argument from this comparison without knowing the permeability of the muscle and the power of penetration possessed by the blood. It is also worthy of notice, that the wing-muscles of insects are separated into very small fascicles, as if, from the violent and rapid action of these muscles, their particles were more quickly deteriorated, and required therefore more frequently to be removed and replaced by others. The muscles of insects, however, are not only very much divided, but are also very complicated in their arrangement.

Lyonet describes 1647 in the larva of *Cossus*, without counting those which belong to the head and to the internal organs; and truly observes, that this great number "ne pourra qu'étonner ceux qui savent qu'on ne fait ordinairement monter tous les muscles de l'homme qu'à 529, et qu'il y en a même qui le fixent à beaucoup moins." It might be objected, that certain fascicles in insect larvæ, as for instance 16, 17, 18, 19 and 20, ought to be considered as parts of muscles rather than as whole muscles, and that the total number therefore must be very much diminished.

If, however, this were a well-founded objection, we should expect to find these fascicles varying in relative size and number; and as, except in certain instances, they do not do so, we must, I think, admit that Lyonet was right in his mode of estimating their number.

Some few, however, of the smaller muscles do vary; and to determine the number and amount of these variations was my chief object in undertaking the present paper.

No naturalist had previously undertaken this task, though Lyonet has mentioned here and there certain variations observed by him.

It would have taken a great deal of time, and seemed to me scarcely worth while, to make this comparison in all the segments of the body; and I have therefore confined myself to the third, fourth, fifth and sixth, thus including a thoracic somite, two abdominal without prolegs, and one with these appendages.

These four segments I compared carefully in nine different specimens, five of which were fed upon Oak and four upon Beech. But in order to determine a few minor points, I dissected perhaps as many more specimens in a cursory manner, which however confirm me in the opinion that the larger muscles scarcely vary at all. Indeed the only mutation observed in them at all worthy of notice was that in one case the muscles of the third abdominal segment, 16, 17 and 18, were not attached to the skin in front, but were continuous with the corresponding muscles of the preceding segment.

The differences which do exist are not exactly those which I expected to find; whilst some things which I rather thought might vary, remain on the contrary always the same.

Let us take for example Nos. 4 and 5. In the first abdominal segment 4 passes on the inner side of 5; the contrary, however, might apparently have been the case, without alteration of the places of insertion, or of the mode of action of the two muscles; and I thought it probable, therefore, that 5 might sometimes lie on the inner side of 4. But although six segments in at least fifteen specimens were examined, making in all ninety instances, the arrangement was invariably the same in every instance.

This remark is applicable to several other muscles, for instance 6 and 8, 7 and 8, and 23 and 18 in the third abdominal segment; and, indeed, I never observed a case in which a muscle varied in this respect in its relation to another.

The muscles 4 and 5, however, offer a different arrangement in the thorax to that which is so constant in the abdomen. Here, if they are rightly identified, which perhaps may be doubted, though I believe that I am correct, 5 is completely double and lies on the inner side of 4.

This altered arrangement appears to be necessitated by the altered position of the fore end of 4, and by the presence of 60 and 61.

Again, 8, which in the following segments lies on the inner side of 11, in the first thoracic segment has shifted its position and passes on the outer side.

A careful examination of the Plates will show a few more instances of this fact, which, however, are not very frequent.

The relative sizes of the different muscles appeared to vary very little in different specimens, except indeed in those muscles which might be termed the variable muscles.

Such were especially 12, 13, 14 and 15; 28, 29 and 30; 56; 59 and 60; and in a lesser degree, 31, 32, 33 and 34; 57 and 58; 11; 23 and 24 in the third thoracic segment, 8 in the third thoracic segment, and 40, 41 and 42.

If we suppose, as seems probable, that muscles composing the series 12, 13, 14 and 15 usually act together, and that the same is the case with the other three series, 28, 29, 30;

31, 32, 33, 34; and 40, 41 and 42; then the variations observed in these muscles will be of very little importance to the animal.

There are, indeed, other muscles and series of muscles which might *a priori* have been considered equally unimportant, and have therefore been expected to show similar variations. Our knowledge, however, of the mechanism of the muscles, and of the functions they subserve, is so small, that we must be very cautious in forming an opinion on the relative importance of different muscles.

It may perhaps prove that the variability of particular muscles is rather an indication of a different arrangement hereafter to be discovered in certain neighbouring groups. We must, however, suspend our judgment upon these facts until we are better acquainted with the myology of other insect larvæ.

I expected to find, in specimens in which the variable muscles were divided into more fascicles than usual, that this tendency to the division of muscles would pervade the whole animal, or at least the whole segment; this, however, did not appear to be at all the case. It seemed also probable that the variable muscle would either be symmetrical, or at least would tend to be so, in the two opposite sides of the same animal; but in the instances in which both sides were examined, this rule was not found to hold good.

Differences in the Third Abdominal Segment.—In the fourth specimen, No. 1 sends off a small branch on the dorsal side at the front end.

No. 5, in the sixth specimen, is partly overlapped by 4 in front.

The series 12 *to* 15 consists normally of four small muscles situated in the hinder part of the segment, and passing forward with a slight inclination downward. However, in the third specimen which I examined, the fore end of 15 was turned under 14. No. 12 was double in front, and 13 was almost entirely double, being only joined together in front. In the fourth specimen 13 and 14 were completely double, and 12 and 15 were divided for the anterior portion. The two branches of No. 15 were unequal, the dorsal one being the longer, and inserted under the anterior end of 14. In the fifth specimen, 12, 13, 14 and 15 were double in front. In the sixth and eighth specimens, on the contrary, 12 and 13 were united together; and in the latter are shorter than, in the former the same length as, 14 and 15.

No. 7 is usually single, but in one specimen it was divided into two, for about the posterior one-third.

No. 20, in the sixth specimen, a little overlapped 19 in front.

No. 22 is usually double for about its anterior half; sometimes, however, it is more deeply cleft, and at others it is almost undivided. Sometimes again it is trifid, and in this case the three divisions may differ in size and in degree of division.

No. 25 varies a good deal in width in different specimens.

Nos. 28, 29 and 30 also vary a good deal. Sometimes all three are of about the same width. Sometimes 28 is much the largest, and is bifid, trifid, or even quadrifid. At others 28 is smaller than 29, and the latter is more or less bifid or trifid. Sometimes both these muscles are bifid, and in one instance 30 was completely double.

Nos. 31, 32, 33 and 34. Sometimes 31, sometimes 32, sometimes 34, is double; sometimes both 31 and 34 are double. Sometimes, on the contrary, 33 and 34 have coalesced.

No. 35 in one specimen was divided into three at the upper end.

No. 37 is sometimes a good deal expanded at its upper end, and sometimes divided into two.

No. 38 in the same way is more or less divided at the upper end.

No. 51 is more or less divided, the two main branches of which it consists being sometimes united for a large proportion of their course, and sometimes, on the other hand, almost entirely separate.

No. 52, which is usually single, was, on the contrary, in one specimen double.

No. 56. This series of muscles varies extremely. There are usually from 7 to 11 fascicles, but they were not alike in any two specimens I examined.

No. 57 was double in the second specimen, and

No. 58 in the fifth.

Second Abdominal Segment.—The cases of variation in this muscle are almost the same as those already described.

No. 1 in the fourth specimen was completely double.

No. 10 in the second specimen was double for the anterior half. In the fourth specimen 10 and 11 were very small and united in front. In the ninth specimen 11 was double in front.

Nos. 12, 13, 14, 15, 27, 28, 29, 30, 31, 32, 33 and 34 offered various differences of the same nature as those already mentioned; besides which, in the fourth specimen, 14 was much longer than 13 or 15.

No. 26 was completely double in the second specimen.

No. 38 was completely double in the fifth specimen; in which also

Nos. 40 and 41 were united by their lower ends.

No. 54 in the eighth specimen was completely double.

First Abdominal Segment.—Nos. 12, 13, 14, 15, 27, 28, 29, 30, 31, 32, 33 and 34 differ as much as usual.

Nos. 10 and 11 are sometimes united in front, sometimes they only converge and do not join.

No. 18 in some specimens does not cover the fore end of 21.

No. 37 in the fifth specimen is double.

Third Thoracic Segment.—Nos. 12, 13, 14 and 15 differ as in the above-mentioned segments; 29, 30 and 31, on the contrary, are much more regular.

No. 8 in the fifth specimen was completely double; in the sixth it was double for the greater length, but united in front.

No. 20, in the ninth specimen, was double in front.

Nos. 23 and 24 differed considerably in different specimens. The arrangement figured is, however, perhaps the most usual.

No. 62. This small muscle was in two cases entirely absent.

No. 68 was double in two specimens.

Nos. 59 and 60 are sometimes united; in the fourth specimen they were separate on one side, and had joined on the other. In the ninth specimen the posterior end of 59, instead of lying at the side of 60, was inserted under, that is to say, at the outer side of it. In two specimens there was a small muscle lying at the dorsal side of 59.

No. 61 is sometimes simple behind, sometimes divided.

I now proceed to compare the muscles of *Pygæra* with those of *Cossus ligniperda*, as described by Lyonet, and of one or two other insects which I have more or less completely dissected.

The following Table shows the letters and numbers used for the corresponding muscles in the abdomen:—

1 = A
2 = B
3 = C
4 = D
5 = G
6 = E
7 = H
8 = F
9 = I
$\left.\begin{array}{l}10 =\\ 11 =\end{array}\right\}\mathrm{L}$
$\left.\begin{array}{l}12 =\\ 13 =\\ 14 =\\ 15 =\end{array}\right\}\mathrm{Q}$

16 = *d*
17 = *b*
18 = *c*
19 = *ff*
20 = *e*
21 = *a*
22 = *i*
23 = *f*
$\left.\begin{array}{l}24 =\\ 25 =\end{array}\right\}g$
26 = *h*
27 = *k*
28 = *p*
$\left.\begin{array}{l}29\\ 30\end{array}\right\}\text{absent}$

$\left.\begin{array}{l}31 =\\ 32 =\end{array}\right\}t$
$\left.\begin{array}{l}33 =\\ 34 =\end{array}\right\}\zeta$
$\left.\begin{array}{l}35 =\\ 36 =\end{array}\right\}\theta$
$\left.\begin{array}{l}37 =\\ 38 =\end{array}\right\}\alpha$
39 = *l* (part)
40 = *m*
$\left.\begin{array}{l}41 =\\ 42 =\end{array}\right\}q$
$\left.\begin{array}{l}43 =\\ 44 =\end{array}\right\}n$
45 = *l* (part)

$\left.\begin{array}{l}46 =\\ 47 =\\ 48 =\end{array}\right\}\gamma$
$\left.\begin{array}{l}49 =\\ 50 =\end{array}\right\}\beta$
51 = δ
52 = ε
$53 = u \left\{\begin{array}{l}\text{in the first figures}\\ \text{and } r \text{ in the last.}\end{array}\right.$
$\left.\begin{array}{l}54 =\\ 55 =\end{array}\right\}y$
56 absent
$\left.\begin{array}{l}57 =\\ 58 =\end{array}\right\}x$

Thus, with very few exceptions, every muscle of the third abdominal segment in *Pygæra* can be referred to its homologue in *Cossus*.

There are, however, some few differences: B in *Cossus* is only as long as the segment, as is also the case in the larva of *Pontia rapi*; while 2, the corresponding muscle in *Pygæra*, has united with the same muscle of the two preceding segments,—the three together forming only one muscle as long as the first three abdominal segments.

Again, G shows traces of subdivision, and is covered in part by F, while 5 is single, and lies on the dorsal side of 8. I also is treble, while 9 is single. L is treble, while 10 and 11 only form two muscles; on the other hand, Q is only treble, while the series from 12 to 15 is quadruple.

e crosses over *ff*, so as to cover it behind instead of lying at the side of it. *k* does not seem to be present in the third abdominal or any of the posterior segments of *Pygæra*, and only makes its appearance in the second abdominal segment.

There seem to be three fascicles, marked ζ, to correspond to 33 and 34; and 35 and 36, which are marked θ, are represented by several fascicles.

First and Second Abdominal Segments.—In these segments there are no further differences of importance. 35 and 36, however, which in *Pygæra* are reduced to a single muscle, continue in *Cossus* compound as before.

Nos. 46, 47, 48, 49 and 50 appear all to be represented by β.

ff and *e* resemble 19 and 20 more than in the posterior segments.

In the thoracic segments it is much more difficult to compare the muscles of *Cossus* and *Pygæra*; indeed, after devoting a good deal of time and thought to it, I have been obliged to give up this task, and do not think that it can be effectually accomplished until we know the arrangement which exists in some of the intermediate genera.

Some, however, of the more remarkable peculiarities of the thoracic segments in *Pygæra* are equally present in *Cossus*. Thus, the altered position of 1, 8, 8′, 18, 22 and 82 resemble those of D, C and E, *c* and *e* and C+. The remarkable muscles, however, marked 76 and 77, do not appear to have any close representative in *Cossus*.

This comparison, however, is made far more difficult by the arrangement of Lyonet's figures, and by the fact that the same letters are certainly not always used for the corresponding muscles in different segments.

In the first abdominal segment of the larva of *Pontia rapi* the larger muscles were arranged nearly as in *Pygæra*, except that 2 was attached to the skin at the posterior end of the segment, as in the larva of *Cossus*. In the larva of *Disphragis cæruleocephala* the muscles 1 and 2 on the one hand, and 16, 17 and 18 on the other, were represented by numerous separate fascicles, amounting to at least ten in each instance.

This separation of the fibres composing a muscle into separate fascicles is carried to a much greater extent in the larvæ of Coleoptera, or at least in *Dyticus* and the wood-feeding Lamellicorns, which alone I have examined. In these two groups each of the larger muscles is represented by at least twenty separate fascicles, which makes it far more difficult to distinguish the arrangement of the muscles.

The reserves of fat in the larvæ of these Lamellicorns are stored up in large vesicles, as much as ·01 of an inch in diameter, and which, being connected together into thin membranes, like a mesentery, have a beautiful bead-like appearance to the naked eye.

The muscular system of the larva of *Tipula oleracea* and of *Ctenophora bimaculata** offers us many interesting points of difference. Being unprovided with legs, these little creatures move by resting one part of their body against some solid object, and then pushing the anterior part forwards. To enable them to do this with facility, an immense number of muscles are attached to the inner side of the skin. The total number, indeed, falls a little, though very little, short of that in *Cossus*; yet the real complexity is greater, since the average number of muscles in each of the body-segments is rather over seventy in *Tipula*, while in *Cossus* it is about sixty. This surely shows greater complexity than the larger total, which is merely made up by the irrelative repetition of a lesser number of muscles in a greater number of segments.

The joints of the back in the larva of *Cossus*, like those of *Pygæra*, allow much less play than those of the ventral side, and we find the muscles entirely in accordance with this structure. On the contrary, in the larva of *Tipula* and of *Ctenophora bimaculata*, the back can be bent almost, if not quite, as much as the belly; and if this were not already known, it might be deduced from the arrangement of the muscles.

Lyonet remarks (p. 154, *l. c.*) that his "*a*," which corresponds to my 21, "est remarquable, en ce que, pendant que les autres muscles droits se terminent aux divisions de leurs anneaux, son extrémité postérieure passe au 4, 5, 6, 7, 8, et 9 anneaux cette division, et s'insère assez avant dans l'anneau qui suit; ce qui vraisemblablement a été ainsi

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* Mr. Walker was kind enough to name for me specimens bred from larvæ resembling, and found with, those which I dissected.

ménagé pour faciliter l'ondoyement que fait le corps de la chenille quand elle marche, et qui en rend le mouvement progressif plus aisé que s'il étoit vermiculaire."

It is hardly necessary to say, that there is no similar muscle on the dorsal side in *Cossus* or in *Pygæra*. In *Tipula*, on the contrary, there is a dorsal muscle to which these remarks would well apply.

The great flexibility of the back shows itself, however, in many other ways. In *Tipula* there lie upon each side of the muscle 6, which is here represented by four distinct fascicles, five muscles, corresponding to 16, 17 and 18 on the ventral side; those on the other side being apparently a great development of 2, which becomes almost as important as 16, 17 and 18 together. Moreover, 1 and 21, instead of having their anterior terminations a little behind those of 16, 17 and 18, completely alternate with them; and, again, there are other muscles whose posterior insertions are close to those of 1 and 21, while they pass as far forwards as 2 on the one hand, and 16, 17 and 18 on the other. These arrangements must make the body much more supple.

Once more, there are strong oblique muscles both at the back and at the ventral side, which must give the animal great powers of twisting itself forward with a corkscrew-like motion.

I hope, however, at some future time to be able to lay before the Society a complete account of the muscles of these larvæ, which I have dissected and figured with great care, and shall content myself at present with mentioning one other remarkable peculiarity.

The muscles of the first four body-segments are alike, and very different from those of the posterior somites; we must suppose, therefore, either that the thorax of insects has in reality four segments, or that the muscles of the first abdominal or last cephalic segment have become developed like those of the thorax; in fact, that the first segment of the abdomen, or the last of the head, has detached itself from its usual position and joined itself to the thorax.

The latter hypothesis seems to me more probable, and it is also supported by the position of the anterior ganglia, which are contained in the second segment (first body-segment), and that of the labium, which also rises in this segment, although its upper surface has partially coalesced with the under side of the head. I am reminded, however, by Prof. Huxley that neither of these conditions is conclusive. The anterior abdominal ganglia not unfrequently move forwards into the thorax, so that the cephalic ganglia may perhaps in this case be moved back; and the labium, not being homologous with a pair of coalesced appendages, but simply a protrusion of the sternal surface, may perhaps in this case have carried out with it a portion of the sternum of the first thoracic segment, in addition to that belonging to the second maxillary segment, of which it normally consists.

Dr. Ratzeburg was under the impression that the last segment of the head put on a thoracic character in the larvæ of certain Hymenoptera. Mr. Westwood, however, has thrown great doubt upon this supposition, if indeed he has not disproved it altogether*.

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* See the Trans. Ent. Soc. vol. ii. p. 125, and Todd's Cyclopædia, article Insecta, p. 871.

DESCRIPTION OF THE PLATES.

TAB. XXXIV. AND XXXV.

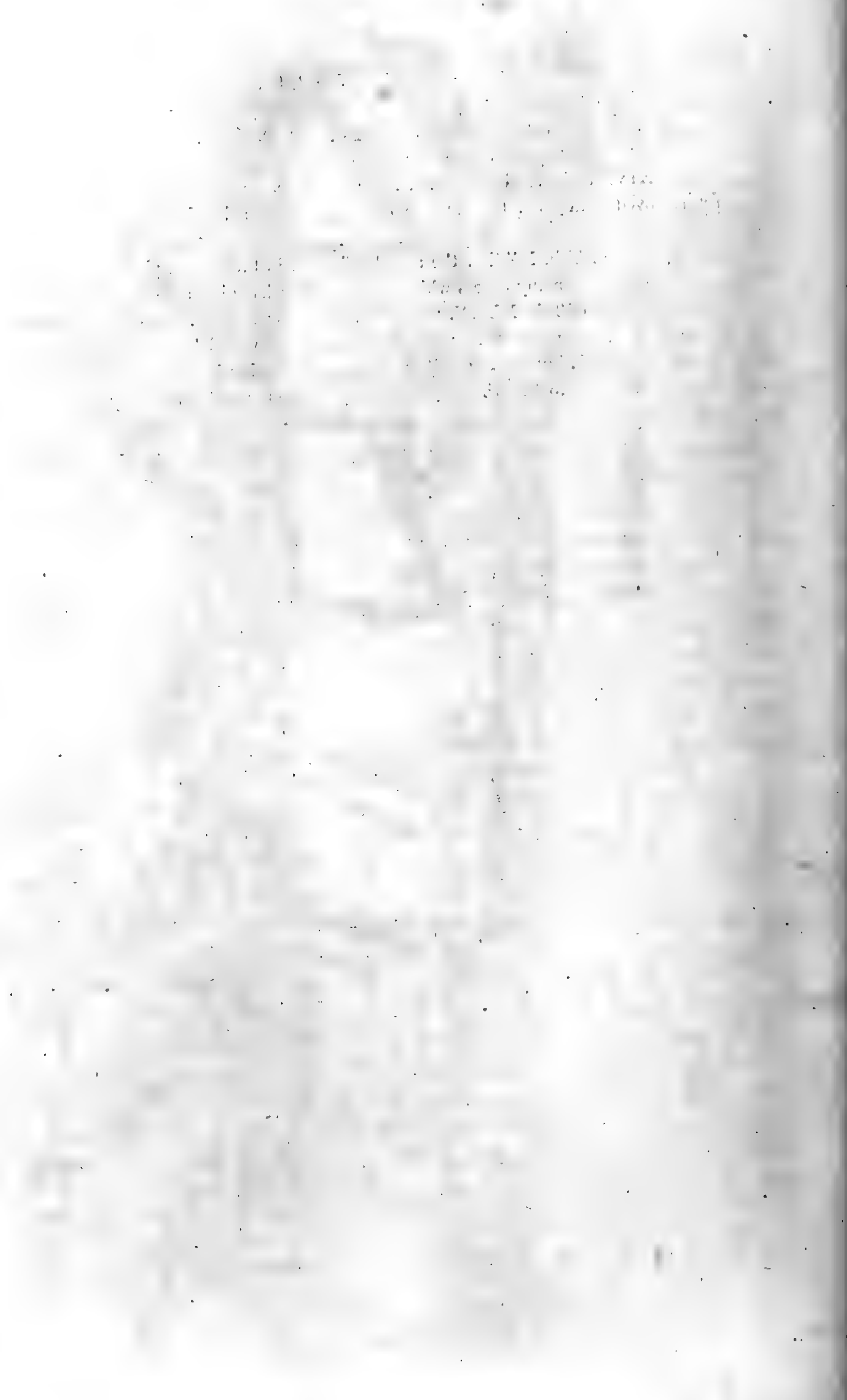
In Tab. XXXIV. the insect is supposed to have been cut open down the side, the internal organs to have been removed, and then the skin to have been flattened. The muscles of one side only are represented.

In the first figure of Tab. XXXV. the muscles figured in the former plate are supposed to have been cut away, so as to expose many others which would at first have been partly concealed.

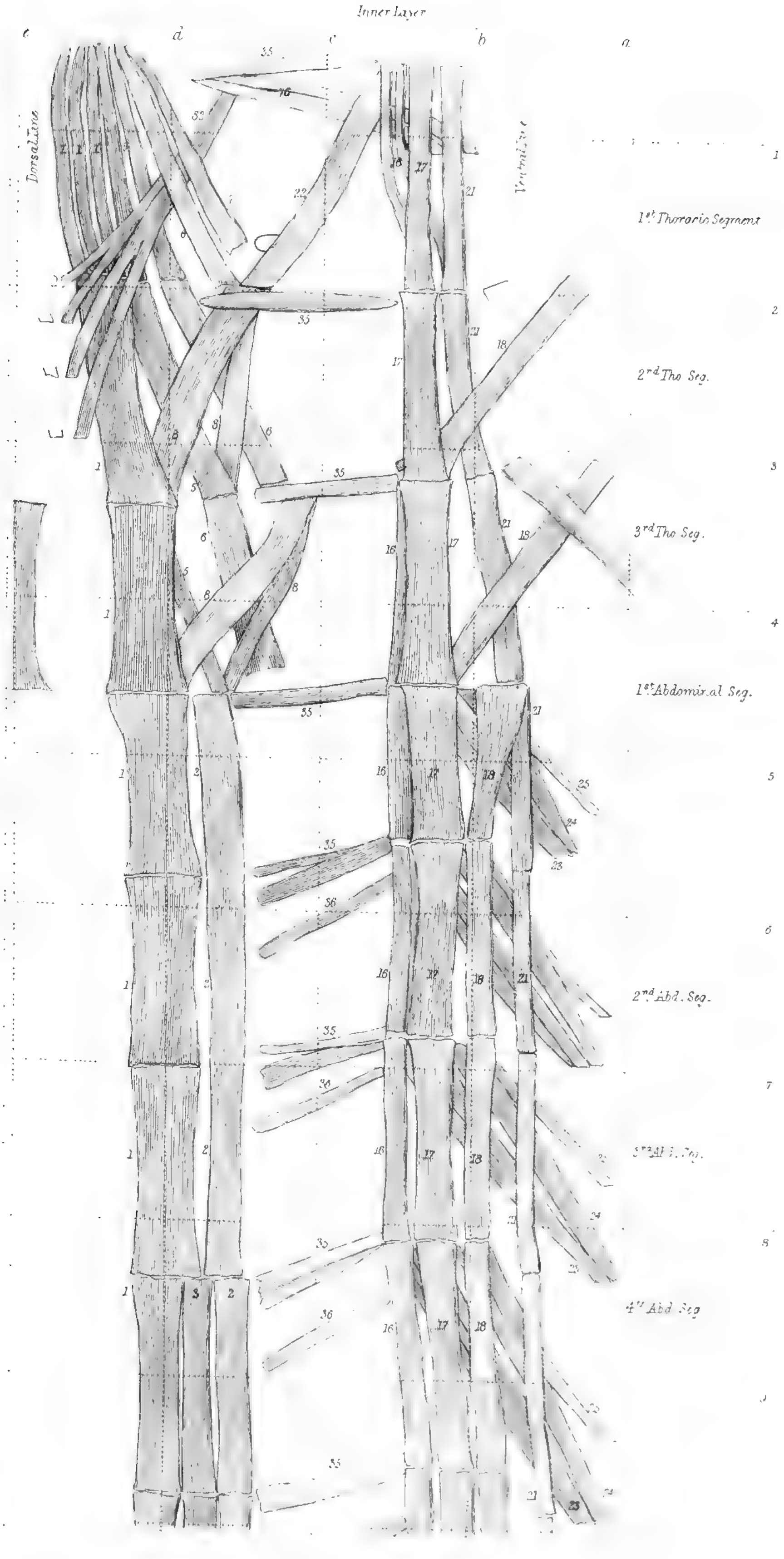
In the second figure of Tab. XXXV. the remainder of the cutaneous muscles are represented.

Of course the muscles represented in the last two figures would have partly appeared between those figured in Tab. XXXIV., but I thought it would cause confusion if they were inserted more than once.

All three figures refer to the three thoracic and first four abdominal segments, and are magnified about 8 times.



Pl 1 Fig 1



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XIV. *On the Agamic Reproduction and Morphology of* Aphis.—Part I. *By* THOMAS H. HUXLEY, *F.R.S., Professor of Natural History, Government School of Mines. Communicated by* G. BUSK, *F.R.S., F.L.S.*

Read November 5th, 1857.

§ 1. Preliminary Remarks.
§ 2. The Viviparous Female, and the Development of the Pseudova.
§ 3. The Oviparous Female, her Reproductive Organs and Ova.
§ 4. The Development of the Pseudovarium in the Viviparous Female.
§ 5. Summary; and Comparison of Germs and Ova.
§ 6. Hypothetical Explanations of Agamogenesis.
§ 7. Classification of the Phenomena of Agamogenesis.

§ 1. *Preliminary Remarks.*

"J'AI souvent pensé qu'on pourrait, dans l'histoire des sciences, désigner les époques par les principales découvertes. Par exemple, 1665 seroit *l'époque de la Gravitation*; 1789, *l'époque de la méthode naturelle en Botanique*; et, *si parva licet componere magnis*, les années 1740 à 1750 seroient *l'époque des Pucerons*[*]."

Without, perhaps, being disposed to go so far as the enthusiastic French investigator of Plant-lice, no physiologist will deny that the experiments conceived and attempted by Réaumur, but first successfully carried out by Bonnet, established facts of the highest importance, and raised questions which still disturb the very foundation of his science.

But what were these great facts, established by Bonnet and his successors or contemporaries, Trembley, Lyonet, Degeer, Kyber, and others?

If the moderns paid due attention to the labours of their predecessors, an accurate answer to this question should be found in every accredited text-book on zoology. But it will be found, on the contrary, that important errors have crept into the current conceptions respecting the reproductive processes and mode of life of the *Aphides*, and that at the present day the state of general information as to the natural history of these singular creatures is in many respects rather behind, than in advance of, that of the past generation.

Bonnet's wonderfully patient and laborious researches[†] proved, beyond all doubt, 1st, that the viviparous *Aphis* may propagate without sexual influence; 2ndly, that the brood thus produced may give rise to young in the same way; that these may repeat this asexual prolification; and so on for as many as ten broods; 3rdly, that the viviparous *Aphides* and their brood may be either winged or apterous; 4thly, that, under certain conditions, winged or wingless males appear and copulate with oviparous females, which, in the instances observed by Bonnet, were wingless.

These are the statements put forth by Bonnet on the evidence of direct observation

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[*] Duvau, Mém. du Muséum, xiii. 1825.

[†] Traité d'Insectologie, 1745.

and experiment, and they have been confirmed by every subsequent original observer whose works I have perused. Besides these matters of fact, Bonnet states, as his strong opinion, that there is no fixed limit to the process of agamic, viviparous reproduction, and that, under favourable conditions of warmth and nourishment, it might be continued for "thirty generations" (*l. c.* p. 102), or, in other words, indefinitely.

The accurate and pains-taking Degeer, who gives an elaborate account of some seventeen species of *Aphis,* affirms as the result of his researches, "that the winged *Aphides* are never oviparous*." He describes at length the apterous males of certain species (P. lisse du Pin, P. du Pommier, P. du Genévrier), and shows that apterous, oviparous, and winged viviparous broods may coexist, as in *Aphis Rosæ.*

Degeer considers that, as a general rule, the oviparous females and the males are produced by alate viviparous females.

The next important original memoir on the *Aphides* is that published in Germar's Magazin der Entomologie for 1815, by Kyber†, evidently a most careful observer, but somewhat wanting in method and clearness as a writer. Kyber is in perfect accordance with Bonnet and Degeer; and more than this, he experimentally proved the justice of Bonnet's supposition, that the duration of the agamic reproductive power is practically indefinite, and is chiefly, if not wholly, dependent on conditions of temperature and nutrition. He says (p. 34):—

"I never saw a male in copulation with a winged female in any species. It was always the apterous females which were attacked by the males; for in many species apterous females remain among the families. Neither have I ever seen winged females lay eggs. This has, indeed, been already remarked by Degeer."

In a note Kyber adds the caution, that he has not observed more than twenty species in copulation, and does not wish to extend his conclusions beyond these.

The fourth note to this important paper contains the following remarkable observation:—……"The winged females especially, in which, even after frost has set in, fully-formed young may always be found, when the apterous females of the same family have long been laying eggs. On the 21st November, 1812, I still had winged *Aphides* (Haberblattläuse) in my possession, although the apterous ones had copulated and laid their eggs in September,—a remarkable circumstance without doubt, and one whence important conclusions with regard to the mode of propagation of the *Aphides* are likely to flow. Possibly, many winged females survive the winter together with their young." (p. 10.)

In other parts of his memoir (p. 2 *et seq.*), Kyber adduces strong evidence in favour of the hybernation of the viviparous forms of some species; which Degeer had already proved to be the case with respect to the remarkable "Puceron des Galles du Sapin."

In the *Aphis Dianthi,* Kyber was never able to observe either copulation or oviposition; and so far from there being any natural term to the number of asexual broods which succeed one another, he states that he raised viviparous broods of both this species and *A. Rosæ* for four consecutive years, without any intervention of males or oviparous

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* Degeer, Mém. sur les Insectes, 1774, vol. iii. p. 74.

† Einige Erfahrungen und Bemerkungen über Blattläuse von J. F. Kyber, Diacon. in Eisenberg.

females, and that the energy of the power of agamic reproduction was at the end of that period undiminished. The rapidity of the agamic prolification throughout the whole period was directly proportional to the amount of warmth and food supplied.

Duvau, in his already cited "Nouvelles Recherches sur l'histoire naturelle des Pucerons," read before the French Academy of Sciences in 1825, states that he had carried the series of successive agamic generations in the *Aphis* of the Bean (fêve) to *eleven*, which was one more than Bonnet had obtained. The process lasted seven months, and the last young was born on the 27th December, but died on the 29th. Duvau, however, kept some alive until January, and naturally asks whether it is not probable that, under favourable circumstances, the agamic process may be continued throughout the winter. The average length of life of his *Aphides* was thirty days, or a little more; but the representative of the ninth generation lived from September 29th to December 19th, or eighty-one days. Like those of preceding observers, Duvau's researches clearly show the influence of temperature on the fecundity of the viviparous *Aphis*.

It is in Morren's in many respects valuable paper on the *Aphis Persicæ*, published in the 'Annales des Sciences Naturelles' for 1836, that the germs of the two most notable errors which have crept into the natural history of the *Aphides* may be found. At p. 76 the following passage occurs*:—

"The influence of temperature on these animals is obvious; in other *Aphides*, and under ordinary circumstances, the female lays her eggs when she has wings and after copulation with the male, who is winged at the same epoch. Oviposition takes place in this manner at the seventh generation for some—at the ninth or even at the eleventh for others; before it, female larvæ alone are produced."

Morren here supposes himself to be simply repeating what he has read. But so far as I am acquainted with the older literature of the *Aphides*, he is entirely mistaken. I can nowhere discover that either Réaumur, Bonnet, Degeer†, Kyber, or Duvau have observed winged oviparous females in any species; nor do the statements of any of these observers justify the belief that the sexual forms always appear after a certain number of generations. All that Bonnet affirms is, that his particular experiments came to an end accidentally after the production of a certain number of agamic generations, which is, of course, quite another matter.

When Morren details his own observations, his results are in exact accordance with those of the older observers. "In the *Aphis Persicæ*," says he, "I have very frequently seen (and I have shown the phenomenon to my colleague, M. Burgraeve) that the winged and fertilizable female never contained ova and never laid any, but that she contained little living *Aphides*, which are born fully developed, and provided with legs, proboscis, and

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* "L'influence de la température sur ces animaux est manifeste; chez les autres pucerons, et dans les circonstances ordinaires, la femelle pond des œufs lorsqu'elle est ailée, et après un accouplement avec le mâle ailé à la même époque. Cette ponte se fait ainsi à la septième génération pour les uns, à la neuvième ou même à la onzième pour les autres; avant elle, il y a seulement naissance de femelles naissant à l'état de larves."—Morren, *l. c.*

† Degeer's account of the gall-forming Puceron du Pin is an apparent exception to this statement, but I believe only an apparent one. Degeer expressly states that he never saw the winged form of this species in copulation; and, besides, it is not a true *Aphis* at all.

antennæ. It was only in November that the apterous females presented eggs in their ovaries and oviducts, and for that effect, a considerable degree of cold was necessary*."

Morren describes the male, female, and agamic organs of reproduction, but less completely than Von Siebold, who, in 1839†, carefully investigated the *Aphis Lonicerœ*, and first demonstrated the existence of the spermatheca and colleterial glands in the oviparous females. Von Siebold distinguishes three forms of this species, two winged and one apterous. The large winged *Aphides* were all viviparous; the smaller, males. The apterous forms were oviparous, and the progeny of the alate females.

Steenstrup says of the *Aphides* (Alternation of Generations, p. 108), "The propagation of these creatures through a series of generations has been already long known. In the spring, for instance, a generation is produced from the ova, which grows and is metamorphosed, and without previous fertilization gives birth to a new generation, and this again to a third, and so on for ten or twelve weeks; so that in certain species even as many as nine such preliminary generations will have been observed; but at last there always occurs a generation consisting of males and females, *the former of which* after their metamorphosis are usually winged; fertilization and the depositing of eggs take place, and the long series of generations recommences in the next year and in the same order."

In the first edition of Professor Owen's 'Lectures on the Invertebrata,' published in 1843, however, Morren's errors are adopted, extended, and enunciated as the law of propagation of the *Aphides*, in the following terms:—

"In the last generation, which is the seventh, the ninth, or the eleventh, according to the species of *Aphis*, the fertilizing influence would seem to have expired‡, and developmental force exhausts itself in more frequent and numerous moultings, in the formation of wings, and in the modification of the female organs already described. Many males, which, like the females, acquire wings, form part of the produce of the last brood, which takes place in autumn. They rise in the air, frequently migrate in incalculable numbers, unite, and the females then produce eggs, which are glued to twigs and leafstalks, retain their vitality throughout the winter, are hatched in the spring, and give birth to the apterous and larviparous females, which continue to produce successive generations of similar females until the close of summer." (p. 235.)

It has not been my good fortune to discover, either in Prof. Owen's writings or those of his predecessors, any evidence in support of the singular statement contained in the last paragraph of this citation, which is incorrect in all important respects, and has, indeed, been omitted in the second edition of the 'Lectures.'

Mr. Walker, in the first of his long and valuable series of papers on the *Aphides* (Annals, vol. i. 1848, p. 259), writes thus:—

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* "Or chez le puceron du pêcher j'ai vu un grand nombre de fois, et j'ai montré le phénomène à mon collègue, M. Burgraeve, que la femelle ailée et propre à la fécondation ne renfermait point des œufs et n'en pondait point, mais qu'elle renfermait des petits pucerons vivants qui naissent tout développés avec leurs pattes, leur trompe, et leurs antennes. Ce ne fut qu'en Novembre que les femelles sans ailes présentaient des œufs dans les ovaries et les oviductes, et pour cela il fallait un froid déjà assez vif."—Morren, *l. c.* p. 76.

† Ueber die inneren Geschlechtswerkzeuge der viviparen und oviparen Blattläuse. Froriep's Neue Notizen, 1839.

‡ This phrase is little more than a translation of a passage in Morren which will be given below.

"I am indebted to my friend Mr. Haliday for the following translation of an extract from Erichson's Bericht, &c., 1844, Ent. Zeitung, pp. 9, 81, 133, 410. Ratzeburg observed a species of *Aphis* on the Birch, which continued to produce a living progeny from August into winter without either male or female appearing. Bouché and Kaltenbach, in explanation, remark that the males in this family are not always winged. However, in the May following, Ratzeburg, continuing his observations, found the winged females, and afterwards (in October) winged males also, which paired with them. The species was then identified as *A. oblonga*, Von Heyden. For the male to pair with a winged female (continues Mr. Walker) is a very unusual case among *Aphides**." In fact, I have hitherto found, in Mr. Walker's long list of 101 species, no case of an oviparous winged female observed by himself. Mr. Walker states as a known fact, that *Aphis Rosæ* habitually lives through our mild winters.

In his work on 'Parthenogenesis' (1849), Prof. Owen modifies his previous statement so far as to say, in a note (p. 59), that the perfecting of the female generative organs in *Aphis* "is not attended by the acquisition of wings; or if they be developed in the oviparous female, they soon fall. I have, however, retained them in the diagram for a better illustration of the analogy. Many of the virgin viviparous *Aphides* acquire wings, but never perfect the generative organs."

The diagram referred to exhibits two figures, (*h*) and (*i*), which, for anything that appears in the text, might be taken to be the author's representation of male and female *Aphides*. On comparing them with the illustrations of Morren's memoir, however, it is at once obvious that they are copies of his figures 1 and 2, of which fig. 2 does really represent a male; while fig. 1, on the other hand, is not an oviparous, but a viviparous female. In the explanation of his figures, Morren indeed merely says of fig. 1, "Femelle vue en dessous;" but it requires no great amount of attention to his text to observe his distinct statement (already quoted), that the winged female is viviparous, and not oviparous. I am obliged to be thus particular in explaining these unusual circumstances, as otherwise the existence of a typical figure of a winged oviparous female *Aphis*, in the work of an accredited author, might be brought forward as conclusive evidence of the ordinary occurrence of such females†.

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* On turning to Ratzeburg's notice in the 'Entomologische Zeitung,' 1844, p. 410 (Fortgesetzte Beobachtungen über die Copula der Blattläuse), which is the last word of the correspondence between Kaltenbach, Bouché and himself on this subject, I find his precise words to be these:—"Wie gross war daher mein Erstaunen, als ich bei meiner ersten, nach der Rückkehr angestellten Excursion, am 22 October gleich auf den ersten Blick unter der Menge von *ungeflügelten Individuen*, welche die des vorigen Jahres bei weitem übertraf, auch *geflügelte Puppen* und *geflügelte Männchen* bemerkte, und wie gross war meine Freude, auch gleich darauf mehrere der letztern in der Begattung zu finden, also in einem Acte, den ich bei Blattläusen selbst noch nicht hätte beobachten können." Subsequently, Ratzeburg states that he was able to observe the copulatory process early and late, at any time between the 22nd October and the 16th November.

It will be observed that there is not a word here about such winged females as Ratzeburg, in a preceding passage, states he saw in May of the same year. The winged pupæ are apparently, from the context, the pupæ of the males, and the forms with which the winged males copulated were the wingless females. So that here, as in all other supposed cases of winged, oviparous true Aphides I have looked into, the evidence, when closely examined, breaks down.

† Professor Owen, in the last edition of his 'Lectures on the Invertebrata,' p. 410, quotes Léon Dufour as having witnessed the coitus of the male Aphis "with the winged female." The reference is to "Dufour, Léon, in Annales

When the natural history of the *Aphides* is freed from the mythical additions which have accumulated around, and obscured it, I believe the following propositions may be said to be established on good evidence:—

1. Ova deposited by impregnated female *Aphides* in autumn are hatched in the spring.
2. From these ova, viviparous, and in the great majority of cases apterous, forms proceed.
3. The broods to which these give rise are either winged or apterous, or both.
4. The number of successive broods has no certain limit, but is, so far as we know at present, controlled only by temperature and the supply of food.
5. On the setting in of cold weather, or in some cases on the failure of nourishment*, the weather being still warm, males and oviparous females are produced.
6. The males may be either winged or apterous.
7. So far as I am aware, there is no proof of the existence of any exception to the law that the oviparous female is apterous.
8. Viviparous *Aphides* may hybernate, and may co-exist with oviparous females of the same species.

So much by way of clearing the ground. I now proceed to the particular subject of this paper, which is primarily, to describe the nature of the process by which the agamic young arises within the body of its viviparous parent. But very few investigators have applied themselves to this question, and those who have are unfortunately in diametrical contradiction to one another as to the most important points.

Prof. Leydig published a notice on this subject in the 'Isis' for 1848, which I have not seen; but subsequently his views, fully stated and accompanied by figures, were promulgated in Siebold and Kölliker's Zeitschrift for 1850, vol. ii. Heft 1. He maintains "that the germ of the (viviparous) Aphis is developed out of cells, and its embryo is as much composed of cells as one which has proceeded from a fecundated ovum" (*l. c.* p. 65). And he particularly details the manner in which one of the large cells contained in the terminal chamber of the proliferous organ of the viviparous *Aphis* becomes detached, enlarges, and is converted into the embryo. Although Leydig does not absolutely say as much, his observations lead to the conclusion that there is no histological difference between the agamic germ in its youngest state, and a true ovum at a corresponding period.

Von Siebold implies, and Prof. Owen, Victor Carus, and the late Dr. Waldo Burnett assert, with different degrees of distinctness, on the contrary, that there is a clear histolo-

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des Sciences Naturelles, vol. i. 1844." I have carefully, and more than once, scrutinized this volume of the 'Annales,' without having been able to discover the passage referred to. Léon Dufour has, in fact, two memoirs in the first volume of the 'Annales' for 1844. The first is on the "Anatomie générale des Diptères;" the second, "Histoire des Métamorphoses et de l'Anatomie du *Piophila Petasionis*." As might be expected, there is no reference to the *Aphides* in either of these papers.

Finally, the authors of the article "Hémiptères" in the 'Suites à Buffon' (1843), p. 600, quote De la Hire as their authority for saying that the oviparous female *Aphis* is winged. I have examined the passage cited (Histoire de l'Acad. Royale des Sciences, 1703), however, and I find only this:—

"M. de la Hire *croit* que les pucerons vivent une année entière, et que pendant l'hiver ils se retirent dans des trous, d'où ils sortent au printems pour pondre leurs œufs, comme le font les mouches ordinaires."

* See Hausmann's "Beiträge" in Illiger's Magazin, Bd. 2.

-gical difference between the primary germs of the viviparous *Aphis* and true ova,—Carus and Burnett reiterating their opinions even since the publication of Leydig's views. Finally, Mr. Lubbock, in his late valuable memoir on *Daphnia*, (Phil. Trans. 1857) has expressed his inability to find any germinal vesicle in the germs of the viviparous *Aphis*, and, so far, may be ranked among Leydig's opponents.

I have recently resumed some investigations commenced two or three years ago on this interesting subject. My object was originally purely morphological,—the *Aphis* suggesting itself as a very convenient subject for working out the general development of *Insecta*; but I have found myself unable to refrain from wandering out of my direct course, and attempting to further the solution of the great problem of Agamogenesis, or asexual reproduction.

My observations are in the main in accordance with those of Leydig. On many minor points, however, we are at variance; and besides this, there are matters of great interest, upon which Leydig does not touch, but on which I hope to be able to throw some light. For, besides yielding an answer to the question as to the existence or absence of any histological distinction between a bud and an ovum, the investigation of the viviparous and oviparous *Aphides* affords decisive evidence as to the soundness of certain explanations of the phenomena of Agamogenesis in general; and finally, the study of the general development of *Aphis* furnishes data of great importance in Articulate Morphology.

I propose in the present memoir to follow out these lines of inquiry. I will in the first place describe the minute structure of the essential reproductive organs or "Pseudovaria" of the viviparous or agamic female; and the development of its germs or pseudova (as I propose to term them) will be considered. Secondly, the reproductive organs of the oviparous female and the development of the ova will be described. Next, I shall speak of the manner in which the proliferous apparatus or pseudovarium of the viviparous female is developed within the germ; and I shall compare together the agamic and sexual reproductive processes. I shall then endeavour by means of these facts to refute a hypothesis which has been offered in explanation of Agamogenesis; and finally, I propose to consider the Morphology of the *Articulata* so far as it is elucidated by Development.

The species of *Aphis*, the reproductive organs of whose viviparous form I am about to describe, appeared this autumn upon a plant of the Ivy-leafed Geranium which hangs in my study, and for the last two months has been regularly giving rise to broods, sometimes winged and sometimes apterous, without any appearance of males or females. With respect to the external characters of the reproductive organs, I have nothing of importance to add to Siebold's or Morren's description.

§ 2. *The Development of the Pseudovum.*

The terminal chamber of any of the cæca of the pseudovarium is a rounded or oval body (Pl. XXXVI. fig. 1, A), united by a delicate ligament (*a*), proceeding from its free end, with the ligaments which pass from the other cæca of the same side, to form the common pseudovarian ligament. The wall of the chamber is a delicate transparent membrane (*b*), in which, here and there, rounded endoplasts (or nuclei) are imbedded; while others lie on its inner side, constituting a sort of epithelial layer (*c*) continuous with the contents of the chamber. These, when perfectly unaltered, are constituted by a homogeneous pale periplastic substance (*d*), containing about a dozen clear spheroidal cavities (*e*) whose walls are a little denser than the rest of the periplast. The cavities have on an average a diameter of $\frac{1}{3000}$th of an inch. In the centre of each is a rounded opake body (*f*) like one of the endoplasts of the wall of the dilatation, and, indeed, obviously of the same nature.

In whatever fluid I have examined this tissue, it began after a time to alter. In the very weak syrup which I ordinarily employed, the change consisted partly in the slightly increased definition of the walls of the clear cavity, but more particularly in the breaking up of the periplast into spheroidal masses, each of which contained a single vesicle and its endoplast*. The resemblance of such a body to an ovum with its germinal vesicle and spot is complete; nor would it be possible for any one ignorant of the origin of the body to say that it was other than an ovum. Water instantly alters the appearance of the tissue, completely destroying its distinctive character. Dilute glycerine shrivels up the vesicles and alters the appearance of their central endoplast, probably by endosmose. Acetic acid renders the periplast dark, and gives an exceedingly marked definition to the parietes of the vesicle. To see the appearances I have described as normal, the part must be examined perfectly fresh, and in a solution of sugar neither too dilute nor too concentrated.

In certain specimens the contents of the lower part of the terminal chamber are different from those of the upper. As much as a third of the whole chamber may be occupied by a mass of periplast containing only a single clear vesicle. Such a condition is figured in fig. 1, Pl. XXXVI. Fig. 2 exhibits a further advance in the same direction; the mass, which, from its close resemblance to a true ovum, I have called a pseudovum, having enlarged so much as nearly to equal the contents of the terminal chamber, from which it is distinguished by a slight constriction. In figs. 3 and 4, the constriction has become more marked, until at length a penultimate chamber is formed, connected only by a narrow neck with the terminal one, fig. 4. It is on an average about $\frac{1}{500}$th of an inch in diameter. The epithelial layer (*c*) of its wall is ordinarily well developed, and when water is added swells up, so as to separate the periplastic substance of the pseudovum from the wall. The periplast itself exhibited no structure, and appeared unchanged except in size. The clear vesicle was sometimes unchanged, sometimes enlarged, but otherwise unaltered. Of its endoplast I was sometimes unable to discover any trace; on other occasions I found a few granules in its place (fig. 3); and, once, two particles, each rather more than half its diameter, appeared to lie side by side in the interior of the vesicle.

The marked contrast between the perfect distinctness of the endoplast in the vesicles contained in the ultimate pseudovarian chamber, and its apparent absence in the very similar vesicle of the mass contained in the penultimate chamber, or in the lower part of the last one, was the more striking, as the two could be readily compared under the same circumstances and in the same field of view.

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* Leydig (*l. c.* p. 63) appears to regard this as the first state of the ovigerms, and he has overlooked the epithelium.

Finally, the vesicle itself ceases to be visible (fig. 4), and the penultimate chamber contains only its epithelium and a mass of apparently structureless substance;—I say apparently structureless, because the addition of water made the mass more clear, and at the same time rendered an irregular areolation and scattered granules visible in its substance. Whether the areolæ are the outlines of delicate vesicles, and the granules their endoplasts, or not, are points which I could not satisfactorily determine; at any rate, I could never observe anything like the regular structure observable in the contents of this chamber when a little larger.

Fig. 5 represents such a chamber, $\frac{1}{417}$th of an inch in length. The endoplasts of the wall are seen lying in or upon it, and occupying its interior is a distinct oval mass of substance agreeing in appearance with the periplast of the pseudovum, but distinguished from it by containing a great number of clear spheroidal cavities not more than $\frac{1}{3200}$th of an inch in diameter, each of which contains a central endoplast of not more than $\frac{1}{10000}$th of an inch. These cavities are closely packed, but not flattened against one another. The walls of the cavities react differently on the addition of acetic acid to the rest of the periplast, becoming darker and more sharply defined. In fact, each cavity is what is commonly termed a nucleated cell, while the intervening periplast is the so-called intercellular substance.

I have here stated merely the histological facts which may be observed by any one who will take the trouble to examine with sufficient care the ultimate and penultimate pseudovarial chambers of a few viviparous *Aphides*. Of the existence of these states, and that the order in which I have detailed them fairly represents the order in which they succeed one another in nature, I have no doubt; and I therefore look upon it as an established fact, that the primary steps in the agamic development of *Aphis* are, first, the enlargement of the periplast around one of the pseudovarian vesicles, and its detachment as a separate body, which, from its resemblance to an ovum, I will call a "pseudovum;" secondly, the contemporaneous formation of a distinct chamber—the penultimate chamber of the pseudovarium; thirdly, the disappearance of the vesicle of the pseudovum, and the conversion of the latter into a germ-mass composed of cells imbedded in intercellular substance and containing minute endoplasts.

I should be sorry, however, to express an opinion as to the exact nature of the process by which these changes are effected, with anything like the same degree of confidence. Three hypotheses present themselves:—

1st. The pseudoval endoplast divides and subdivides, so as to give rise to the endoplasts of the germ; or—

2nd. The pseudoval endoplast is resolved, and the endoplasts of the germ are developed autogenously in its periplast; or—

3rd. The pseudoval endoplast disappears, and the endoplasts of the germ are supplied from the epithelium of the walls of the pseudovarial chamber.

Of these three hypotheses, I strongly incline towards the first, as most in accordance with what we know of histological development in general. The whole progress of modern research, in fact, goes to show that cells and endoplasts hardly, if ever, arise autogenously, but are the result of the subdivision of pre-existing cells and endoplasts. If this be the case, however, the second hypothesis is excluded, and the third is improbable in itself, and is supported by no evidence. In the absence of such evidence, the marked contrast in size and appearance between the epithelial endoplasts of the penultimate chamber and those of the germ tends to show that the two have no direct relation to one another.

Those who have followed the details of the development of the pseudovum and its resulting germ, given above, will not fail to admire the clear insight of Morren, when he affirmed that the agamic offspring of *Aphis* was developed by "the individualization of a previously organized tissue." A more neat and expressive definition of the process could not be given: and as Morren nowhere entertains the absurd doctrine that an organized tissue must be as complex as "mucous membrane" or "muscular fibre," which has been attributed to him, the criticisms to which his views have been subjected on this ground are sufficiently baseless. No one will pretend to deny that the pseudovarium is "organized," nor that the pseudovum is a portion of it which has become "individualized." But I subjoin Morren's words, that the reader may form his own judgment as to his merits :—

"A dire vrai, je me refuse à émettre une opinion au milieu d'un tel dédale, et je tiens pour plus philosophique d'avouer son ignorance dans un phénomène où la nature nous refuse même l'apparence d'une explication. S'il fallait une explication à toute force, j'admettrais que la génération se fait ici comme chez quelques entozoaires, *par individualisation d'un tissu précédemment organisé.* La génération n'est pas pour cela spontanée: une *génération spontanée* doit être la production d'un être organisé de toutes pièces, lorsque les élémens inorganiques se réuniront pour produire un animal, une plante. Cette génération est impossible et n'a jamais lieu. Une *génération équivoque* est celle où des tissus organisés préalablement par un être déjà pourvu de vie, s'individualisent, c'est à dire, se séparent de la masse commune et participent encore, après cette séparation de l'état dynamique de la masse, c'est à dire, de sa vie, mais à son propre profit. C'est ainsi qu'un tissu produit un entozoaire*. C'est de la vie continuée. Mais supposez que la vie ait assez d'énergie pour imprimer au tissu que s'individualise la forme de l'espèce productrice, et vous avez la génération des pucerons. Cette énergie se perd au bout de quelques générations, et une nouvelle impulsion devient nécessaire, c'est celle du mâle.

"Voilà à tout hasard, une hypothèse que dans ma jeunesse j'aurais embrassée avec plaisir; mais aujourd'hui je préfère douter: les faits que j'ai exposés plus haut valent mieux qu'une théorie."—Morren, sur le Puceron du Pêcher, Annales des Sc. Nat. série 2. vi. 1836, p. 90.

§ 3. *Description of the Oviparous Female Aphis and of the Development of the Ovum.*

Throughout the two months during which the Ivy-leafed Geranium, on which my viviparous *Aphides* are living, has been in my possession, neither males nor females have

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* I need hardly remark, that no evidence of the development of *Entozoa*, in the way supposed by Morren, is in existence.

made their appearance. Therefore, being extremely desirous to compare the process of the development of the germ with that of the ovum, before completing this paper, I began in the last days of October to seek for oviparous females of some other species.

An Oak-tree in the Zoological Gardens at length supplied me with that which I sought. The small twigs and leaves afforded habitation to a number of minute wingless *Aphides*, all so nearly equal in size, that I did not doubt their non-viviparous, and hence in all probability their oviparous character.

Microscopic examination fully confirmed my suspicions; for not only were the *Aphides* full of ova, but I found multitudes of similar ova adhering to the plant in the axils of the leaves, and more particularly between the outer bracts of the buds*.

These *Aphides* were very different from my viviparous species. They were about $\frac{1}{12}$th of an inch in length. The general hue of the body was pale green; but it was diversified in the dorsal region by four longitudinal rows of blackish rounded spots, one spot in each row being seated on the tergum of most of the somites, from the prothorax backwards. Hence, there were nearly as many transverse rows of four spots each, as segments of the body. The two median spots in each row were larger, and situated close to the middle line. The external spots were more upon the sides of the body. The spots upon the mesothorax, and thence to the sixth abdominal somite inclusive, were the largest and most conspicuous. Each spot was constituted by a dark elevation of the integument, which supported a tuft of long setæ, knobbed at their extremities like the glandular hairs of certain plants. The hairs were not confined to these localities, however, but were scattered over the head and other parts of the body. The eyes were red, and produced into a small tubercle on their posterior margins. The distal portions of the antennæ, and the tarsi, were blackish. The antennæ were not more than equal to half the body in length; they were seven-jointed, the penultimate joint being somewhat swollen at its extremity. Both this and the preceding and following joints were so sculptured as to appear, at first, minutely annulated. The basal joint was the thickest of all, the second less thick, but stronger than the others. The proximal half of the antennæ was sparsely setose. The promuscis was short, extending, when deflexed, no further than the posterior edge of the prothoracic sternum. The abdomen tapered into a cone beyond its sixth somite, on whose dorso-lateral region the very short trumpet-mouthed siphons were situated. The abdomen was terminated by two subcylindrical rounded setose tubercles, of which the lower was the larger. They had the anus between them, and acted as anal valves. The posterior limbs, when fully extended, hardly reached beyond the end of the abdomen.

The eggs when first laid are of a dark green hue and very soft; afterwards they appear to become black.

The vulva of the oviparous *Aphis* (B) opens between the eighth and ninth abdominal sterna, the eighth (8) being a little prolonged, so as to form a sort of inferior lip to the vaginal aperture (Pl. XL. fig. 1). The vagina (C) is a thick-walled tube provided with a

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* I do not think that my *Aphis* of the Oak is identical either with that described by Réaumur, or that described by Bonnet. None of my specimens attained the size of theirs, nor do either of those writers mention the peculiar dorsal markings of my species: furthermore, the proboscis in both Réaumur's and Bonnet's was long; in mine it is very short. The proper specific names of both the *Aphides* alluded to in this memoir will be discussed in a final note.

layer of external transverse, and internal longitudinal, striated muscles. After entering the sixth abdominal somite, it divides into two branches—the oviducts (DD), whose walls exhibit the same muscularity, but are less thick. Both vagina and oviducts are lined by a well-developed epithelium.

The oviducts divide into four ovarian cæca, whose delicate structureless wall is unprovided with muscles, and lined by a columnar epithelium. Each cæcum is ordinarily divided by constrictions into six chambers. Of these I found the posterior (that nearest the vulva) (E) always empty, and of nearly the same length, though of a much smaller diameter than that which precedes it, or the fifth from the apex of the ovarium. This fifth chamber (F) always contained a fully formed ovum, provided with a chorion and an opake coarsely granular yelk.

The fourth chamber (G) is smaller than the fifth; it contains a coarsely granular vitelline mass in which no germinal vesicle can be perceived, and which ordinarily has no investing membrane.

The third chamber (H) is still smaller; and its contents are usually only slightly granular, so that the germinal vesicle and spot of the ovum in this chamber are beautifully distinct (fig. 2).

The second chamber (I) is the smallest of all; the germinal vesicle and spot of its rudimentary ovum can be easily seen; and but very few fine granules are deposited in the substance which will eventually form the yelk.

A clear cord-like mass (*q*), commonly divided longitudinally, so as to appear double, traverses this chamber, and can be traced into the next.

The apical chamber (K) is as large as the third, but is longer transversely than longitudinally, while the reverse is the case with the third chamber. Its outer wall is formed by a continuation of the same structureless membrane as that which constitutes the rest of the cæcum. The epithelium (*p*), which is particularly thick in the upper part of the second chamber, especially at the neck or constriction between the first and second, is suddenly attenuated as it spreads on the inner face of the wall of this chamber, and becomes very thin from the flattening of its cells. From having the characters of a cylinder-, it takes those of a pavement-epithelium.

It is at first extremely difficult to understand the nature of the contents of the apical chamber. All its anterior part appears to be filled with about a dozen closely appressed bodies (*l*), which, if examined without due attention, or under a low power only, may easily be confounded with ova. Each of these bodies has a sort of wedge shape, such as would result from the compression of rounded masses in a spherical envelope which they nearly fill. Its apex is turned inwards; its base outwards. Each consists of a thick transparent outer coat closely investing a denser and well-defined membranous sac. The latter contains a clear substance, in which many irregular granules are imbedded. The lines of separation between the appressed sides of these bodies are well seen, either in a sectional or a superficial view. In the latter case, they appear as polygonal meshes; in the former, as lines separating the bodies from one another, and bounding their curved bases on the side of the epithelium. On tracing the lines of separation towards the central interval between the ends of these bodies, they become lost, and a mere clear, homogeneous substance seems to occupy the whole central part of the chamber; but on carrying the eye backwards, this clear mass is seen to be continuous with the two cords which I have above described as entering the second chamber (Pl. XL. fig. 3).

The histological constitution of these bodies is at once sufficient to convince the observer that they are not ova, and I regard them as glandular masses which secrete the matter of the clear cord-like bodies which descend into the second and third chamber.

The ova themselves, or rather the rudiments of the future ova, are not always to be seen with ease; and if the epithelium of the lower part of the apical chamber has become much altered, they cannot be detected: for they are visible exclusively in this part of the chamber, of whose epithelial cells they are, as I believe, merely a modification. However this may be, germinal vesicles and spots of all sizes intermediate between that of the ovum of the second chamber and that of an ordinary epithelial cell are seen in close contact with the parietes of the chamber. I have detected as many as six in this position. When the chamber is subjected to compression they may be set free, and are then seen to be surrounded by a zone of clear substance, the rudimentary vitellus. Under similar circumstances, the "glandular bodies" may also be isolated; when they present themselves as vesicles surrounded by a clear homogeneous substance, which is frequently prolonged at their apical extremity. It is gradually dissipated, and the inner sac set free by the action of water.

I have not seen any ovarian ligament in the oviparous *Aphis*.

The structure which I have described was wholly unexpected and new to me; and I am not aware that anything similar has yet been noticed in the ovaria of Insects*. I am inclined to believe that the glandular bodies contribute directly to the formation of the vitellus, because I have more than once seen cases, like that figured in Pl. XL. fig. 3, where the clear cord-like body appeared to pass directly into the mass of the ovum. There was always a widely open communication between the first and second, and between the second and third chamber; but the passage between the third and fourth was closed by the meeting of the epithelial lining. Does each ovum, as it is given off from the ovary, and passes backwards, carry with it a gelatinous mass, the product of one half of the glandular bodies, and only cease to be connected with these glands when it has taken the third place?

Three cæca open into the dorsal side of the lower part of the vagina; of these the anterior single one is the spermatheca, the posterior pair are the colleterial glands (Pl. XL. fig. 1, *m*, *n*).

The spermatheca (*n*) is a sac with a narrow neck, dilated at its extremity, which opens considerably in advance of the colleterial glands, while its enlarged end lies between them. The duct of the spermatheca has thick walls continuous with those of the vagina; but its dilated portion is thin, and has a yellowish colour. It contains a multitude of large filiform spermatozoa bent upon themselves, and is very tough and resisting.

The colleterial glands (*m*) are subcylindrical, but are constricted inferiorly where they

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* Unless, as I am strongly inclined to suspect from Leydig's description, and from a hasty examination on my own part of the ovaria of *Coccus*, the corresponding chamber of that insect's remarkable ovaria presents a similar structure. (See, however, the note which concludes this paper.)

open close to the vulva. They consist of a delicate structureless coat lined by a thick layer of granular substance, whose cellular composition is very indistinct in the fresh state, but becomes obvious on the addition of acetic acid.

The interior of the gland contains a clear, viscid, strongly-refracting substance, apparently separated from the epithelial lining by a membranous layer. I am in doubt, however, whether this apparent membrane be anything more than the folded and wrinkled outer layer of the viscid matter. When the *Aphis* is suddenly placed in glycerine or subjected to slight pressure, a drop of the colleterial secretion not unfrequently exudes and manifests its viscidity by leaving a long trail.

The fully-formed ovum (Pl. XL. fig. 1, F) measures about $\frac{1}{70}$th of an inch in length. It is oval, rather smaller anteriorly, and of a deep green hue, in consequence of the colour of the yelk. The chorion is a tough transparent membrane, about $\frac{1}{9000}$th of an inch thick, and presents no external sculpturing or internal structure. Internal to the chorion is a delicate vitelline membrane which immediately invests the yelk. It is, however, connected with the chorion posteriorly. When the egg is heated with caustic potass, the yelk is driven away from the sides (eventually dissolving), and with it the vitelline membrane on the sides and at the anterior part of the ovum; posteriorly, however, I always found it adherent. The yelk itself is very coarsely granular; so that there would be no chance of discovering the germinal vesicle, even if it existed.

The recent observations of Leuckart and Meissner on the micropyle of the ovum in Insects naturally induced me to look for such a structure in the egg of *Aphis*.

Leuckart, in his elaborate essay, clearly shows that the micropyle may be single or multiple, and may occur at either or both poles of the egg; but unfortunately he gives us less information respecting the ova of the Homopterous *Hemiptera* than regarding those of any other great group of Insecta. *Cercopis*, in fact, is the only genus of this division in which he has observed the micropyle with certainty, and here there are two, one on each side of the anterior pole.

The anterior extremity of the chorion in *Aphis* (Pl. XL. fig. 4, B) presents a small conical papilla, in which I have been unable to discover any aperture. Internally, however, the corresponding surface of the chorion appears as it were rough and uneven; and when caustic potass is added, it, like the rest of the inner surface of the chorion, exhibits a very curious marking, as if so many circles or more irregular figures were impressed upon it. The thickness of the papilla is about $\frac{1}{4000}$th of an inch; and in young ova a delicate filiform appendage more than once appeared to be continuous with it: this, however, was invariably absent in fully-formed ova.

At the opposite pole (fig. 4, A), the ovum presents a curious appendage, about $\frac{1}{530}$th of an inch in length. When the ovum is in its natural position within the ovary, the epithelium of the latter, which closes over it below, leaves a sort of chamber in which this appendage, ordinarily more or less closely applied against the chorion, is received.

When the ovum is extracted, the appendage appears like a rope with loosened strands, or a closely-plaited membrane, and is seen to be coated with a clear gelatinous substance, in which many minute rod-like filaments of about $\frac{1}{4000}$th of an inch in length are imbedded. Treated with caustic potass, this clear substance and its imbedded particles are dissipated, and the central cord becomes less distinct; but I have never yet seen it dissolved, and sometimes it seems altogether to resist the reagent. The rounded tubercle of the chorion to which it is attached, however, now clearly exhibits a central funnel-shaped body, continuous with the axis of the appendage, and appearing like a canal (fig. 4, C).

Is this a micropyle, and what is the nature of the appendage? I regret that I have not the leisure to pursue the inquiry far enough to answer this question satisfactorily; but I incline to think that the micropyle is really situated here*.

The albuminous papilla surrounding the bundle of spermatozoa in the impregnated ova of *Musca*, *Dexia*, and *Melophagus* (Leuckart, *l. c.* pl. 7. figs. 1, 2, 4, 5), reminds one strongly of the envelope of the appendage in *Aphis*.

The micropyles of *Libellula*, *Dexia*, and *Musca*, again, exhibit a sort of "mouthpiece" formed by a prolongation of the chorion surrounding the micropylar aperture.

The account which I have given of the reproductive organs of the oviparous *Aphis* is in general agreement with that of other observers. Morren describes the reproductive organ of the wingless oviparous female of *A. Persicæ* thus:—

"The ovigerous cæca well deserved their name; for no fœtuses were any longer visible in them. Each was exactly composed of three chambers, of which the first or terminal was enlarged and spherical, and filled with twelve to twenty-four little, well-formed ova, yellow in the centre, and white peripherally. These ova descended into the second chamber, and then elongated and enlarged; but in general they acquired their hard covering only in the third or last chamber, which in all the females was occupied by a very large ovoid greenish ovum. These ova became covered at the same time with the sebific liquid; for some were seen to be provided with a little appendage intended to fix them to the bodies in which the parent lays them. This appendage was mucous, and arose from a thickened viscous liquid." (*l. c.* p. 89.)

I recognize in Morren's "twelve to twenty-four ova" the ovarian glands which I have described. His microscope was obviously inadequate to show him the true ova; but it seems difficult to suppose that in this species there is, as he maintains, neither colleterial glands nor spermatheca. His objection to Dutrochet's statements appears to me to be well founded, for Dutrochet examined a viviparous female; but I strongly suspect that he has himself overlooked the "sebific" apparatus in the oviparous forms.

Von Siebold states that the ovarian cæca of the oviparous *Aphis Lonicerœ* are divided into only two chambers:—

"In the undeveloped state the whole tube forms only a simple pyriform appendage of

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* After describing the cup-like micropyle at the anterior pole of the ovum of the Louse, Leuckart (*l. c.*) goes on to say—"Besides this micropylar apparatus at the anterior pole, there is at the posterior pole of the ovum a structure which attracts attention. It may be described as a blunt cone, which is attached rather on one side of the centre of the posterior pole, and has acquired a peculiar striated appearance by reason of its longitudinal folds, and band-like thickenings. The interior diameter of this structure measures $\frac{1}{50}'''$; the upper is less, about $\frac{1}{85}'''$; and the length is about the same. A hollow space is contained within this body, so that it might be compared to a bell; but it seems as if from the roof, or cupola, as it might be termed, of this bell, a number of closely appressed elevations and points depended. With respect to the import of this remarkable apparatus, I will only throw out the supposition that it is an apparatus of attachment. For a long time I thought I had discovered in it a second micropylar apparatus; but I renounced this view when I was unable to discover any aperture in it." (p. 140.)

the oviduct; but as development proceeds, the upper globular chamber becomes by degrees separated by a constriction, and at the same time a great difference makes its appearance between the upper and the lower chambers: for the lower chamber contains a finely granular mass which gradually becomes modelled into an oval egg; the upper chamber, on the other hand, is filled with vesicular bodies, in which smaller vesicles containing a nucleus are distinguishable. If these bodies are to be regarded as germs of ova (Wollte man diese blasenförmigen Körper als Eier-keime betrachten), we may assume that these *Aphides* were capable of bringing forth more than eight ova."

Von Siebold then goes on to describe the colleterial glands, and the spermatheca, which had not before been seen. If the ovaries of *Aphis Loniceræ* are not constructed on a totally different plan from those of the species I have described, it is, I think, pretty clear that Von Siebold, like Morren, has mistaken the ovarian glands for the rudiments of the ova. Indeed, his phraseology indicates that he himself had no great confidence in his interpretation of the parts.

§ 4. *The Development of the Pseudovarium.*

In the viviparous female, the germ increases in size, and gradually becomes separated from the terminal chamber by the successive development and separation by constriction of new pseudova. The number of chambers between the terminal one and that nearest the vagina, therefore, varies until it attains its maximum, which is necessarily regulated by the ratio between the time required for the perfection and birth of a larva, and the rate at which new pseudova are detached from the pseudovarium. In the species of *Aphis* which I examined, I found ordinarily four or five such chambers. Germs between $\frac{1}{400}$th and $\frac{1}{250}$th of an inch in length presented the following characters (Pl. XXXVII. fig. 1):—They exhibit a central darkish matter, surrounded by a clear cortex. The latter is composed of a single layer of a substance similar in appearance to that composing the mass of the germ above described, while the central substance is obscured by a number of minute granules which hide its internal structure. Nevertheless, I have occasionally detected what I believe to be endoplasts, scattered through its substance, as in Pl. XXXVII. fig. 1, which represents a germ in this stage treated with very dilute acetic acid; and as in a more advanced condition we shall find such bodies easily recognizable, I do not doubt that the central substance has the same fundamental composition as the peripheral layer. The central mass, it will be observed, completely simulates the vitellus of an impregnated ovum; and I will therefore term it a "pseudovitellus." The peripheral clear layer is, on the other hand, in all essential respects comparable to a blastodermic vesicle; and I see no reason why it should not be called a blastoderm, since the term is not necessarily confined to the product of impregnation.

In a more advanced condition (fig. 3), the blastoderm has become thicker in all parts, so as to consist of at least two or three layers of "cells;" but the thickening shows itself especially upon one side of the distal end of the germ (that turned towards the vagina), where the blastoderm is nearly twice as thick as in other parts. A linear demarcation appears in the midst of this thickened layer (fig. 4); and at the same time indications of a separation are traceable between the distal extremity of the thickened portion and the rest of the blastoderm: it is as if the latter were giving way at this point. In some specimens the cell-cavities of the inner portion of the thickening were particularly well marked; and the coarsely granular central substance exhibited a tendency to break up into large globular masses, which became particularly distinct on the addition of water.

It is in the largest of these germs that the resemblance of the pseudovum to an ovum is completed by the formation of a pseudovitelline membrane (fig. 3, *a*). This structureless homogeneous membrane is, doubtless, developed by a process of excretion, either from the pseudovum or from the walls of the chamber which contains it. It completely envelopes the pseudovum, and acquires greater thickness and strength as development proceeds.

The embryo first becomes clearly fashioned in pseudova between $\frac{1}{200}$th and $\frac{1}{150}$th of an inch in length (Pl. XXXVII. fig. 5). At the distal extremity, in the region of the thickening of the blastoderm, the latter appears separated into two portions, the outer of which forms a sort of hood over the inner. The hood eventually becomes the hinder part, if not the whole, of the abdomen of the larva. It is continuous, on the side answering to the dorsal side of the larva, with the rest of the blastoderm, which now, instead of enclosing the pseudovitellus, lies partly beneath and partly behind it. That portion of the blastoderm which lies behind the pseudovitellus, and parallel with the hood, is the rudiment of the sternal region of the thorax; and I shall hereafter term it the thoracic segment of the blastoderm. That part of the blastoderm which lies beneath the pseudovitellus will become the sternal region of the head; and I shall therefore call it the cephalic segment, while the hood itself is the abdominal segment of the blastoderm.

The thoracic segment, it will be observed, is in this stage bent up at right angles to the axis, and reaches the dorsal region, which it bounds posteriorly. The cephalic segment, on the other hand, hardly extends upwards at all, but lies in one plane; so that the anterior end of the embryo is almost wholly formed by the pseudovitellus. The latter is aggregated into a few large globular masses, which are in immediate contact with the pseudovitelline membrane on their dorsal surface.

The pseudovitellus is in immediate contact inferiorly with a layer of the blastoderm of a more pellucid aspect than the rest, and separated from it by a more or less distinct line of demarcation. This layer (*q*) could be detected only on the dorsal face of the thoracic and cephalic segments, and owed its superior transparency to the comparatively large size of the clear cavities surrounding its endoplasts.

That portion of the layer which covered the posterior portion of the thoracic segment was particularly remarkable for the size and clearness of its cells and their endoplasts (*r*). In the progress of development, the central portion of the alimentary canal occupies a place nearly corresponding to the centre of the clear layer; while, if we trace out the site of the rest of the mass in larger and larger embryos (Pl. XXXVIII. figs. 1, 3, 4, 5), we find it always retaining the same relative position to the reflected abdominal hood, but gradually enlarging, and eventually becoming subdivided into five oval lobes upon each side, each of which surrounds itself with a membrane, and assumes the form of the terminal chamber of one of the pseudovarial cæca. It would be a great mistake to suppose that it is only one of these chambers, however; it is in fact the rudiment of an entire cæcum; and before the embryo leaves the parent, it becomes divided into three chambers by the gradual development and metamorphosis of pseudova in the way described above.

The granular pseudovitellus takes no part whatever in the formation of the reproductive organs. In embryos of $\frac{1}{94}$th of an inch in length, I could very plainly observe a clear space with an endoplast in the middle of each of its spheroidal masses (Pl. XXXVIII. fig. 3). Similar masses constitute a larger or smaller proportion of the corpus adiposum of the larva and adult insect; and I believe that the latter proceeds from the former.

§ 5. *Summary and Comparison of Germs and Ova.*

I will now sum up the results of the observations which have been detailed in the preceding pages.

1. The pseudovarium consists of vagina, oviducts, and pseudovarian cæca.
2. The vagina is unprovided with either spermatheca or colleterial glands.
3. The pseudovarian cæca are each divided into many chambers by constrictions.
4. The apical chamber contains bodies which are not distinguishable from the germinal vesicles and spots of the true ovaria.
5. These bodies, surrounded by a mass of clear substance representing a yelk, are set free as pseudova, and are then undistinguishable from true ova.
6. The pseudova are eventually converted into cellular germs, apparently by the same process as that by which an ovum is converted into an embryo.
7. In these germs the central part becomes a granular pseudovitellus, the peripheral a blastoderm; the rudiments of the different organs next appear, and the germ becomes surrounded by a pseudovitelline membrane.
8. Eventually the pseudovitellus probably becomes the corpus adiposum.
9. All the other organs are developed from the blastoderm, which becomes distinguished into two layers. From the outer of these the muscles, nerves, limbs, and tegument are developed, while the inner gives rise to a part of the alimentary canal (?) and to the reproductive organs or pseudovarium of the larva.
10. The pseudovarium contains no particle of unchanged tissue of the germ, but is a considerably differentiated and readily distinguishable mass. The mass divides into ten lobes anteriorly; and these lobes become the pseudovarian cæca. Before the larva is born, each cæcum is divided into three chambers, the two posterior of which contain rudimentary embryos.
11. The genital apparatus of the oviparous female consists of a vagina, oviducts, and ovarian cæca. The latter are multilocular; and the vagina is provided with the spermatheca, and the two colleterial glands first demonstrated by Von Siebold.
12. The rudiments of the ova are undistinguishable from those of the pseudova. They are developed in the lower part of the apical ovarian chamber, the upper part of which is occupied by the bodies I have termed ovarian glands. The ova are not at first enveloped in a chorion.
13. In the lowest chamber the ova are provided with a chorion, vitelline membrane, and what appears to be a micropyle.

If these propositions are correct, I see no valid objection to the conclusion, that the agamic offspring of *Aphis* is developed from a body of precisely the same character as that which gives rise to the true egg. The pseudovum is detached from the pseudovarium in the same way as the ovum from the ovarium. In both cases, the act of separation is in every respect a process of gemmation.

From this point onwards, however, the fate of the pseudovum is different from that of the ovum. The former begins at once to be converted into the germ; the latter accumulates yelk-substance, and changes but little. Both bodies acquire their membranous investment rather late; within it the pseudovum becomes a living larva, while the ovum is impregnated, laid, and remains in a state of rest for a longer or shorter period.

Although, then, the pseudovum and the ovum of *Aphis* are exceedingly similar in structure for some time after they have passed out of the condition of indifferent tissue, it cannot be said that the sole difference between them is, that the one requires fecundation and the other not. When the ovum is of the size of a pseudovum which is about to develope into an embryo, and therefore long before fecundation, it manifests its inherent physiological distinctness by becoming, not an embryo, but an ovum. Up to this period the influence of fecundation has not been felt; and the production of ova instead of pseudova must depend upon a something impressed upon the constitution of the parent before it was brought forth by its viviparous progenetrix.

In this respect, the ova of *Aphis* exhibit the same relation to the pseudova as the ephippial eggs of *Daphnia* (whose development has been so well described by Mr. Lubbock) bear to the agamic eggs; for the histological change in the ovarium of *Daphnia*, which precedes the development of the ephippial eggs, is clearly shown by Mr. Lubbock to have no relation to fecundation.

Let me remark on yet another interesting, though perhaps only partial, analogy. Von Siebold has shown that the ova of the Queen bee produce females or males, according as they are fecundated or not. The fecundated ovum produces a queen or a neuter according to the food of the larva and the other conditions to which it is subjected; the unfecundated ovum produces a drone. Now, what have we seen in *Aphis*? The fecundated egg produces viviparous *Aphides*, which are the equivalents of the neuter bees; and from them are eventually produced males and oviparous females. The oviparous females are fecundated and lay eggs which produce only viviparous or neuter *Aphides*.

On the view which Dr. Carpenter and myself take of the zoological individual, the whole produce of a single fecundated ovum of the *Aphis* is as much the *Aphis* individual as it is the Bee individual. Consequently we have two equivalent and related series.

	I.		II.		
Bee.	Impregnated ova	producing	Neuters or females	producing	Ova requiring impregnation, and males.
Aphis.	Impregnated ova		Viviparous neuters		Females which give rise to ova requiring impregnation, and males.

The fact that in the one case the males are developed from pseudova resembling fully-formed true ova, and in the other from pseudova resembling imperfectly-formed ova, makes no essential difference in the analogy, but only demonstrates still more clearly the impossibility of drawing any absolute line of demarcation histologically between ova and buds.

§ 6. *Hypothetical Explanations of Agamogenesis.*

The majority of writers on the wonderful phenomena of Aphidian life, have been content to state the facts more or less clearly; but Morren, who has done this so clearly and philosophically, has in addition carelessly thrown out a hint of a mode of explaining them. The agamic *Aphis,* he says, is a portion of organized tissue which individualizes itself:—

"Suppose that vitality is sufficiently energetic to impress, on the tissue which individualizes itself, the form of the producing species, and you have the generation of the *Aphides.* This energy becomes lost at the end of a certain number of generations, and a new impulse becomes necessary. It is that of the male. In my youth I might have adopted with pleasure such an hypothesis as this; but now I prefer to doubt: the facts which I have set forth are worth more than a theory."

The hypothesis is, however, to my mind, in no essential particular distinguishable from that hypothetical explanation which has been propounded by the author of the well-known work on "Parthenogenesis." Substitute for "energy of the male," in the foregoing passage, "spermatic force;" and the difference between the two hypotheses becomes evanescent.

But this is a question of minor importance as compared with the value of the hypothesis in itself; and it is with regard to this latter point that I now propose to make a few remarks.

Professor Owen's views are, I believe, fairly stated in the following extracts from the work cited:—

"We find derivative germ-cells, and masses of nuclei like those resulting from the final subdivision of germ-cells, retained unchanged at the filamentary extremities of the branched uterus forming the ovaria of the larval Aphides."—*l. c.* pp. 7, 8.

"According to my own observations, the germs are perceptible in the embryo Aphis, above the simple digestive sac, before any organs have been formed for their reception. And with regard to the nature of the organs when formed, I may remark that the continuity of the ovarian tubes with the oviducts in all insects, is such as to render the negation of the term 'ovary' to those two bodies from which the slender extremities of the eight oviducal and uterine tubes proceed in the larval Aphis, to say the least, quite arbitrary. My examinations agree with those of Siebold, in determining scarcely any appreciable difference between the ovaria of the oviparous and those of the viviparous females. The contents of the ovarian tubes differ, inasmuch as they contain oval masses of granules or nuclei, comparable to the germ-mass in its state of minutest subdivision, in the virgin Aphides, and not ova with the germinal vesicle as in the oviparous females." —*Ibid.* p. 38.

"The completion of an embryonic or larval form by the development of an ovarian germ-cell, or germ-mass, as in the Aphis, without the immediate reception of fresh spermatic force, has never been known to occur in any vertebrate animal.

"The condition which renders this seemingly strange and mysterious generation of an embryo without precedent coitus possible, is the retention of a portion of the germ-mass unchanged. One sees such portion of the germ-mass taken into the semitransparent body of the embryo Aphis, like the remnant of the yelk in the chick. I at first thought that it was about to be enclosed within the alimentary canal, but it is not so. As the embryo grows, it assumes the position of the ovarium, and becomes divided into oval masses and enclosed by the filamentary extremities of the eight oviducts. . . ."—*Ibid.* p. 69–70.

"It would be needless to multiply the illustrations of the essential condition of these phænomena. That condition is, the retention of certain of the progeny of the primary impregnated germ-cell, or in other words, of the germ-mass unchanged, in the body of the first individual developed from that germ-mass, with so much of the spermatic force inherited by the retained germ-cells from the parent cell or germ-vesicle as suffices to set on foot and maintain the same series of formative actions as those which constituted the individual containing them."—*Ibid.* p. 72.

"The physiologist congratulates himself with justice when he has been able to pass from cause to cause, until he arrives at the union of the spermatozoon with the germinal vesicle as the essential condition of development—a cause ready to operate when favourable circumstances concur, and without which cause these circumstances would have no effect.

"What I have endeavoured to do has been to point out the conditions which bring about the presence of the same essential cause in the cases of the development of an embryo from a parent that has not itself been impregnated. The cause is the same in kind, though not in degree, and every successive generation, or series of spontaneous fissions, of the primary impregnated germ-cell, must weaken the spermatic force transmitted to such successive generations of cells.

"The force is exhausted in proportion to the complexity and living powers of the organism developed from the primary germ-cell and germ-mass."—*Ibid.* pp. 72, 73.

These statements are repeated in the recently published second edition of Prof. Owen's Lectures on the Invertebrata.

The paragraphs I have cited contain two kinds of propositions—assertions with respect to matters of fact, and deductions from those assertions. The former are, according to my observations, incorrect; and, as I conceive, the latter are unfounded.

As regards the first citation, for instance, the contents of the apical chambers of the pseudovaria are *not* by any means identical with those "resulting from the final subdivision of germ-cells retained unchanged," as the most cursory comparison of the two structures will show.

In the second citation it is affirmed that the germs are perceptible in the embryo before any organs are formed for their reception. This, again, is an error if my observations are correct. The absence of figures, and the too vague and general character of the descriptions in Prof. Owen's work, render it very difficult to understand what he really has seen; but I imagine that he has taken the substance which constitutes the rudiment of the whole pseudovarium, and which becomes differentiated partly into pseudova, partly into the walls of the organ, for a mass of germs. What is meant by "those two bodies from which the slender extremities of the eight oviducal and uterine tubes proceed," and which are supposed to be ovaries, I am at a loss to divine. There are no such bodies, that I can discover.

In the latter part of the same citation, the existence of a histological difference between the contents of the pseudovarium and those of the ovarium is asserted. But there is assuredly nothing in the former to which the description can apply; and I re-affirm the impossibility of drawing any histological line of demarcation between the pseudova and the young true ova.

How any one who carefully studies the development of *Aphis* can arrive at the conclusion that a portion of the germ-mass is taken into the body of the embryo *Aphis*, "like the remnant of the yelk of the chick," I know not; and, for the reasons mentioned above, I even doubt if I clearly apprehend what is meant. Dr. Burnett (*l. c.* p. 73) assumes that what is intended by "portion of the germ-mass" is what I have termed the pseudovitellus. In that case the statement is erroneous; for the pseudovitellus takes no share in the formation of the pseudovarium. If, on the other hand, the true rudiment of the pseudovarium is indicated, the statement in question is equally incorrect; for this is never out of the body, and hence can hardly be taken into it, nor can that out of which the so-called "oviducts" are produced be properly said to become "connected with them," or to "aid in forming their filamentary extremities."

When the basis of a hypothesis is shown to be incorrect, the hypothesis itself is commonly considered to be disposed of; but possibly in the present case it may be urged that, although the contents of the pseudovarium *are* wholly dissimilar "to the germ-mass in in its state of minutest subdivision," they are nevertheless so little changed that my criticism of the phrase is trivial. To this I reply that, whether the alteration be small or great, it is *as* great as that which occurs in the terminal cæca of a gland, or in a true ovarium, and that the tissue of the apical pseudovarian chamber is far more differentiated than the indifferent tissue which constitutes the youngest portion of an ordinary epithelium or epidermis.

Whatever conclusions are based upon the resemblance of the tissue of the pseudovarium to that of the embryo, must therefore apply in equal or greater force to the tissues which I have just named; and, unless reason can be shown to the contrary, whatever powers are possessed by the one, in virtue of this similarity, must be possessed in equal or greater degree by the other.

But in this case what becomes of the hypothetical explanation of the asexual reproduction of *Aphis*, under discussion?

The condition of such reproduction is, according to the hypothesis, the retention of "certain of the progeny of the primary impregnated germ-cell unchanged," "with so much of the spermatic force, inherited by the retained germ-cells from the parent-cell or germ-vesicle, as suffices to set on foot and maintain the same series of formative actions as those which constituted the individual containing them."

Let us imagine, for the sake of argument, that the amount of histological change in the pseudovarian mass is unimportant. I am ready to suppose even, in accordance with the hypothesis, that its cells retain sufficient "spermatic force" (whatever that may be) to commence an independent life. But I ask, how does this explain agamogenesis? Why does not the epithelium of the ovarium (which is as little or less changed) give rise to young without impregnation? Why are not the young cells of glands, which are as little changed, "parthenogenetic"? Why, finally, does not the deep substance of our epidermis and epithelium, which absolutely more nearly resembles embryonic tissue than the structure of the pseudovarium does, give rise to young?

It may be replied, however, that the supposed "spermatic force" is exhausted by the repeated subdivisions of the germ-cell before it becomes a part of the deep epidermic tissue; for it is one condition of the hypothesis, that every successive generation or series of spontaneous fissions of the primary impregnated germ-cell must weaken the "spermatic force" transmitted to such successive generation of cells.

I presume, however, that the original "spermatic force" is at least as strong in a Man as in an *Aphis*. The average size of the embryo-cells in *Aphis* is at least not greater than in Man, and the specific gravities of their essential tissues are not very different; so that we may fairly assume that as many embryo-cells go to form a given mass of *Aphis* as of Man. In that case the impregnated embryo-cell must subdivide as often; and therefore the "spermatic force" must become as much exhausted in forming, say, a grain or a pound of *Aphis*, as in giving rise to the like quantity of human substance.

In his Lectures, Prof. Owen adopts the calculations taken by Morren (as acknowledged by him) from Tougard, that a single impregnated ovum of *Aphis* may give rise, without fecundation, to a quintillion of *Aphides**. I will assume that an *Aphis* weighs $\frac{1}{1000}$th of a grain, which is certainly vastly under the mark. A quintillion of *Aphides* will, on this estimate, weigh a quatrillion of grains.

He is a very stout man who weighs two million grains; consequently the tenth brood alone, if all its members survive the perils to which they are exposed, contains more substance than 500,000,000 stout men—to say the least, more than the whole population of China! And if the law cited above be correct, the "spermatic force" in each cell of an *Aphis* of this brood must be diminished 500,000,000 times as much as that of a single human cell; nevertheless the "spermatic force" of the *Aphis* cell is enough to impel it to the production of young, while that of the human cell is not!

When to these considerations I add, that it has been shown that the agamic propagation of the *Aphis* may, under proper conditions, be continued for four years without interruption, in which case the "spermatic force" in the later broods must stand in an infinitely minute ratio even to that contained in the cells of the tenth generation, the *reductio ad absurdum* by simple arithmetic, of the so-called explanation, appears to me to be sufficiently obvious.

For the sake of argument, however, I am willing still to suppose for a moment that agamogenesis does take place in consequence of the retention of a "spermatic force." But I must ask, how does this phrase constitute an explanation of the phenomena? Nothing is more common than the misuse of the word "force" on the part of those who are more versed in the phraseology, than trained in the severe methods, of physical science. The impatient inquirer every now and then calls in the aid of molecular force, or chemical

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* I have not thought it worth while to add, in the products of the generations preceding the tenth.

force, or magnetic force, or od-force, to account for the existence of a mass of phenomena which will not arrange themselves under any of his established categories—forgetting that a "force," the conditions of whose operation (that is, whose laws) are undetermined, is but a scientific idol, at once empty and mischievous,—empty, because it is but a phrase without real meaning; mischievous, because it acts as an intellectual opiate, confusedly satisfying many minds and obstructing the progress of inquiry into the real laws of the phenomena. If we show that a fact is a case of a law, we explain that fact; but explanation by reference to an undefined "force," of questionable existence, is simply 'ignorance writ large.'

Now, how does the hypothesis fulfil the indispensable conditions of a genuine explanation? In the first place, what proof is there of the existence of such a force as "spermatic force." All that we *know* is, that an ordinary ovum will not undergo those changes which constitute development without the contact of the spermatozoon. Hence it is concluded that some force contained in the spermatozoon is the efficient cause of all these changes. But what would be thought of the artillerist who should imagine he had explained the propulsion of a bullet by saying it was 'trigger force'? Or to take an illustration from phenomena of a like order to those under discussion: a seed will not grow unless it is exposed to a certain amount of warmth and moisture; but have I explained the growth by saying that it is the effect of 'heat and moisture force' which becomes diffused through the seed?

The very existence of this "spermatic force," then, is a gratuitous assumption; and if we seek for its laws of action, we find but two stated: first, that it becomes weakened by the successive divisions of the germ-cell; second, that "the force is exhausted in proportion to the complexity and living powers of the organism developed from the primary germ-cell and germ-mass."

I have shown to what singular consequences the first assumption leads us; it remains only to consider the second. If it be true, the occurrence of agamogenesis in the animal kingdom must bear an approximatively inverse ratio to the complexity of the organization of the different groups. Let us examine one or two subkingdoms in this point of view. Among the *Annulosa*, the *Rotifera* and *Turbellaria* possibly possess it to a small extent; the *Nematoidea* do not possess it at all. Many *Trematoda* possess it; others, such as *Aspidogaster*, have nothing of the kind. The *Acanthocephala* are not known to possess it; the *Echinodermata* are regarded by Prof. Owen as possessing it, but their different families show every gradation from simple metamorphosis to something like agamogenesis. A few *Annelida* possess the power in a marked degree; in many, nothing of the kind is known. The *Nais* has it; the Earth-worm and the Leech have it not. Of the *Crustacea*, some, such as many *Branchiopoda*, exhibit it in the highest perfection; but no trace of it has yet been found in *Copepoda*, *Cirripedia*, *Pœcilopoda*, *Edriophthalmia*, or *Podophthalmia*. In the *Myriapoda* and *Arachnida* the process is not known: but we find it in the highest *Articulata*—the *Insecta*—and this not, so far as we know at present, in *Aptera* or *Orthoptera*, but in a few *Hemiptera*, *Hymenoptera* and *Lepidoptera*; and there is every reason to believe that it only occurs in isolated, though perhaps in many, genera of these orders. Take the *Mollusca* again: agamogenesis occurs in the *Polyzoa* and *Ascidioida*, not in the *Bra-*

chiopoda. It is not known to occur in any of the *Lamellibranchiata*; and among the higher *Mollusca* the nearest approach to it is presented by the animal (whatever it is) which gives rise to the "Synapta-schnecken" (high Gasteropods), and by the Hectocotyligenous *Cephalopoda.*

After this simple statement of well-known facts, I need not remind even the tyro in zoology, that there is no evidence of an inverse relation between the occurrence of agamogenesis and complexity of organization.

I have hitherto, in the course of this argument, confined myself in the main to the development of *Aphis*; but it is only just to observe that the author of the hypothesis brings forward yet another original observation in support of his large generalization:—

"In the freshwater polype, the progeny of the primary impregnated germ-cell retained unaltered in that body, may set up, under favourable stimuli of light, heat, and nutriment, the same actions as those to which they owed their own origin; certain of the nucleated cells do set up such actions, those, *e.g.* in the *Hydra fusca,* which are aggregated near the adhering pedicle or foot; and the result of their increase by assimilation and multiplication is, to push out the contiguous integument in the form of a bud, which becomes the seat of the subsequent processes of growth and development; a clear cavity or centre of assimilation is first formed, which soon opens into the stomach of the parent; but the communication is afterwards closed, and the young hydra is ultimately cast off from the surface of the parent*."—'Lectures,' 2nd ed. p. 124.

I have had occasion carefully to watch the process of gemmation not only in *Hydra,* but in many species of all the other subdivisions of the *Hydrozoa*; and I venture to assert that no such process as that described by Prof. Owen takes place in any one of them.

The bud is from the first in communication with the cavity of the body, of which it is a mere diverticulum, whose walls are a little thickened at the extremity. No special cell or group of cells can be discovered as the centres whence growth proceeds. No "integument" is pushed out by any thing beneath it; but the outer layer of the body of the animal thickens and grows *pari passu* with the growth of the bud. No especial accumulation of derivative germ-cells can be seen in any part of the body of any *Hydrozoon*; and before gemmation commences there is no distinguishable difference of texture between the part in which gemmation commences and any other portion of the body. Furthermore if a complex Hydrozoon, such as a *Physophora* or *Agalma,* be examined, it will be found that there is no histological distinction whatsoever between that part of the body which is to give rise to a free swimming generative zooid, and that which produces merely a bract, a tentacle, or a stomach.

In this case then, as in that of the *Aphis,* the hypothesis receives no support from, but is totally opposed by, facts; and I unreservedly adopt the conclusion (long since clearly and well expressed by Dr. Carpenter), that "spermatic force" is but a name without definite meaning, applied to that which is not proven to exist, and the assumption of whose existence, even, does not help us a single step towards the understanding of the wonderful phenomena of agamogenesis.

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* I have cited this passage from the 'Lectures' rather than from the work on "Parthenogenesis," as they may be supposed to contain the expression of the author's latest views.

Truly we may say, with Degeer (*l. c.* p. 129), "Les Pucerons sont des insectes bien capables de déranger tout système formé de génération, et de mettre en déroute tous ceux qui s'efforcent d'expliquer ce mystère de la nature."

But the question may be asked: if the "spermatic force" be a myth, what *is* the cause of the phenomena? Considering that the groundwork of modern physiology is not a score of years old, I do not think the confession of our inability to answer that question at present is any opprobrium to science.

When we know why, in a mass of tissue of identical structure throughout, one part becomes a brain, and another a heart, and a third a liver—when we can answer these every-day questions of the sphinx, we may attempt her more difficult riddles without running too great a risk of being devoured.

At the present time it seems to me well nigh hopeless to look for an explanation of these phenomena. Some such classification of them, however, as will indicate their analogies with other vital manifestations, may fairly be attempted, and, when successfully carried out, will prove the first step towards an explanation.

§ 7. *Classification of the Phenomena of Agamogenesis.*

It does not seem to be very difficult to effect such a classification. In the course of the development of the total product of a single impregnated ovum (which, with Dr. Carpenter, I regard as the zoological individual), one of two things may occur: either all the living products may remain in connexion with one another, or they may become separated from one another. The former case I term *Continuous*, the latter *Discontinuous Development.*

In continuous development, the size may increase, the form and texture remaining unchanged—constituting simple *growth*; or, the size remaining unchanged, the form and texture may alter—constituting simple *metamorphosis*; or the two processes may be combined, as in all those changes which we term *gemmation*, without separation from the parent.

Discontinuous development differs from continuous only in this, that the products of the growth and metamorphosis of the embryo become separated into two or more portions, which when they retain their vitality independently are termed "zooids."

When the produced "zooid" is capable of development into an independent organism without the influence of an act of conjugation with another zooid, I term the process *agamogenesis.* The producing zooid may be devoid of sexual organs, as in the *Salpæ*, many *Hydrozoa*, many *Trematoda*—in fact, in the great majority of cases of agamogenesis.

I term the first producing zooid of the individual the *protozooid*; the produced zooids, *deuterozooids.* In some cases the deuterozooids acquire sexual organs, and give rise to ova and spermatozoa; but in others they produce new zooids: thus broods of *tritozooids*, &c., will be produced. When the producing or protozooid possesses no sexual organs, I think Prof. Owen's term of "*metagenesis*" might well be applied to the kind of agamogenesis; but where the protozooid possesses sexual organs, and its buds have all the histological characters of ova, then the process may fairly enough be termed *parthenogenesis.*

Finally, the produced zooid may be incapable of development into an independent organism, unless it conjugate with another zooid. In this case we have sexual reproduction, or *gamogenesis.*

The natural character of this classification of the various modes of development is manifest when it is thrown into a tabular form:—

Development.	Continuous		Growth. Metamorphosis. Gemmation without fission.
	Discontinuous (Gemmation with fission).	Agamogenesis.	Metagenesis. Parthenogenesis.
		Gamogenesis.	

Whatever hypothesis we may entertain with respect to the nature of these processes, and however we may think fit to conceive the nature of the "individual," I think it must be admitted, that all the phenomena of development in the animal kingdom (and I would venture to add, in the vegetable kingdom also) fall under one or other of these heads.

Furthermore, all these modes of development pass into one another. Growth and metamorphosis are combined in all animals. Gemmation, so long as the gemma continues attached, is but a peculiar kind of growth and metamorphosis. From the fixed bud to the separate one, we have all gradations; and fission is little more than a peculiar mode of budding.

Free gemmation is "metagenesis" when the bud is not developed within the homologues of the sexual reproductive organs; it becomes "parthenogenesis" when the bud is developed within such organs; finally, when the free bud requires conjugation with another free bud for its development, we have gamogenesis, or sexual reproduction: but cases such as those of *Daphnia* and *Apis* show that the histological element, which is at one time agamogenetic, may at another be gamogenetic.

Time was when the difficulty of the physiologist lay in understanding reproduction without the sexual process. At the present day, it seems to me that the problem is reversed, and that the question before us is, why is sexual union necessary? Far from seeking for an explanation of the phenomena of gemmation in the transmitted influence of the spermatozoon, the philosopher acquainted with the existing state of science will seek, in the laws which govern gemmation, for an explanation of the spermatic influence.

XV. *On the Agamic Reproduction and Morphology of* Aphis.—Part II. *By* Thomas H. Huxley, *F.R.S., Professor of Natural History, Government School of Mines. Communicated by* G. Busk, *F.R.S., F.L.S.*

Read January 21st, 1858.

§ 1. *Embryogeny of the external organs of* Aphis.

In the previous part of this paper I sketched so much of the development of the embryo of *Aphis* as was indispensable to the clear understanding of its reproductive processes; but it appears to me that the bearings of the embryogeny of this Insect upon morphology render it worthy of a more attentive and detailed consideration.

It would be well worth while, indeed, to trace out the development of all the organs of this remarkable animal; but as I shall have for some months no leisure for labours involving so great an expenditure of time, I will content myself for the present with a notice of some of the leading features presented by the development of the external organs.

I have already stated, that one of the earliest changes in the germ of the young of the viviparous *Aphis* is the differentiation of its cellular mass into a central portion, which takes on the appearance and functions of a yelk, and which I termed "the pseudovitellus," and a peripheral coat or layer, the blastoderm. The blastoderm next becomes thickened posteriorly; and in this thickening a division takes place from without inwards, so that it is separated into a posterior flap and an anterior portion, which are only continuous dorsally. It is the flap which is the rudiment of the abdomen, while that portion of the blastoderm against which it is folded stands in the same relation to the thorax. In front of this is the rudiment of the head, constituting by far the largest portion of the blastoderm.

Dorsally and posteriorly, the rudiment of the head is originally continuous with the thoracico-abdominal thickening; but a separation early takes place at this part, and the interval is occupied by the pseudovitellus, which here comes into immediate contact with the pseudovitelline membrane.

In an embryo $\frac{1}{160}$th of an inch in length (Pl. XXXVII. fig. 5), this interval has increased so much, that the cephalic blastoderm does not extend on to the dorsal region at all, but lies almost flat under the pseudovitellus, in the anterior half of the ventral region.

In embryos $\frac{1}{140}$th of an inch in length (Pl. XXXVII. fig. 6.), I have found the cephalic portion of the blastoderm beginning to extend upwards again over the anterior face of the germ, so as to constitute its anterior and a small part of its superior wall.

This portion is divided by a median fissure into two lobes, which play an important part in the development of the head, and will be termed the "procephalic lobes." I have already* made use of this term for the corresponding parts in the embryos of *Crustacea*.

The rudimentary thorax presents traces of a division into three segments; and the dorso-lateral margins of the cephalic blastoderm, behind the procephalic lobes, have a sinuous margin.

It is in embryos between this and $\frac{1}{100}$th of an inch in length that the rudiments of the appendages make their appearance; and by the growth of the cephalic, thoracic, and abdominal blastoderm, curious changes are effected in the relative position of these regions.

In embryos about $\frac{1}{100}$th of an inch in length (Pl. XXXVIII. fig. 1, 1*a*), the procephalic lobes are so completely bent backwards as to lie close against the tergal surface of the rest of the cephalic blastoderm, so that no pseudovitelline granules can any more be seen in this region of the body. At the same time the lobes have enlarged, and extend back as far as the base of the fourth pair of visible cephalic appendages. Their infero-lateral angles are rounded and produced, forming an elevation which appears to be the rudiment of the eye.

Below the anterior extremity of the embryo, the blastoderm is produced on the median line into a tongue-like process (*lb*), whose inferior part eventually becomes the labrum, while superiorly it sends a triangular process (the rudiment of the clypeus) into the interval between the procephalic lobes.

Immediately behind the labrum, the blastoderm curves at first downwards, and then sharply upwards and backwards, to a little beyond the line of the posterior edge of the procephalic lobes.

The whole of this portion of the blastoderm belongs to the head. In the re-entering angle between it and the labrum the mouth is placed; it is a small aperture, whence the œsophagus can be traced ascending and passing backwards with a gradual curve.

Behind the cephalic region, the thoracic blastoderm passes nearly horizontally backwards, and already presents traces of a division into its three somites. Its upper surface is close to the pseudovitelline membrane, and consequently is covered by but a very thin layer of yelk-like granules.

At the end of the rudimentary thorax the blastoderm is suddenly folded forwards, so that the sternal surface of the hinder part of the future abdomen is almost in contact with that of the thorax. Having come opposite the anterior edge of the thorax, it is bent backwards, at right angles to its previous direction, for a short distance,—the extreme end being finally folded parallel with this part, and with its apex towards the head.

The great mass of the yelk lies over the abdominal blastoderm, in the space left between it and the pseudovitelline membrane. The appendages present a singular and beautiful uniformity. No trace of the pigment of the eyes is to be seen. The next anterior pair of appendages (*a t*) are more slender and elongated than the others, and are bent inwards near

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* 'Lectures on General Natural History,' Med. Times and Gazette, 1856–7.

their base so as to form a sort of elbow. In consequence of this, their terminal portions are more approximated than their distal ones, and lie close together and parallel. These appendages are the antennæ; and it is worthy of remark, that they arise from the procephalic lobes, or from the point of junction between them and the rest of the cephalic blastoderm above the mouth.

Behind these and behind the mouth (though the anterior pair are very close to that aperture, and might even be described as more or less lateral in relation to it) are three pair of short, similar, conical processes. Of these the anterior pair (IV′) are the largest, and are the mandibles; the two other pairs are nearly equal: the anterior (V′) represent what are ordinarily termed the maxillæ, but which might be more properly called "first maxillæ," since the second pair (VI′), which eventually give rise to the so-called "labium," are precisely like them, and, as Zaddach (*l. c. infra*) has shown, fully deserve the title of "second maxillæ."

Three pairs (VII′, VIII′, IX′) of short processes, unjointed and not much longer than the trophi, represent the thoracic limbs.

The abdomen presents obscure traces of a division into segments.

In an embryo $\frac{1}{95}$th of an inch in length (Pl. XXXVIII. fig. 1, 1*a*, and 2), the procephalic lobes have extended so far back as completely to cover the tergal region of the head, and even to pass a little beyond the line of the last maxilla posteriorly. The fold or depression separating the thorax from the head has become deeper; the antennæ have greatly elongated, and are bent downwards and inwards, so as to meet in the middle line below, and cover the mandibles.

The first maxillæ are larger than the mandibles, and somewhat expanded at their extremities. The second maxillæ are more slender; and their bases are in a line with those of the mandibles, while those of the first maxillæ have taken a more external position. Consequently, the bases of the trophi, instead of forming two nearly parallel rows as at first, are now arranged as a hexagon, whose outer angles are constituted by the first maxillæ.

The thoracic members have greatly elongated, the hinder pair being the longest.

In embryos $\frac{1}{70}$th of an inch in length (Pl. XXXVIII. fig. 5), the blastoderm is found to have undergone a wonderful change. Instead of being folded upon itself ventrally by the flexure of the abdomen against the thorax, it has become completely extended; and so thoroughly has this extension taken place, that the abdomen is now convex inferiorly. At the same time the blastoderm has grown upwards over the sides of the body, and roofs-in its tergal region. The head is closed by the union of the procephalic lobes, and is now, in consequence of the increased length of the body, proportionally much smaller. The pigment of the eyes appears in a few scattered granules towards the posterior margin of the head on each side.

If the appendages be examined as they become metamorphosed in a succession of specimens intermediate in size between $\frac{1}{100}$th and $\frac{1}{70}$th of an inch, the antennæ are found gradually to increase in length and to become jointed. The growth of the mandibles and first maxillæ in length, on the contrary, is suspended; and they remain as short thick tubercles (Pl. XXXIX. fig. 2), from whose inner surface a long chitinous filament gradually arises. These filaments, thickening and elongating, become the blades of the mandibles and maxillæ. The growth of the second maxillæ makes up, by its excess, for the arrest of development of the mandibles and first maxillæ; for having already approximated, their confluent or connate bases elongate as one great process, which extends back in the middle line between the thoracic legs, until at length it attains more than half the length of the body, and constitutes the well-known proboscidi form "labium" of the *Aphis* [*].

The thoracic members or legs have elongated so much, that their terminations are bent inwards, to allow of their lying within the pseudovitelline membrane. Their characteristic subdivisions are indicated; and the terminal claws are beginning to be formed.

From this size up to that at which the larvæ are born (Pl. XXXIX. fig. 4) (when they are less than $\frac{1}{40}$th of an inch in length), the principal changes are the following. The appendages as compared to the body, and the latter as compared to the head, undergo great elongation. The anterior pair of thoracic limbs and its somite, the prothorax, come into very close contact with the head, so that the cervical separation becomes obsolete, or is only indicated by a groove. The labrum and labium acquire their characteristic form and proportions; and the mandibular and maxillary setæ elongate, and take their final position.

The "siphons," so characteristic of the genus, appear as obtuse tubercles on the dorsolateral region of the fifth abdominal somite. The little larva exhibits unequivocal signs of life, but still remains enclosed within its pseudovitelline membrane, to which another transparent and structureless envelope, fitting the body of the larva and all its limbs as a loose glove fits the hand, seems to have added itself. This second coat is, in fact, the embryonic integument, which is now being cast; so that the creature must undergo its first ecdysis either before, or immediately after, it is born. The head assumes its normal proportions. The corneæ become facetted; and the pigment increases greatly in amount, assuming the form of an oval deep-red patch. The clypeus and the procephalic lobes unite, but readily give way when the head is crushed, and allow of the exit of the cerebral mass, which has in the meanwhile been produced by a differentiation of the inner substance of the procephalic lobes, just as the other ganglia are the product of the blastoderm of their somites.

If the account of the development of the external organs of *Aphis* which I have just given be compared with the statements of Kölliker [†] and Zaddach [‡], it will be found that there is a close correspondence in all essential respects between the embryogenic phenomena of at least three orders of *Insecta*—the *Hemiptera*, the *Diptera*, and the *Neuroptera*. And, considering the universality of the law that the embryogenic processes of members of the same class have a similar fundamental character, I do not doubt that the development of all insects is, in its main features, a process similar to that described in *Aphis*.

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[*] Zaddach considers, from his observations on *Phryganea* and other Insects, that the labium is the product, not of confluent maxillæ, but of an outgrowth of the sternum by which these are supported, the maxillæ remaining as the labial palpi. I do not deny that this may be the case in *Aphis*; but I have been unable to find positive evidence of the fact.

[†] De prima Insectorum Genesi, 1842.

[‡] Die Entwickelung des Phryganiden-Eies, 1856.

§ 2. *Embryogeny of* Mysis *as exemplifying the* Crustacea.

But more than this, if we extend our researches into the embryogeny of the other two principal* classes of the *Articulata*, the *Arachnida* and *Crustacea*, we shall see that it presents a most remarkable agreement with that of the Insect.

To illustrate this important truth, I might cite Rathke's account of the development of *Astacus* as a type of crustacean embryogeny; but I prefer to speak from my own knowledge, and I will therefore describe the development of *Mysis*, the Opossum-shrimp.

The fertilized ova of this crustacean have a diameter of $\frac{1}{25}$th to $\frac{1}{30}$th of an inch, and consist of a yelk enclosed within a colourless and thin, but strong vitelline membrane.

The yelk is composed of two elements—small and large yelk-masses, the former having about $\frac{1}{3000}$th to $\frac{1}{4000}$th of an inch average diameter, and being usually so closely wedged together as to appear polygonal. The latter are large ($\frac{1}{1000}$th of an inch or more), spherical, and imbedded in the mass formed by the smaller kind of yelk-granules.

I was unable to detect any trace of endoplasts or cells in these ova. Acetic acid developes neither granules nor endoplasts in the yelk-masses. Upon the yelk thus constituted, the blastoderm makes its appearance as a rounded patch, which reflects the light more than the yelk, and therefore appears white by reflected, and dark by transmitted light. The contrast is greatly heightened by the addition of alcohol†, or of acetic acid. When the latter reagent has been employed, or even before, if the examination be very carefully conducted, the structure of the blastoderm is seen to be widely different from that of the rest of the yelk. No yelk-granules are visible in it, but it appears to be very finely granular; and imbedded within it are numerous close-set vesicular endoplasts, having a diameter of $\frac{1}{1800}$th to $\frac{1}{2000}$th of an inch. These usually contained many granules, sometimes only one; but I cannot say I have been able to detect any definite nucleolus in them.

The discoid blastoderm is thickest in its middle region, thinning off gradually on both sides, and internally is sharply defined from the substance of the vitellus. In the centre it exhibits a more or less marked depression. As development goes on, this depression becomes more and more marked, while the disk thickens and increases circumferentially. At the same time, the layer of yelk in immediate contact with the disk, and co-extensive with it, is found to have a somewhat different constitution from the rest. The globules are large, dark, and sharply defined, and acetic acid gives them a granular appearance, but developes no endoplast.

The depression above alluded to now increases, so as to form a fissure which separates a small tongue-shaped process from the rest of the blastoderm, to which it nevertheless remains closely applied. This process is the rudiment of the abdomen, and in a front view it is rendered more distinct by several clear lines, which mark the commencement

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* I have no doubt that the *Myriapoda* will be found to exemplify the same morphological laws, with the exception of that relating to the total number of somites in the body, as their congeners; but I find so much that is unsatisfactory in the existing accounts of their development, and so many points in their anatomy requiring re-investigation, that I prefer for the present to be silent about them.

† Rathke, in his numerous embryological researches, appears to have constantly availed himself of this property of alcohol in order to render the blastoderm more distinct.

of the future caudal bristles. In front of the end of the abdominal process, two minute conical prominences, at first marked by similar, but fewer clear striæ, gradually raise themselves up on each side from the surface of the blastoderm and elongate, their apices being directed backwards. They are the rudiments of the antennules and antennæ.

A delicate structureless membrane is now visible, covering these parts and the adjoining portions of the germinal membrane. It is produced into the terminal setæ of the end of the abdomen and of the two pairs of appendages, and is the commencement of the first skin of the larva*.

The anterior part of the blastoderm is wider than the posterior, and is produced into two great lobes divided by a median fissure. These are the "procephalic lobes," and have the same relation to the anterior division of the head as the corresponding parts in the embryo *Aphis*.

In this state the embryo becomes a larva, for it bursts its vitelline envelope and lies naked in the pouch of the mother. The rudimentary abdomen is at the same time extended, so that the little creature is now about $\frac{1}{20}$th of an inch in length, and is very like a pear in shape, the stalk being represented by the abdomen, which is terminated by a flattened, bifid, spinulose fin.

The whole larva is covered by a continuation of the delicate membrane already noticed on the limbs and abdomen. The blastoderm invests the abdomen almost completely, but in front it covers only a somewhat fiddle-shaped area on one face of the yelk. It is still more deeply bilobed in front, and the antennules and antennæ are much elongated. The larva next begins to grow, being doubtless nourished by the fluid contained in the maternal pouch; and at the same time its ventral region assumes a curve, contrary to that which it originally possessed, becoming more and more convex.

The cephalic region is now clearly distinguishable; it occupies nearly one-half of the whole length of the body. The procephalic lobes extend upwards over the anterior face of the vitellus, and upon each a large rounded elevation, the rudiment of the ophthalmic peduncle, has made its appearance in front of the antennule. The latter, like the antennæ, elongate greatly, and become divided longitudinally, within the sheath afforded by the primitive integument, into their two terminal branches.

A slight constriction indicates the boundary between the antennulary and antennary sterna, and behind these, similar depressions mark off the surface of the blastoderm into seventeen additional segments.

Attached to them are as many pairs of appendages, which in the youngest larvæ examined had the following form:—

The first pair were rounded massive elevations, situated one on each side of the pit indicating the position of the oral aperture; from their anterior edge a short oval palp already projects. These are the rudimentary mandibles.

The next pair, or first maxillæ, are small rounded elevations meeting in the middle line. The second maxillæ succeed, and are more elongated, three-jointed, and bent back parallel with one another. The maxillipedes and the thoracic ambulatory legs form one continuous

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* See, for illustrative figures of the development of *Mysis*, my 'Lectures' above cited.

series of similar appendages, all elongated and bent back against the sternal surface of the body.

The abdomen is very short, but is clearly distinguishable from the thorax by its less complete segmentation, and by the rudimentary condition of all its appendages save the last pair.

The blastoderm as yet extends only for a little way on the sides of the body. The primitive larval integument still invests the whole body loosely, but passes smoothly over all the appendages, except the antennules and antennæ, which continue to be ensheathed by it.

The larva remains in this general condition until it attains $\frac{1}{14}$th of an inch in length, the principal differences in its later stages being the increased growth of the body as compared with the head, the completion of the dorsal surface by the upward extension of the blastoderm, and the gradual restriction of the yelk to the anterior part of the body.

I have been unable to determine, as precisely as in *Aphis*, the exact share taken by the procephalic lobes in the composition of the roof of the head in the crustacean; but they assuredly extend over a considerable part of its latero-dorsal parietes.

The carapace appears at first as a ridge-like process developed from the dorso-lateral region of the antepenultimate and preceding thoracic and cephalic somites, as far forwards as the bases of the antennules. It is certainly not an extension backwards of the terga of any of the anterior cephalic somites, but is from the first continuous with, and developed from, the thoracic somites.

It is needless to trace the history of the larval *Mysis* further,—what has been said sufficiently proving the close resemblance of its development to that of *Aphis*.

§ 3. *Embryogeny of* Scorpio *as exemplifying* Arachnida.

I have not yet had the opportunity of working out the development of an Arachnidan; but the researches of Rathke* and Herold† are so full and clear, that the omission is of little moment.

Rathke's observations on the development of the Scorpion show that after, or even before, the blastoderm has extended over the whole yelk, a papillary elevation appears at one pole. It is the rudiment of the future abdomen, including under that term all the segments of the body behind that which carries the last pair of respiratory organs. In front of this, eleven pairs of closely approximated thickenings make their appearance; and then, at the sides of the sixth to the tenth pair of them, inclusively, counting from the rudimentary abdomen, papillary processes are developed. It is clear, from Rathke's figures, that the anterior pair of thickenings are the "procephalic lobes," while the succeeding ones are the sterna of the somites between the mouth and the abdomen. The five pairs of processes thrown out by the five anterior of these are the great chelæ and the four pairs of ambulatory appendages. The antennæ make their appearance subsequently from the procephalic lobes (or their junction with the rest of the blastoderm) in front of the mouth. It is not expressly stated, but I do not doubt, from Rathke's figures, that the upper region of the head is formed, as in *Insecta* and *Crustacea*, by the union of these lobes.

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* Reisebemerkungen aus Taurien, 1837.

† De Generatione Aranearum, 1824.

Rathke's account of the number of rudimentary post-oral sterna would lead one to suppose that in the embryo one sternum is wanting. I believe, however, that the truth is, that the sterna of the genital and pectiniferous somites were already so much smaller than the rest in the embryos which Rathke chanced to examine, as to be regarded by him as one.

I base this conclusion upon the condition of the nervous system, which consisted of eleven pairs of clearly distinguishable post-oral cephalo-thoracic ganglia; that is, of just the same number as in an embryonic *Astacus*. Of these, the four posterior were widely separated, and lay in the pulmoniferous somites; while the seven anterior pairs extended only a little way beyond the ambulatory appendages, and were united into a triangular mass. The anterior of these ganglia were the largest, the posterior the smallest. The anterior pair gave off the nerves to the chelæ.

It would be difficult to obtain a more clear and conclusive proof than this, that the chelæ of the Scorpion are the homologues of the mandibles of the Crustacean, and that the succeeding somites, as far as the last pulmoniferous one, correspond with the fifth to the fourteenth somites, inclusively, of the typical Crustacean. The six succeeding somites are the homologues of the six abdominal somites of the Crustacean; the aculeated sting corresponds with the telson; and the only difference presented by the pre-oral somites is that common to all air-breathing *Articulata*, viz. the sessile eyes, and the non-development of one of the pairs of antennæ.

§ 4. *Generalizations regarding the Embryogeny of the* Articulata, *and Morphological Laws based on these.*

From all these facts of development, I deduce the following morphological laws (some of which have already been enunciated for particular classes) for the *Articulata* (*Insecta, Arachnida, Crustacea*) generally.

1. The first-formed rudiment of the embryo corresponds with its sternal surface, or with the side upon which the great centres of the nervous system are placed. It is a neural rudiment.

2. In the thorax and abdomen this neural rudiment grows up on each side towards the tergal region, or that on which the great centre of the circulation is placed.

3. In the Articulate embryo, therefore, the neural wall is formed first, and gradually extends tergally so as to form the hæmal wall.

4. The cephalic blastoderm very early undergoes a peculiar flexure, a greater or less portion in front of the mandibles being bent up at right angles to the rest, and even in many instances extending backwards, so as to constitute the entire hæmal region of the head. In these cases the top of the head is in reality a sternal, and not a tergal, surface.

As a consequence of this flexure, the line of attachment of the bases of the eyes and antennæ is frequently altogether above that of the other appendages, so that they appear to be tergal, and not sternal, appendages.

5. The anterior extremity of the cephalic blastoderm becomes early divided by a median fissure, each lateral portion being a "procephalic lobe." In Insects the line of junction of these procephalic lobes is the epicranial suture.

6. In *Insecta* and *Crustacea* the head, in the embryo, is easily distinguishable from the rest of the body. In Podophthalmous *Crustacea* it is clearly seen to be composed of six somites, each possessing a pair of appendages; of these, the first are the eyes; the second, the antennules; the third, the antennæ; the fourth, the mandibles; the fifth, the first maxillæ; and the sixth, the second maxillæ.

In *Insecta*, on the other hand, only four pairs of appendages appear in the head, the eyes being sessile, and one pair of antennary organs remaining undeveloped.

In the *Arachnida* it appears to me to be quite clearly shown by development that the anterior pair of appendages are antennæ; the second pair, mandibles, with a hugely developed palpus; the third pair, first maxillæ; and the fourth pair, second maxillæ, converted, like the next two pairs of appendages, into ambulatory legs.

It follows, therefore, if we take the number of moveable appendages as the test, that in the *Articulata* never more than six, and never fewer than four somites enter into the composition of the head. But is the number of moveable appendages a just test of the number of somites entering into a part? No one will pretend that it is so in the abdominal and thoracic regions; and if we consider the head of *Crustacea* alone, we find the eyes becoming sessile, and one pair of antennary organs aborting, without the least reason for concluding that the typical structure of the head is altered. It seems to me, then, hardly a hypothesis to assume that the sessile eyes of Insects represent the appendages of a somite, since it is universally admitted that they do so in *Edriophthalmia*. But by this assumption we arrive at a still closer approximation of the different classes in regard to their cephalic structure; for all would, on this supposition, have either five or six cephalic somites,—the former number being invariably met with in the true air-breathers (though in many purely aquatic forms also), while the latter is found only in those which respire by means of gills.

I repeat, I can see nothing in this generalization but a simple expression of the facts. But I would go a step further, and add to this the *hypothesis*, that in the *Articulata* the head is normally composed of six somites, which are all fully developed only in *Podophthalmia*, *Stomapoda*, and some *Branchiopoda*; while in other *Crustacea*, some one or more of the pre-oral somites is more or less abortive, and in *Arachnida* and *Insecta*, the appendages of the first somite are sessile, and those of the second or third undeveloped. Admitting this hypothesis, I find further, that of the six cephalic somites, the sterna of three (the mandibular and two maxillary) are always situated behind the mouth and on the ventral surface of the body. The position of the other three varies; but the most anterior or ophthalmic is always bent upwards in consequence of the cephalic flexure, and not unfrequently, as in Insects, constitutes the greater part, or the whole, of the dorsal region of the head. The next two, or antennulary and antennary sterna, may present every variation from approximative parallelism with the axis, in *Squilla*, to extreme reflexion, as in *Insecta* and many *Crustacea*.

7. Nothing can be more variable than the number of the somites whence appendages are developed in the various classes and orders of the *Articulata*; and in the *Myriapoda* the total number of somites even is susceptible of an extreme amount of variation. But in the other classes it appears to me that there is a typical number of somites, from whence

but comparatively few forms depart either by way of excess or defect. Thus, if we leave out the *Læmodipoda*, all Podophthalmous and Edriophthalmous *Crustacea* have twenty somites, of which six are cephalic, eight thoracic, and six abdominal. In a very few *Branchiopoda*, and in *Trilobita*, there is more than the typical number of somites; but I believe that in all other *Crustacea*, where the number of somites is not twenty, it is less.

The question of the typical number of somites in the body of the *Insecta* is one which has been much discussed. But all the theories on this subject with which I am acquainted are, in my apprehension, vitiated by the mistaken view which their authors take of the composition of the Insect's head. Many seem to consider it to be a simple segment; while those who admit a multiplicity of segments, appear to be misled by the position of the eyes and antennæ, into regarding them as tergal appendages of the segments over whose sternal appendages they lie—as a kind of wings of the cephalic somites, in short. Again, it is supposed by many that the labrum and the lingua are the representatives of the appendages of distinct somites, a conception which is at once negatived by the study of their development.

As I have endeavoured to show, there are certainly five, and hypothetically six, somites in the head of *Insecta*; there are certainly at least three in the thorax; but the number in the abdomen has been as much disputed as the number in the head. Zaddach considers, as a general rule, ten to be the number of abdominal somites in Insect larvæ; Westwood and Newport enumerate eleven in some *Hymenoptera*, and this last is, I believe, the maximum number of somites which has yet been found in the abdomen. Now, if we assume the number of somites in the head to be six, the number in the thorax three, and the number in the abdomen eleven, we shall arrive at twenty as the maximum number of somites in the body of an Insect.

This conclusion is in remarkably close accordance with the results obtained by M. Lacaze-Duthiers from his laborious and remarkable researches into the structure of the female genital apparatus of *Insecta*. M. Duthiers finds that the vulva always opens between the eighth and ninth abdominal somites, and that in *Neuroptera*, in *Orthoptera*, in most *Hemiptera*, and in *Thysanura*, three somites intervene between the vulva and the anus, which is always placed at the very extremity of the body. There are thus eleven abdominal somites, and, therefore, a total number of twenty, in these four orders.

Some *Hemiptera* have the last abdominal somite abortive, and this appears to me to be the case in *Aphis*. In *Coleoptera* and *Hymenoptera*, the tenth and eleventh somites abort, nine only remaining: in *Lepidoptera*, finally, all three post-genital somites remain undeveloped. M. Lacaze-Duthiers' researches tend to show that a fundamental unity prevails amidst those apparently most diverse apparatuses which we know as stings, borers, and ovipositors, and that they are always the result of a modification undergone by the ninth abdominal somite.

I do not consider myself competent to give an opinion as to the details of the investigations to which I have just alluded, but I cannot refrain from expressing the belief that the labours of future investigators will bring only a confirmation of their general accuracy.

The only adult Insect, besides *Aphis*, which I have studied with sufficient care in reference to these views, is the common Cockroach (*Blatta orientalis*), an insect which I can recommend as admirably adapted for investigation. Here it is very easy to find the eleven abdominal somites, and to satisfy oneself that the vulva is placed between the eighth and ninth, and that the two outer elongated pieces of the curious clasping apparatus for the ovisacs are formed by a modification of parts of the ninth somite. The smaller and inner processes, on the other hand, are clearly developed from the sternum of the tenth somite, while the lateral anal valves represent the eleventh somite.

I have found that while the vulva opens between the eighth and ninth somites, the aperture of the spermatheca is situated on the sternum of the ninth, and that of the colleterial glands on the sternum of the tenth somite.

In the male the complex penis is formed by a modification of the tenth somite, and the aperture of the vas deferens is on the sternum of this somite, or between it and the eleventh.

Weighing all these facts, the conclusion to which they point seems obvious, viz. that in *Insecta*, as in *Crustacea*, the typical number of the somites is twenty.

I have shown above that the development of the Scorpion proves that there are seventeen post-oral somites besides the sting (which is plainly the homologue of the telson in the *Crustacea*) in this Arachnidan. If we make the same assumption for the Scorpion as for the Insect, that one of the antennary somites is abortive, we shall have a total of twenty somites here also. The anatomy of the adult Scorpion appears to me fully to confirm this view. Beginning at the hinder end, we find, including the telson, six segments behind those which carry the respiratory apertures. Of these there are four; and in the three posterior, the sternum has nearly the same length as the tergum; but in the anterior one the sternum is much longer than the tergum. Furthermore, these sterna at first seem to occupy the whole space up to the posterior boundary of the cephalothorax, while, on the dorsal side, two narrow terga lie between the tergum corresponding with the anterior sternum and the cephalothorax.

It appears, therefore, as if there were two more terga than sterna in the abdomen; but on more careful investigation, the missing sterna show themselves as the supports of the pectines and of the genital aperture in front of these last curious organs. Indications of the terga which belong to the two posterior pairs of ambulatory limbs are clearly visible on the posterior part of the cephalothorax, and these limbs are strongly distinguished from the anterior two pairs by the absence of the triangular processes directed towards the mouth, which characterize the bases of the latter. Indeed, the anterior ambulatory legs, by means of these processes, take part in the formation of the oral cavity as completely as do the maxillæ of any other Articulate animal.

Another exceedingly natural demarcation between the two anterior and two posterior pairs of ambulatory limbs is afforded by the so-called 'diaphragm' which divides the thoracic from the cephalic cavity, and whose attachment corresponds with the interval between these two sets of appendages.

In *Galeodes*, the two posterior pairs of ambulatory legs are attached to distinct segments.

There is no necessity to enter into any disquisition upon the homology of the appendages and the general uniformity in plan, so far as the anterior part of the body is concerned, in all *Arachnida.* But it may be asked, what becomes of the hinder thoracic and the abdominal somites in the Spiders and Mites? Without, at present, giving a positive answer to this question, I am inclined to think that the Spiders stand to the Scorpion in the relation of *Læmodipoda* to *Amphipoda,* and that many of their posterior somites are aborted.

I do not doubt that many minor variations will be detected when the morphology of the *Articulata* is carefully examined; but I venture to think it a result of no small moment, if it can be proved that a Lobster, a Cockroach, and a Scorpion are composed of the same primitive number of somites; that the head in each consists of the same number of parts, and that the great differences are the consequence of the different modification of the thoracico-abdominal somites, all fourteen of which bear appendages in the Lobster, while only three (or if we consider the genital apparatus in the light of appendages, five) are so provided in the Insect, and only two (leaving out of consideration the "pectines") in the Scorpion.

8. I have elsewhere* explained at length my views with regard to the nature of the carapace in the *Crustacea,* and I will only repeat here, that there seems to me to be no constancy in its composition. The rudimentary carapace of *Squilla* is assuredly developed from not more than four somites, the antennary, mandibular, and maxillary. In *Apus,* I doubt whether more than the six cephalic somites enter into its composition. In *Cuma* it is constituted by the cephalic and three anterior thoracic somites, in *Mysis* by the cephalic and six or seven anterior thoracic, and in ordinary *Podophthalmia* by all the cephalic and thoracic somites.

9. Lastly, there are certain parts developed singly in the median line in the *Articulata.* Of this nature are the frontal spines of *Crustacea,* their telson, and the sting of the Scorpion, whose mode of development appears to be precisely similar to that of a telson. In the same category we must rank the labrum in front of the mouth, which in the *Crustacea* (at least) appears to be developed from the sternum of the antennary or third somite, the metastoma (or so-called labium or lingua) of *Crustacea,* and the lingua of *Insecta,* behind the oral aperture.

However much these appendages may occasionally simulate, or play the part of, appendages, it is important to remember that, morphologically, they are of a very different nature, and that the confusing them with true appendages must tend completely to obscure the beautiful relations which obtain among the different classes of the *Articulata.*

§ 5. *The Embryogeny of the* Articulata, Mollusca, *and* Vertebrata *compared.*

I find it difficult to conclude this memoir without saying a few words on the resemblances and differences between the embryogenic changes of the *Articulata* and those of the *Mollusca* and *Vertebrata.* Absolute and fundamental differences appear to me to separate the members of these three classes almost from the first appearance of the germ.

As we have seen, it is the neural side of the Arthropod which is first developed, while, so far as I am aware, it is the opposite or hæmal side which is first formed in every

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* "Lectures," Med. Times and Gazette, 1857.

Mollusk. The germ of the Arthropod becomes antero-posteriorly segmented; the germ of the Mollusk never does so. From these two fundamental differences a multitude of others necessarily follow.

The Articulate embryo is no less markedly separated from that of a Vertebrate animal, although in the latter, as in the former, it is the neural surface which is first developed; for I know of nothing in the Articulate embryo to be compared with the primitive groove, the chorda dorsalis, and the dorsal plates of the Vertebrate*. They, like the amnion and the allantois, are, I believe, structures without a representative in the other two sub-kingdoms.

There is perhaps, as Zaddach maintains, a certain analogy between the primitive segments of the Articulate animal and the primitive vertebræ ("Urwirbel" of Remak) in the Vertebrate, but with the commencing differentiation into tissues the resemblance entirely ceases. The appendages of the Vertebrate embryo are more Molluscan than Articulate in their primitive mode of development. Notwithstanding all these great and real differences, however, there appears to me to be one respect in which a most singular analogy obtains between the Vertebrate and the Articulate type:—it is in the construction of the head.

Adopting, in some respects, the views of Prof. Goodsir†, I can recognize at least six more or less complete segments in the completely ossified Vertebrate cranium. It is clear that the Vertebrate mouth opens like that of the Articulate animal, though on the opposite side of the body, between an anterior and a posterior set of cephalic segments. In the interior of the cranium a no less natural boundary between the anterior and the posterior set of cephalic segments is afforded by the pituitary body and its fossa, when the latter exists.

I find, again, in the cranio-facial bend of the base of the cranium in the Vertebrate embryo, something wonderfully similar to the cephalic flexure of the Articulate head, and in the cranial trabeculæ (Schädel-balken of Rathke), analogues of the procephalic lobes.

While fully recognizing the fundamental differences between the Articulate and the Vertebrate type, then, I think we should greatly err if we overlooked such singular analogies as these. Future research will show whether they are or are not the outward signs of a deeper internal harmony than has yet been discerned, between the *Articulata* and *Vertebrata*.

Since the present memoir was read to the Society, some additional facts of importance have come to my knowledge. In the first place, my friend Mr. Lubbock, having undertaken to work out the development of *Coccus*, was led thereby to search for what I have called "ovarian glands" in other insects. His results will be published at length elsewhere; but he permits me to say that corresponding organs exist in all *Lepidoptera*, *Hymenoptera*, Geodephagous and Hydrodephagous *Coleoptera*, *Diptera*, and most *Neuroptera*, while they are absent in *Orthoptera*, *Pulex*, *Libellulidæ*, &c., and are all terminal,

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* I therefore by no means agree with what Zaddach says on this subject, or with regard to the homologue of the amnion in *Articulata*.

† As expressed in the Edinburgh New Philosophical Journal, 1857, p. 118 *et seq*.

instead of forming groups between the egg-germs, in the non-geodephagous *Coleoptera* and *Hemiptera*. They have been figured in *Lepidoptera* by Herold, Meckel, Thompson, and Stein, in *Diptera* by Stein and Leuckart, and in *Coleoptera* by Stein.

Secondly. In September last I received the fourth Part of the fourth volume of Moleschott's 'Untersuchungen,' which contains a long and remarkable Essay by Leuckart, "Zur Kenntniss des Generations-wechsels und der Parthenogenesis bei den Insekten." The first article in the memoir is on the "Alternation of Generations in the *Aphides*." The author describes at length, and figures, the female reproductive organs of *Aphis Padi*; and although the arrangement of these organs is somewhat different from what obtains in my *Vacuna*, I am happy to say that his account of the ultimate structure of the ovaries essentially coincides with mine. The view which Leuckart takes of the relation of the ova and agamic germs (p. 346) is also in close agreement with my own. I lay the more weight upon these coincidences because Prof. Leuckart's observations must have been made at the same time with, and were of course wholly independent of, mine.

Lastly, not having the works of either Kaltenbach or Koch at hand when my memoir was read, I abstained from attempting to give the specific names of my *Aphides*. I have no doubt now that the viviparous form is the *Aphis Pelargonii* of Kaltenbach, especially as my friend Mr. Dallas, who has paid particular attention to the *Hemiptera*, is of that opinion. The oviparous female resembles so much in form and habit the *Vacuna dryophila* of Schrank, that I have little doubt it is really that species, though, when carefully examined, the antennæ are found to have six unquestionable joints, and seven, if the swollen base of the last division of the antenna is to be regarded, as I believe it should be, as a distinct joint. The eyes also have a small and inconspicuous tubercle; and the promuscis is not nearly so long as either Kaltenbach or Koch states.—*Nov.* 16, 1858.

DESCRIPTION OF THE PLATES.

TAB. XXXVI.

Aphis Pelargonii.

The letters have the same signification throughout. The fractions indicate the measured size, in parts of an inch, of the objects.

Fig. 1. The three anterior chambers of a pseudovarium: A. the apical chamber; B. the second; C. the third. *a*. Pseudovarian ligament; *b*. wall of the pseudovarium; *c*. its epithelium; *d*. periplast or homogeneous matrix of the apical chamber; *e*. clear vesicle; *f*. its endoplast, the two corresponding with the germinal vesicle and spot of an ovum; *g*. a pseudovum partially detached, its periplast greatly enlarged; *e'*. its vesicle, whose endoplast is invisible; *h*. blastoderm; *i*. pseudovitellus.

Fig. 2. Terminal chamber of a pseudovarium, with the second chamber beginning to be formed in

consequence of the enlargement of the pseudovum (*g*), which is about $\frac{1}{900}$th of an inch in diameter.

Fig. 3. The pseudovum is still more enlarged, and the second chamber is nearly distinct. The vesicle, *e'*, remains, and exhibits certain indistinct granules in its contents. The cells of the blastoderm of c measure about $\frac{1}{2500}$th of an inch in diameter.

Fig. 4. The second chamber is quite distinct from the first, and contains a mass (*g*) in which no clear vesicle could be discovered: this mass became clearer and irregularly areolate by the action of water.

Fig. 5. The cellular germ-mass. The cells or clear cavities have a diameter of about $\frac{1}{3200}$th of an inch; their endoplasts are hardly more than $\frac{1}{10000}$th of an inch in diameter.

TAB. XXXVII.

Aphis Pelargonii. Letters as before.

Fig. 1. A portion of the blastoderm and pseudovitellus of an unaltered germ, only $\frac{1}{386}$th of an inch in length, but otherwise like the preceding. The clear vesicles measured $\frac{1}{3200}$th of an inch; the endoplasts $\frac{1}{18000}$th.

Fig. 2. A germ extracted from its chamber and treated with acetic acid. It has no pseudovitelline membrane.

Fig. 3 *a*. A germ extracted from its chamber. It is enclosed within a pseudovitelline membrane (*k*); and its pseudovitellus is arranged in obscure spheroids, of which one is represented in 3 *b*. acted on by water. Its granules are about $\frac{1}{9000}$th of an inch in diameter.

Fig. 4. Germ $\frac{1}{215}$th of an inch in length. The cells of the posterior end (3) present a sort of break (*l*), and the blastoderm on one side is greatly thickened. The thickened portion offers an indication of a division (*m*). The anterior end (*y*) is also somewhat thickened.

Fig. 5 *a*. Germ $\frac{1}{160}$th of an inch, enclosed within its pseudovitelline membrane: *n*. rudiment of the abdomen; *o*. of the thorax; *p*. of the head; *l'*. gap corresponding with *l*, and now filled by the pseudovitellus; *q*. inner layer of the germ; *r*. that portion of it which will become the pseudovarium. 5 *b*. Diagrammatic view of the same, viewed from above.

Fig. 6. Lateral view of a larger germ without its pseudovitelline membrane. The anterior part of the cephalic blastoderm (*p*) has extended upwards, and constitutes the procephalic lobe *p'*. The rudiment of the pseudovarium (*r*) is still more distinct than in the preceding.

TAB. XXXVIII.

Aphis Pelargonii.

Fig. 1. Embryo enclosed within its pseudovitelline membrane. The pseudovitellus has aggregated over the abdomen, and more or less completely left the thorax. Letters as before, except—*s*. the first larval integument; *lb*. labrum; *at*. antenna; iv'. mandible; v'. first maxilla; vi'. second maxilla; vii'. first, viii'. second, and ix'. third thoracic leg. 1 *a*. The same embryo seen from below.

Fig. 2. Embryo of the same size, viewed from below and the side, the blastoderm unfolded, and the appendages separated.

Fig. 3. Highly magnified view of part of the pseudovitellus, and of the rudiment of the pseudovarium, in an embryo $\frac{1}{90}$th of an inch in length.

Fig. 4. Embryo $\frac{1}{84}$th of an inch, enclosed in its pseudovitelline membrane.

Fig. 5. Embryo $\frac{1}{70}$th of an inch, in its pseudovarian chamber.

Tab. XXXIX.

Aphis Pelargonii.

Fig. 1. A. Nearly full-grown fœtus, extracted from its investments, and somewhat unfolded: *t*. anus, whence the alimentary canal is seen taking a curved S-like course to the mouth. B. Terminal chamber of one of the pseudovarial cæca of this embryo.

Fig. 2. The mouth of this embryo seen from below. The "labium" (VI′) already appears as a large single process bilobed at its free end.

Fig. 3. Side view of the head of a similar embryo, showing the relative position of the different appendages and the course of the œsophagus.

Fig. 4. A nearly full-grown fœtus in its pseudovitelline membrane: I′. the pigment of the eye; *s*. rudimentary siphons.

Fig. 5. A partially diagrammatic figure of the wingless viviparous form of *Aphis Pelargonii.* The Roman numbers indicate the typical somites of the body and their appendages; the other numbers mark the abdominal somites. A. Anus; G. genital aperture; S. siphon.

Tab. XL.

Reproductive Organs of the oviparous Aphis (*Vacuna dryophila*).

Fig. 1. The female organs entire. One ovarian cæcum only is represented; and I have purposely selected one of those, the ovarian glands in whose apical chamber are very similar, at first sight, to ova. A. Anus; B. vulva; C. vagina; D. oviducts; E, F, G, H, I, K. chambers of the ovary; L. ovarian glands; *m*. colleterial glands; *n*. spermatheca; 7, 8. seventh and eighth abdominal sterna.

Fig. 2. The three anterior chambers of an average ovarian cæcum. Letters as before, with the addition of—*o*. germinal vesicle of the nascent ova in the terminal chamber (K); *o*′. germinal vesicle of ovum in I; and *o*″. of ovum in H; *p*. epithelium; *q*. cord-like secretion of ovarian gland, *l*; *l*′. inner capsule of ovarian gland.

Fig. 3. The end of another ovarian cæcum, showing very distinctly the apparent continuity of the cord, *q*, with the ovum in the third chamber. The granules of the viscid vitelline mass (which is surrounded by no membrane) are so numerous as to hide the germinal vesicle.

Fig. 4. A. Posterior extremity of the ovum unaltered: *r*. chorion; *s*. tubercular elevation; *t*. appendage; *u*. its gelatinous investment; *v*. rod-like bodies imbedded therein; *v*′. the same more magnified. B. Anterior end of the ovum after the action of potash; *y*. papillary elevation; *z*. internal markings of the chorion (*r*); *w*. vitelline membrane; *x*. vitellus. C. Posterior extremity treated in the same way: *s*′. micropyle?

Fig 2

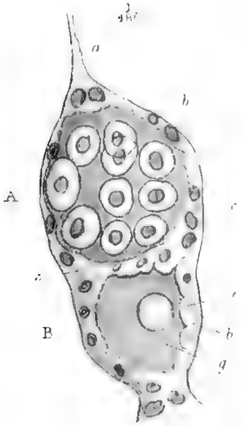


Fig 1

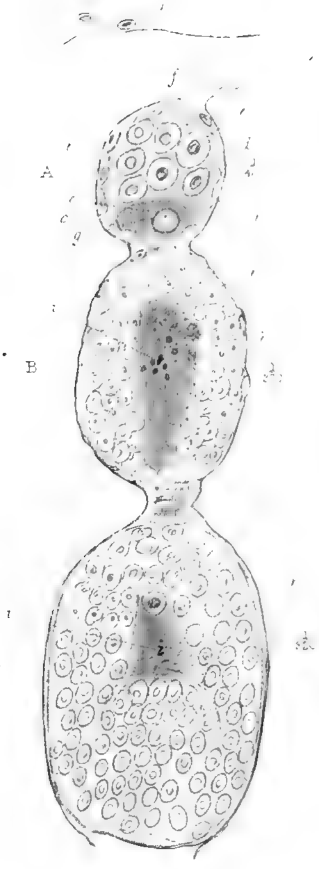


Fig 5

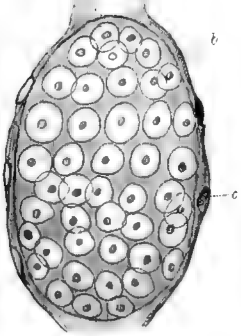


Fig 3

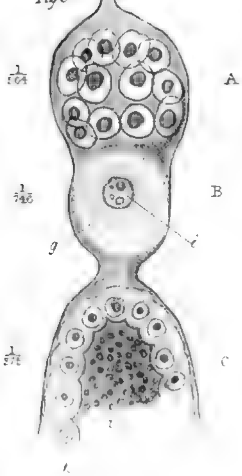
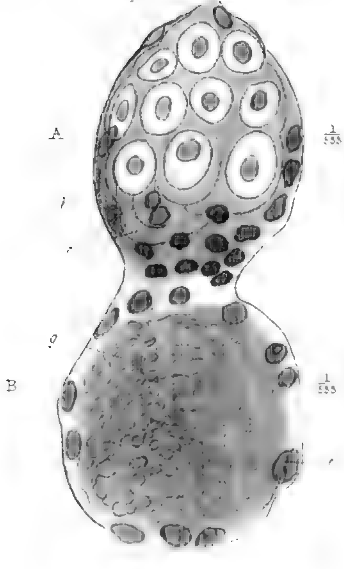


Fig 4



T.H.H. ad Nat. del.

G. Jarman sc.

Fig 1

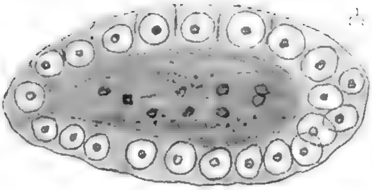


Fig 2

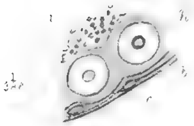


Fig 4

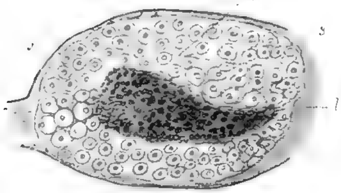


Fig 5 a

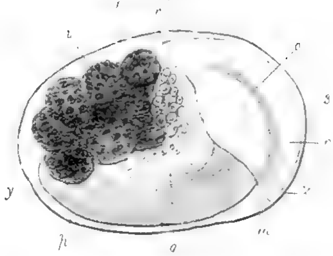


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Fig 3 b

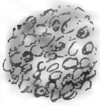

Fig 5 b

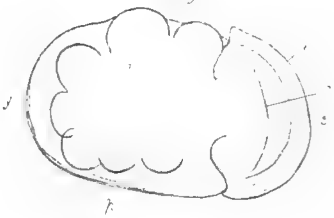

Fig 3 a

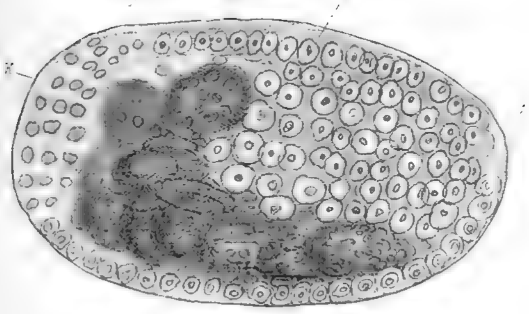

Fig 6

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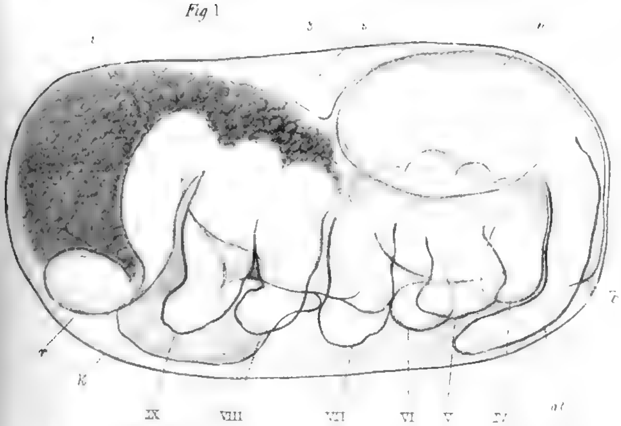
Fig 1



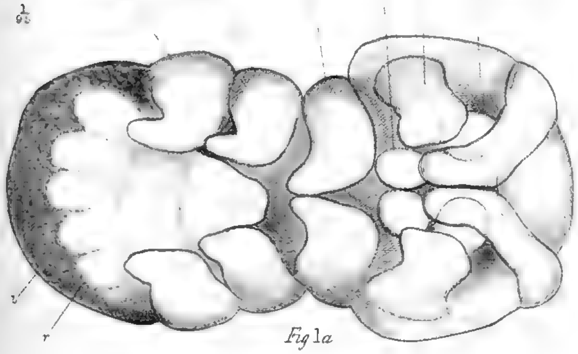


Fig 1a

Fig 2

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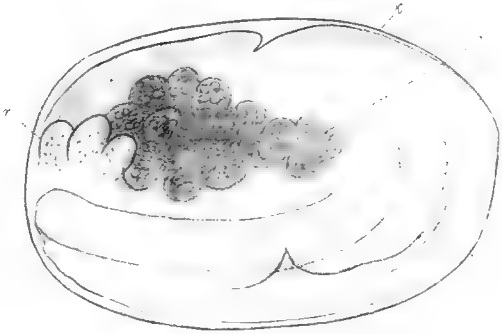


Fig 3

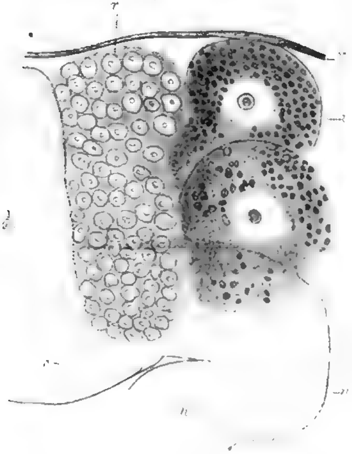
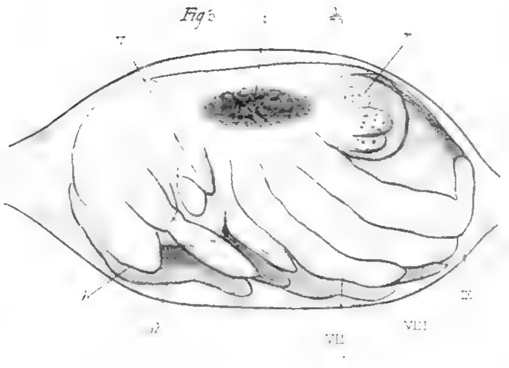


Fig 5



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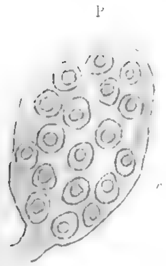



Fig. 2

Fig. 4

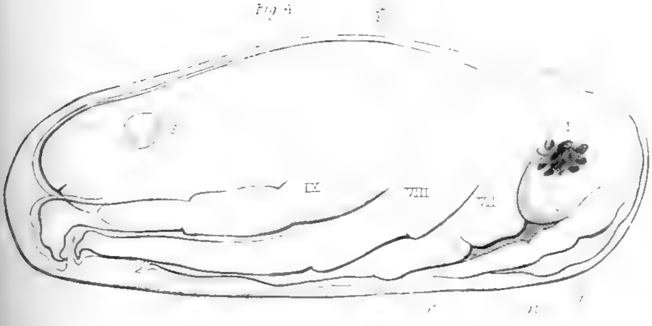
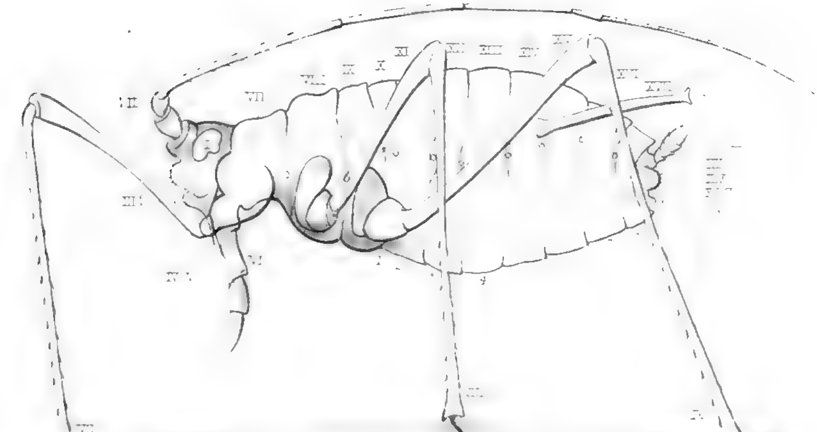


Fig. 3

Fig. 5



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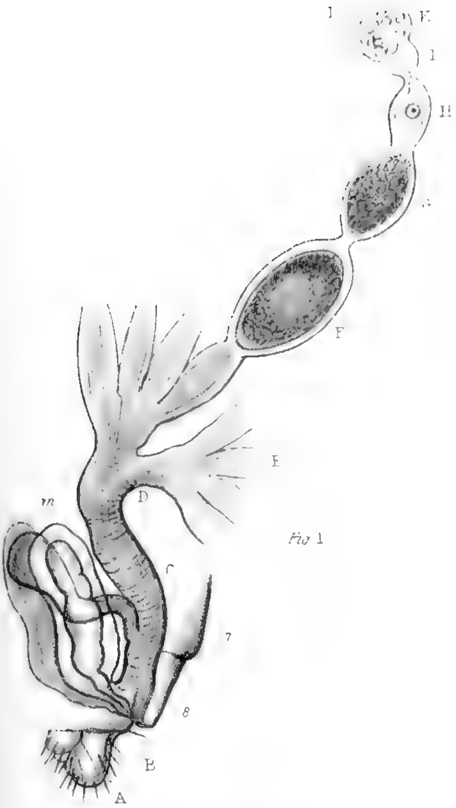


Fig 1.

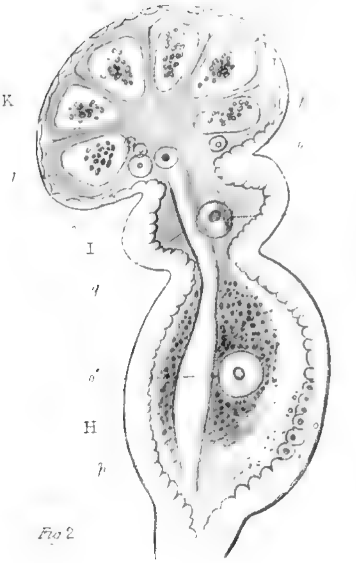


Fig 2.

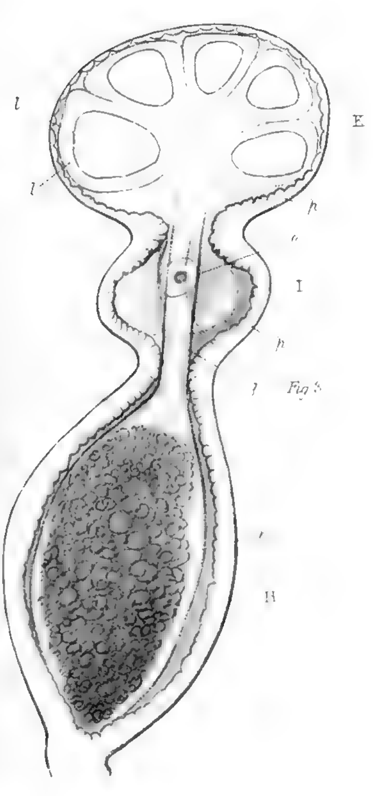
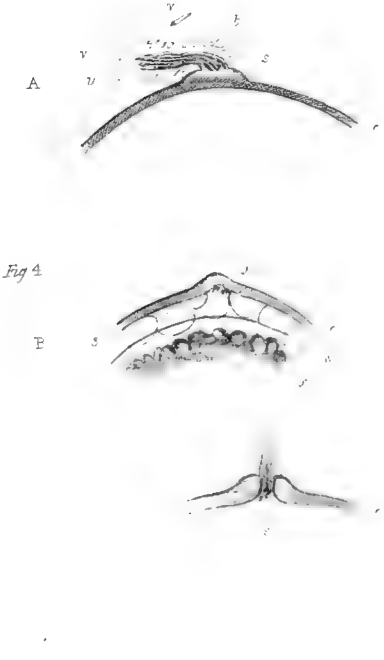


Fig 3.

Fig 4.



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G. Jarman sc.

XVI. *On the external Anatomy and Natural History of the Genus of* Annelida *named* Palolo *by the Samoans and Tonguese, and* Mbalolo *by the Fijians.* *By* JOHN DENIS MACDONALD, *Assistant-Surgeon of H.M.S. 'Herald,' employed on Surveying Service in the South-western Pacific, under the Command of Captain* H. M. DENHAM, *R.N., F.R.S.* *Communicated by* G. BUSK, *F.R.S., F.L.S.*

Read December 3rd, 1857.

ON the examination of specimens of a remarkable *Annelidan,* obtained at the Navigator Islands (Samoa), and presented to the British Museum by the Rev. J. B. Stair, Dr. Gray founded a new genus, which he called *Palolo,* adopting the native name of the animal. It is thus characterized :—

"Body cylindrical separated into equal joints, each joint with a small tuft of three or four spicula on the middle of each side. Head ? Last joint ending in a couple of tentacles. Eggs globular.

"*Palolo viridis,* n. sp. Green, with a row of round black spots down the middle of the dorsal ? surface; one spot on the middle of each joint.—*Habitat.* Navigator's Islands."

Dr. Gray found his specimens so mutilated, that he could not detect a single head amongst all the broken pieces; and consequently this essential part remained without description. He seems to refer his want of success in this respect to mere casualty. It is very remarkable, however, that we at first experienced the same difficulty, and only obtained a single head, though we carefully examined considerable numbers of this species in the Fiji Group, where it makes its short annual appearance at a period which the natives predict with unerring precision by observing the phases of the moon, as at Samoa. The comparison of specimens from both these localities proves them to be specifically identical; moreover, the Fijian name for the animal is *Mbalolo, Mb* in that language being substituted for the Samoan *P.*

The great antiquity of this name is attested by the fact, that the parts of the year nearly corresponding with our months of October and November are respectively named *Mbalolo lailai* (little), and *Mbalolo levu* (large). The latter, as its name implies, is distinguished by the appearance of the *Mbalolo* in such vast numbers, that it is collected by the natives as a dainty article of food, and is so much prized that formal presents of it are often sent considerable distances, from certain chiefs, to others whose small dominions do not happen to be visited by the *Mbalolo.* The Fijians entertain superstitious ideas connected with it; but further notice of these would be foreign to our present purpose.

Reverting to the separation or absence of the anterior extremity of the *Mbalolo* (as first noticed by Dr. Gray, and subsequently by us, in the specimens including different species) at the regular period of visitation, this fact is too remarkable to depend upon coincidence or casualty. It would rather seem to indicate the fulfilment of some important end in the propagation of the species. Mr. F. M. Rayner suggested to me that the phenomena of reproduction in the case of *Tænia* and *Bothriocephalus* afford a curious parallel to the circumstance just alluded to with reference to the *Mbalolo*. The transverse fission in the latter case is evidently connected with the dispersion of the ova, rather than the development of new individuals from the pre-existing materials of the animal's body, as in *Nereis*, &c.

I had the good fortune to discover a single head of the *Mbalolo*,—and the only one to be found amongst a large bottleful of bodies and tails collected for me by my esteemed friend, the Rev. S. Waterhouse, Wesleyan Missionary, Fiji. The joints of the body, to the number of about twenty, remaining in connexion with the head, were considerably smaller than those that would succeed them were the specimen perfect; besides which, the *aciculi*, of two sorts, were more numerous in the little bundles springing from the lateral tubercles. The dark spots and characteristic markings of the dorsal surface were also very faint, or scarcely distinguishable. The head itself was very little narrower than the joints of the neck, blunt and rounded, with a slight emargination in front. Eyes two, placed one on either side of the upper surface, including, in the space between them, three conical tentacula, of which the central is the longest, and projects a little beyond the head. The mouth was inferior, subterminal, and armed with two pairs of jaws—those of the first pair being sickle-shaped and simple, and those of the second broad and jaw-like, having a curved external outline and a series of dental points on their opposable border. The tissues in the neighbourhood of the jaws appear to be much indurated; and one structure in particular is worthy of notice, that its true nature, if not already known, may be investigated in the neighbouring genera. It consists of two slightly diverging series of scale-like plates overlapping one another from before backwards, in which direction also they gradually increase in size. The free edges of the plates are directed backwards; and as distinct muscular bundles may be traced into their deep surface, it is highly probable that they are capable of elevation and depression, acting, so to speak, as a prehensile palate, opposable to the jaws.

The typical elements of the lateral appendages of the body-segments (often so distinctly seen in allied Annelida) appear to have become blended together, more or less, so as to form a single setigerous tubercle, transmitting, however, as is usual, two characteristic kinds of setæ, and bearing a simple papilla-like, dorsal cirrus above, and a somewhat smaller ventral cirrus below,—the former lying near the outer extremity of the tubercle, and the latter somewhat nearer the base. The repetition of these cirri may be traced backwards, through all the annuli, to the penultimate joint, in which they are quite suppressed; but both reappear in the anal segment, and the ventral cirri in particular, having attained considerable length, project posteriorly like those of better-known *Nereids*. Besides the supporting stylets of the feet (exhibiting so much sameness of character in all the Annelida furnished with them), the setæ of *Mbalolo*, as above noticed, are of two distinct kinds—one being of a very long slender and bristle-like form slightly compressed on the sides, twisted on its long axis, and terminating in an exquisitely fine point; while the other is much stouter and shorter, with a small claw-like terminal appendage having two minute conical teeth on its concave edge. The bundles of *setæ* generally consist of two or three of each of these forms, the latter holding a position inferior to the former.

Mbalolo has been supposed to exhibit an alliance with *Arenicola*; but the anatomical characters above given refer it, very clearly, to the *Nereidæ*.

DESCRIPTION OF THE PLATE.

TAB. XLI.

Fig. 1. Portion of *Mbalolo*. Natural size.

Fig. 2. Magnified figure of the head, with its three frontal tentacula and eyes, each of which appears to consist of two distinct organs closely approximated. The position of the retracted jaws is shown in the central dark space behind the tentacula.

Fig. 3. The double set of jaws, with their basal plates.

Fig. 4. The palatal ? erectile plates noticed in the text.

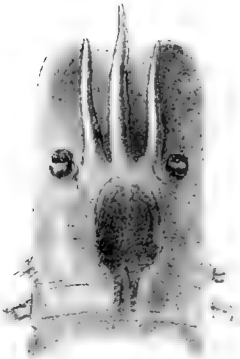
Fig. 5. Three of the feet, seen from below: *a.* setigerous tubercle; *b, b, b.* dorsal cirri; *c, c, c.* ventral cirri; *d.* muscles which protrude the aciculi, acting through the basal stylet, *e*; *f.* retractor muscles, derived from the lateral border of a longitudinal muscular band, *g*, running along the ventral surface.

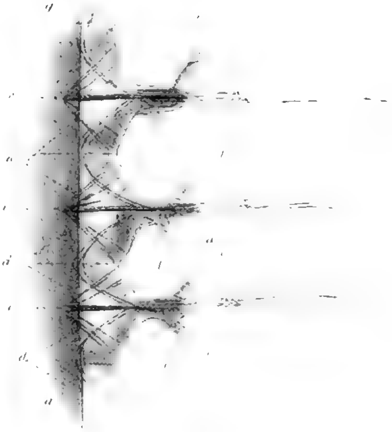
Fig. 6. Posterior extremity of the *Mbalolo*, dorsal aspect: *a.* terminal dorsal cirri; *b.* terminal ventral cirri, or oval styles so called.

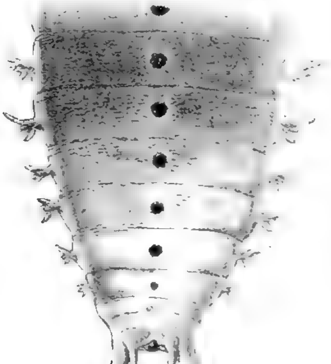
Fig. 7. Basal stylet, or that which affords support to the lateral tubercles.

Fig. 8. Whip-like aciculus.

Fig. 9. Clawed aciculus.







H. Martens & R.N. Moat del. [illegible] West lith

XVII.—*On the probable Metamorphosis of* Pedicularia *and other forms; affording presumptive evidence that the Pelagic* Gasteropoda, *so called, are not adult forms, but, as it were, the Larvæ of well-known genera, and perhaps confined to species living in deep water.*

By JOHN DENIS MACDONALD, *Assistant-Surgeon of H.M.S. 'Herald,' employed on Surveying Service in the South-western Pacific, under the command of Captain* H. M. DENHAM, *R.N., F.R.S. Communicated by* G. BUSK, *F.R.S., F.L.S.*

Read February 18, 1858.

IT has been long known that certain genera of Gasteropoda, which are shell-less in the adult state, possess both shell and operculum not only while yet within the ovum, but for some little time after their liberation, and that ciliated vela precede the more perfect development of the foot. This is especially true of the *Nudibranchs*; and *Janthina*, which exhibits so near an approach to them in its organization, merely loses the little operculum of its embryonic condition, while the spiral shell is retained. But a more striking change than this occurs in the case of the genus *Pedicularia*, if my observations be correct; for I believe that I have identified the anatomy of a certain species whose shell presents a beautifully cancellated nucleus, with that of one of our little pelagic Gasteropods also having a cancellated shell, but presenting an aperture so closely resembling that of *Cheletropis* as to have misled me in naming figures of its labial and lingual dental organs, given in illustration of a former paper. I am, however, now in a position to prove that the oral teeth of *Cheletropis* are not lateral as in the little Gasteropod just referred to, and that its lingual ribbon is triserial and constructed on the type of that of *Murex, Purpura, Turbinella, Ricinula*, and such genera,—not septiserial as in *Pedicularia* and the little animal which I believe to be its fry. In the latter case moreover, it must be mentioned that the external series of uncini are often rudimentary, or not at all apparent,—a fact which is clearly in accordance with the common law of development of the lingual ribbon (as noticed in a previous paper, with an illustrative figure selected from the fry of *Cypræa umbilicata*). Without reference to the contained animals, the most acute conchologist could only regard *Cheletropis Huxleyi* and its little oceanic ally as distinct species of one genus, although we now know that it would be a violation of the simplest anatomical principles to place them even in the same family. Here, to a certain extent, similar conditions have arisen out of similar necessities in two otherwise very dissimilar beings. The final modelling, and thickening of the lip, moreover, afford no proof whatever that these shells have attained their adult state; for this change is usual in other cases, as in *Carinaria*, where its further progress is more easily traced, not only as an indication of the close of one stage of development, which had been going forward during the early part of the active life of the being, but as establishing a basis upon which the characteristic lines of growth of the future shell are laid.

Macgillivraia pelagica possesses the labial plates of *Natica* or *Triton*, and the lingual teeth of *Ranella* or *Dolium*, with the spherical otolithes common to all; and it is highly probable that it will ultimately prove to be the young of some neighbouring genus. The little shell itself is perfectly identical with the summit of the spire of a species of *Malea* which is very common in the South Seas. I regret much that I have not yet had an opportunity of examining the animal of the latter for the purpose of more accurate comparison; but this much I can say—that the lingual teeth of *Dolium*, which cannot be far removed from *Malea*, very closely resemble those of *Macgillivraia*.

I formerly figured and described a pelagic Gasteropod with six ciliated arms, and which I believe may be safely referred to the *Tritonidæ*. I now offer the portrait of another species, obviously belonging to the same genus, though occupying a very differently shaped shell. In the paper alluded to I also noticed a minute *Natica*, with mentum, lateral labial plates, septiserial tongue-strap, and, in fact, only differing from other or at least full-grown members of the genus in the possession of a cervical circlet of ciliated arms, and a vesicular float; but I am now quite satisfied that I have identified this species with the nucleus of a handsomely spotted *Natica* occurring in deep water.

It is very remarkable that the characteristics just mentioned should be present in all the little pelagic Gasteropoda, while their internal anatomy unmistakeably refers them to very different families. But if, in connexion with these particulars, we take into consideration the large size of the fatty globules contained in the sacculi of the liver, indicative of almost incipient development, and the total absence of *ova* or *spermatozoa* (at least so far as the matter has yet been investigated), it can scarcely be doubted that these little creatures are not perfect, but transitional forms, the further development of whose head and proboscis, coincident with the shedding of the ciliated arms and a general adaptation to a new sphere of existence, may, with all propriety, be regarded as a veritable metamorphosis. It also appears to me that a bold indication of a developmental change such as this, is exhibited in the abrupt transition from the marking of the young shells into the very different and characteristic sculpturing of the adult state of the corresponding species,—an occurrence which takes place long subsequent to the period at which, in some instances, a sinistral nucleus merges into a dextral shell.

Since the above remarks were written, as if to afford them additional support, a successful haul of the towing-net has made me acquainted with another little genus, of which I had no previous knowledge. It was invested with a thick and globose cartilaginous envelope, with an irregular subterminal aperture, not very unlike that of the cartilaginous covering of the Pteropod *Eurybia*.

On endeavouring to remove the animal from this singular shell, I found that it was indeed but an external case, probably the egg-capsule itself; for the little creature very readily came away occupying the true shell, which was yet so membranous and delicate as to become folded by pressure, without fracture. The necessity of a further protection to the tiny occupant, cast abroad upon the ocean of life, will be at once apparent on inspecting the figure. The tentacula were of considerable length, with ocelli at their bases; and the mouth was encircled by a deeply cleft calyx of four segments, with richly ciliated margins. The foot much resembled that of *Atlanta*, minus the swimming plate, and presented a very distinct though rudimentary creeping disc and a broad three-lobed posterior part bearing no operculum. The margin of the mantle, as in *Jasonilla*, was rather thick; and a pectinate gill extended along the dorsal region. The mouth was armed on each side with a beautifully set pavement of sharp-pointed labial teeth; and the lingual ribbon, supporting 7 series of members, exhibited the closest relationship to that of *Hyponyx* and *Pileopsis*. Finally, single spherical otolithes were apparent through the transparent pedicle of the foot. Here is an incontrovertible case of a young oceanic Gasteropod still undergoing development, but manifesting every essential anatomical character present in *Macgillivraia* and *Cheletropis*, which we have hitherto regarded as perfect forms.

EXPLANATION OF THE PLATE.

Tab. XLII.

Fig. 1. Little cancellated pelagic shell, closely resembling the minute spire of *Pedicularia*.

Figs. 2 & 3. Enlarged back and front views of the same.

Fig. 4. Small portion of the shell, more highly magnified to show its characteristic sculpturing agreeing with that of *Pedicularia*.

Fig. 5. The operculum.

Fig. 6. One transverse row of the lingual ribbon.

Fig. 7. A species of *Pedicularia* brought up from a depth of 40 fathoms, on a small Madrepore, 1 mile and a half off Elizabeth Reef. Lat. 29° 55′ 27″ S., Long. 159° 2′ 54″ E. (The natural size is seen to the left.)

Fig. 8. One transverse row of the lingual teeth of the same, for comparison with fig. 6, which is not so fully developed, but in other particulars very similar.

Fig. 9. Enlarged figures of a minute pelagic Gasteropod, having six ciliated arms and a clawed operculum, allied to a species previously figured and described.

Fig. 9 *a*. Portion of mantle with ciliated bands and processes, more highly magnified.

Fig. 10. Three-quarter view of the same shell.

Fig. 11. Lateral labial teeth.

Fig. 12. Lateral view of small pelagic Gasteropod enclosed in a stout cartilaginous case.

Fig. 13. Front view of the same.

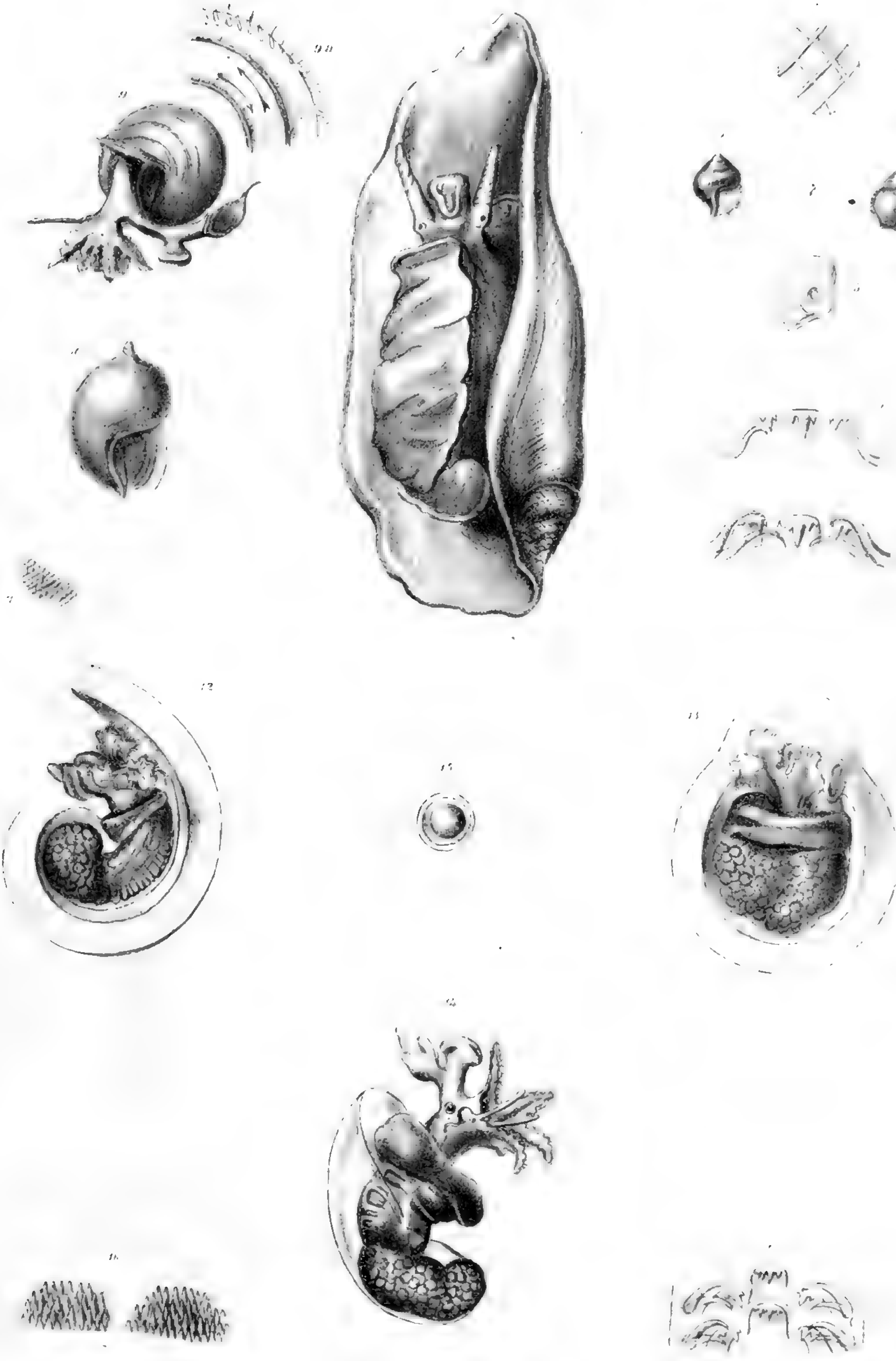
Fig. 14. The animal removed from the outer case and slightly twisted in its rudimentary shell.

Fig. 15. The auditory capsule.

Fig. 16. Lateral labial teeth.

Fig. 17. Portion of lingual ribbon.

PEDICULARIA &c.



J.D. Macdonald R.N. ad nat. del. Tuffen West lith.

XVIII.—*On the Anatomy of* Eurybia Gaudichaudi, *as bearing upon its Position amongst the* Pteropoda. *By* JOHN DENIS MACDONALD, *Assistant-Surgeon of H.M.S. 'Herald,' employed on Surveying Service in the South-western Pacific, under the command of Captain* H. M. DENHAM, *R.N., F.R.S. Communicated by* G. BUSK, *F.R.S., F.L.S.*

Read February 18th, 1858.

ONE of the most constant products of the towing-net, in the S.W. Pacific, is the little Pteropod *Eurybia Gaudichaudi.* It is often captured in the daytime, which is seldom the case with other members of its class.

The enveloping mantle forms a sac of an oval figure and scarcely exceeding $\frac{1}{6}$th of an inch in length, with an anterior transverse subterminal slit on the ventral side, giving passage to the head with its tentacula, a rudimentary foot, and the swimming-fins. It is composed of large spheroidal cartilage-cells, in which the nuclei are distinctly visible, and a sparingly interspersed fibrous tissue, opposing an almost insuperable obstacle to the study of the internal anatomy of the animal.

The *Eurybia* may be said to possess a distinct head and neck, the head bearing on either side a large tapering and gently curved tentaculum, with a small nipple-like process at the inner side of the base. All these appendages are richly ciliated, the cilia being generally disposed in parallel, longitudinal lines, and exhibiting a dextral, undulatory motion.

The mouth is a vertical opening, with moderately prominent lateral lips, just within the borders of which may be noticed, according to the age of the animal, one, two, or three longitudinal series of small square plates, with a delicate cutting edge near the outer part of each.

The lingual ribbon is somewhat more lengthy than that of any other Pteropod with which I am acquainted. It presents a single row of simple, lancet-shaped teeth in the rachis, and a single row of fang-like uncini in each pleura. The buccal mass is globose in figure, and composed of fibro-cartilage with investing muscular fibres.

A very distinct though rather small foot springs from the under surface of the body, considerably behind the head, having a flat creeping-disc, with a subquadrate anterior and a pointed posterior extremity, and in many particulars closely resembling the foot of the true pelagic Gasteropods.

The swimming-fins are unquestionably the epipodia of this foot, arising by a subcylindrical base, just above the lateral border, and near the middle of its root. These organs at first diminish a little in size, and then gradually expand to form a broad and laterally compressed paddle, widely emarginated at its extremity.

The œsophagus holds a dorsal position, and is distinguished from the other parts of the alimentary canal by the thickness of its walls and its richly ciliated lining.

The stomach is large, consisting of several wide sacculated portions, the exterior of which is beset with large hepatic lobuli containing cells distended with rich brown-red, yellow, and green fatty globules, imparting to them a beautifully variegated appearance. No gastric plates or teeth are visible, though universally present in the true Thecosomata. Having left the stomach, the intestine soon curves forwards to terminate anteriorly near the generative openings, on the right side of the body.

The salivary secretion is furnished by two irregularly lobulated organs, lined with rather large secreting cells, and lying one on either side of the œsophagus as it emerges from the buccal mass.

The heart occupies an antero-dorsal position, and its long axis appears to lie transversely; but I have not been able to detect a respiratory organ, or even the actual distribution of the blood-vessels.

The main centres of the nervous system are the subœsophageal ganglia, which are well developed, and support the auditory capsules containing vibrating otokonia on their inferior surface.

The ovarium consists of a fan-like expansion of lobuli, on the borders and extremities of which the ova are clustered within the enveloping sheath. From this expansion a number of tubuli arise, and ultimately unite to form a wide oviduct distinguished from the spermatic duct and intestine by the large longitudinal and nucleated fibres of its muscular coat. A large cæcal appendage, distended with a bright-orange and plastic fluid, appears to open by a short duct at the same external orifice. This organ is probably the homologue of the so-called spermatheca of the Pulmoniferous Gasteropods; and its contained fluid offers a remarkable analogy to that occurring in the ovarian sac of some Cephalopods.

The lobuli of the testis lie upon and coincide so closely with those of the ovarium, that it is difficult to distinguish them; but the stout vas deferens, arising from the point at which the divisions converge, soon communicates, above and a little to the right of the ovary, with a spheroidal sac or vesicula seminalis, which may be readily seen from without, through the cartilaginous mantle. The spermatic duct thence proceeds forwards in company with the oviduct, and enters the neck of the external male organ, to terminate in a perforated dart or rigid point, which occupies the fundus of the inner protrusible membrane of a double-walled pyriform sac having an external orifice near that of the oviduct, on the right side, behind the corresponding swimming-fin.

The spermatozoa of this Pteropod are remarkable for their great length and peculiar looping and spirally twisting movements, as illustrated in Pl. XLIII. fig. 8 B *b*. The filaments appear to rotate on their long axes, and twirl up, like an over-spun thread unlay themselves, and twist up again, with wonderful rapidity while their activity lasts.

Eurybia is ovo-viviparous; and the development of the young may be studied with much interest while yet within the body of the parent. The simple capsule of the ovum offers but little for remark; but the included embryo in the comparatively advanced stage exhibits many points of analogy to that of an ordinary Gasteropod.

The incipient cartilaginous mantle is of large size compared with the embryo itself. It is globose in figure, with an opening at one end, through which the ciliated vela of the young *Eurybia* may be seen protruding. These latter organs form expanded lobes, lying one on either side of the head, having the borders beset with large vibratile cilia. A frontal elevation rises up between them, from which, it would appear, the future tentacula spring. At this period of development the rudimentary external parts exhibit a loose cellular structure, the basis of the more complex tissues of the full-grown animal.

The cephalic ganglia show themselves very distinctly, through the transparent envelopes, as disproportionately large and rounded masses; and the auditory sacs, containing a single primordial otolithe, lie quite in contact with their nervous centres.

The intestine may be seen taking a simple horse-shoe flexure towards the neural surface, while the gastric dilatation fills up the hollow of the curve to a considerable extent.

The organ above described as corresponding with the spermatheca of the Pulmoniferous Gasteropods is just visible on the right side; and what appears to be the true vesicula seminalis on the left.

The external surface of the mantle is pretty equally divided into three zones, by two ciliated rings disposed transversely, and consisting of a single series of prominent cells bearing moderately large cilia.

The development of the cartilage-cells of the mantle may be traced at any part, from the round transparent nucleus and its acquisition of a membranous investment, to their perfect condition as structural elements.

The fibrous tissue may be also seen in course of evolution, from very thin-walled cells formed upon plastic but minutely granular nuclei. Having attained a certain size, the cell-wall shoots forth into delicate tubular processes, which either spring from two opposite ends, or irregularly from several parts of the circumference. As the nutrition of the cells goes forward, the simple tubular processes increase in length and in bulk, more particularly at the base, and break up into numerous and exquisitely delicate ramusculi, by which the ultimate fibrillation of the body of the cell seems to be effected. The elongated or fusiform nuclei permanently remain to strengthen the tissue, which now begins to assume a reticulated structure in the intercellular spaces.

The remains of the ciliated rings of this embryo are distinguishable in *Eurybiæ* of considerable size; and from what has been above noticed of the anatomy of the animal and the intimate structure of the mantle (which, though answering the purpose of a shell, is, strictly speaking, not homologous with such), it is evident that this genus is not conformable to the characters of the Thecosomata or first section of the Pteropoda proposed by De Blainville.

The principal points of difference may be thus analysed:—

THECOSOMATA.	EURYBIA.
1. Animal furnished with an external shell.	1. No external shell.
2. Head indistinct.	2. Head and neck quite distinct.
3. Foot and tentacula rudimentary, combined with the fins.	3. The foot is small, and only on this account rudimentary; the tentacula are large, and not combined with the fins.
4. Mouth situated in a cavity formed by the union of the locomotive organs.	4. The mouth is not situated in a cavity formed by the locomotive organs.
5. Respiratory organs contained within the mantle-cavity.	5. This last particular may possibly apply.

In the following synopsis of the principal genera of Pteropoda, *Eurybia* occupies a position suggested by general anatomical principles, and which I believe to be the natural one*.

PTEROPODA.

- *Gymnosomata.* Animal naked, head distinct. No gastric teeth apparent ....
  - Having a lingual pavement, dental cheek-pouches, and a membranous envelope ....
    - Central series of lingual pavement absent. Cheek-pouches deep and tentacular suckers large and well-developed .... PNEUMODERMON.
    - Central series of lingual pavement present. Buccal pouches shallow, and tentacular suckers minute or rudimentary ...... CLIO.
  - Having a triserial lingual strap, numerous and minute lateral labial plates cutting longitudinally, and a cartilaginous mantle...................................... EURYBIA.
- *Thecosomata.* Animal protected by a shell, with the head indistinct. — Having a triserial lingual ribbon, large and definite lateral labial plates cutting transversely, and two or more gastric teeth ......
  - Shell cartilaginous (symmetrical); gastric teeth 2 .... CYMBULIA.
  - Shell calcareous; gastric teeth more than 2..
    - Shell symmetrical
      - With lateral slits through which processes of the mantle protrude ......
        - Commissures of the aperture closed.. HYALÆA.
        - Lateral slits communicating with the aperture.... DIACRIA.
      - Lateral borders entire
        - Parietes angular or compressed antero-posteriorly .... CLIODORA.
        - Parietes round and smooth or crimped transversely......
          - Subcylindrical, apex decollated. CUVIERIA.
          - Acuminate, apex entire .... CRESEIS.
    - Shell sinistrally spiral............
      - Inoperculate...... LIMACINA.
      - Operculate ...... SPIRIALIS.

It will be seen by the Table, that *Eurybia* differs still further from the true Thecosomata in the peculiar structure of its labial dental organs (whose cutting edges run longitudinally, not transversely), and in the total absence of gastric teeth.

The members of the last division, having calcareous shells, are too closely related by their internal anatomy to admit of their separation into two distinct families; and I am much inclined to believe, though not certain, that *Cymbulia* ought to be received amongst them. The families thus indicated are the *Cliidæ*, *Eurybiidæ*, and *Hyalæidæ*, the principal amendment of the commonly received arrangement being the separation of *Eurybia* from the *Hyalæidæ*, with which it has been improperly associated; and the union of the *Limacinidæ* with the same family, from which they have been unnecessarily dismembered. The species of *Spirialis* occurring in these seas may be truly described as the soft parts of *Creseis* occupying a spiral operculate shell aping that of the Gasteropod.

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* This table is advanced with a little more confidence as, it has benefited by the revising hand of Mr. W. S. MacLeay.

EXPLANATION OF THE PLATE.

TAB. XLIII.

Fig. 1. *Eurybia Gaudichaudi.* Natural size.

Fig. 2. *Eurybia Gaudichaudi*, magnified to show more distinctly its head, tentacula, oral aperture armed with lateral dental cells, the swimming-fins, and foot. The abdominal viscera are imperfectly seen through the transparent mantle.

Fig. 3. Portion of the fibro-cartilaginous mantle, highly magnified.

Fig. 4. The lateral labial teeth, forming in this case a double series.

Fig. 5. Six of the dental cells belonging to the right side, still further magnified to show the longitudinal cutting edge near the external border of each.

Fig. 6. Three transverse rows of the lingual ribbon. In this view the curvature of the lateral teeth is scarcely apparent.

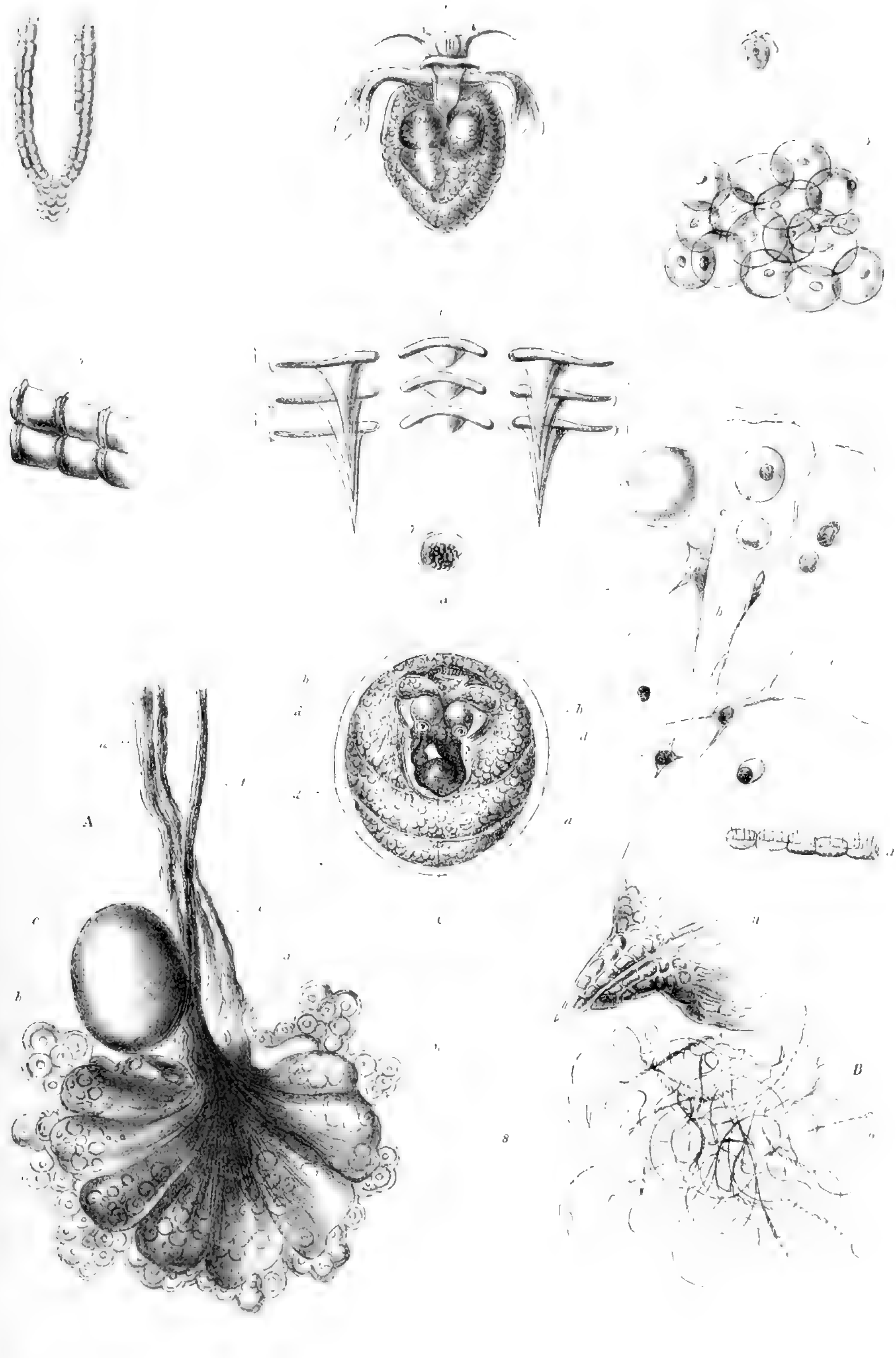
Fig. 7. The auditory capsule containing otokonial particles.

Fig. 8. Generative systems: A *a*. expansion of the lobules of testis and ovarium lying in juxtaposition; A *b*. ova seen through the walls of the ovarian lobuli; A *c*. primary oviducts uniting in A *d*, the common duct; A *e*. vesicula seminalis; A *f*. the vas deferens; B *a*. pointed extremity of the penis, composed of indurated cells, and traversed by the ejaculatory canal; B *b*. spermatozoa exhibiting their peculiar looping and twisting movements.

Fig. 9. Embryo of *Eurybia* within the ovum: *a*. frontal and lateral ciliated head-lobes; *b, b*. subœsophageal ganglia supporting the auditory sacs with their single primordial otolithes; *c*. alimentary canal with the rudimentary abdominal viscera; *d d, d d*. two ciliated rings which gird the exterior of the incipient cartilaginous mantle.

Fig. 10. Structural elements of the mantle: *a*. portion of one of the ciliated rings of the embryo; *b*. stages of development of the fibrous tissue; *c*. cartilage-cells in different stages.

EURYBIA.



J.D. Macdonald R.N. Ad nat. del. Tuffen West lith.

W. West imp.

XIX.—*Notes on* Phoronis hippocrepia. *By* F. D. DYSTER, *Esq., F.L.S.*

Read July 1st, 1858.

HAVING recently had an opportunity of examining the very remarkable creature, first described by Dr. Wright* under the above appellation, I was desirous of contributing some details, with respect to its structure, in addition to those contained in that author's observations.

The colony on which my observations were made appeared in a tank, on a small piece of hard limestone which had been in the aquarium for a considerable time (I believe, some months), and which, covered with *Serpulæ* and other tubicular Annelids, and *Actiniæ*, was clearly derived from between tide-marks. To the naked eye, the *Phoronis* presents very much the appearance of *Cycloum*, but is rather more robust in build. The animals grow closely aggregated together, each individual inhabiting a tube buried in holes in the rock, but which does not project beyond its surface, and is considerably larger than the body: the tube is membranous and flexible, and appears to be formed by the incorporation of mud with an exudation furnished by the worm. In colour they present the silvery whiteness of the Polyzoa. They differ greatly in size, varying from $\frac{1}{16}$th to $\frac{5}{16}$ths of an inch in length (when fully protruded), of which length the tentacula make about $\frac{1}{6}$th; the breadth of the body is from $\frac{1}{100}$th to $\frac{1}{33}$rd of an inch, and the spread of the tentacula from $\frac{1}{16}$th to $\frac{3}{16}$ths of an inch. The body is cylindrical, slightly flattened on the hæmal surface, and semitransparent, presenting no trace of somites, annulations, setæ, or uncini. Truncate obliquely forwards and backwards, with a slight dilatation at the summit, it is crowned with a double row of tentacles springing from the two margins of a horseshoe-shaped lophophore, round the rami of which they are continued, recalling most vividly the cephalic apparatus of the hippocrepian Polyzoa. The outer row of tentacles spread into a cup, while the inner row arch towards each other, covering the space between the arms of the horseshoe, interlacing at their tips, and forming a cradle for the ova; the tentacles are filiform, silvery white, varying in number from 16 to 86, and united for a short distance from their bases by a delicate membrane. The motions of the tentacles are individually voluntary, and somewhat sluggish. The creature itself is timid; and the slightest touch, or any jar communicated to the water, causes it to withdraw with great activity: but the tips of the tentacles always protrude from the tube. The whole body is in constant gentle swaying motion, and is capable of considerable extension as well as protrusion. The animals are provided with great power of reproducing lost parts. An abstracted head is renewed within 48 hours, not completely developed, but with a serviceable mouth and its covering valve and stumpy tentacles which do their work of providing food. The tentacles are

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* Edinburgh New Philosophical Journal, vol. vii. p. 313, tab. vii.

situated as in the Polyzoa, in lines, and not (as in many tubicular Annelids) all over the surface. They exhibit no trace of thread cells, and do not appear to be used as organs of prehension, but provide the food required by the worm by the current produced by the cilia. The body is not ciliated externally. Below and between the rami of the lophophore are two somewhat sigmoid ridges, which are the terminations of the oviducts. In some individuals, and always in large ovigerous specimens, at the posterior inner margin of the concavity of the lophophore, are seen two nearly circular lips, apparently with a perforation in their centre. Their use I cannot indicate. They may possibly be the terminations of the sperm-ducts; but as when the worm is in a position to exhibit the protrusion of the ova, these organs are hidden, I am unable to say whether any action occurs in them simultaneously with the deposition of eggs. The integument of the body is composed of a very delicate epidermis, beneath which are bundles of longitudinal muscular fibres, connected transversely by others, shorter and more delicate. The length of the largest specimens dug out from the rock would vary from $\frac{1}{2}$ to $\frac{3}{4}$ths of an inch.

Between the two rows of tentacles, on the neural side of the body, but nearer the hæmal row, is the mouth, which is somewhat elliptic, ciliated, and surrounded by a muscular sphincter, and covered by a delicate transparent marginated crescentic lip, attached by its concave edge to the convex portion of the lophophore. The mouth opens into a delicate expansible (non-ciliated?) œsophagus, which occupies the middle of the body. I have failed to detect the bands of areolar tissue alluded to by Dr. Wright as the stays of the alimentary canal. Just below the portion of the body protruded from the tube, the œsophagus opens, apparently through a sphincter, into an oblong stomach, richly ciliated, in which the food revolves rapidly in pellets, as in Pedicellina. What lies beneath the stomach I am unable to state decisively. The lower part of the body is so deeply imbedded in the hard rock, and its substance so fragile, while the tube is comparatively so tough, that very many hours of effort failed to extract one in perfect integrity; and the lower portion is so opaque that its walls do not permit its contents to be seen. I believe, however, that the stomach terminates in a very capacious intestine, which, filled with fæces, occupies the lower portion of the body, and which, traversing the whole tube and gradually narrowing, ascends again to terminate in a circular anus lying a little above, behind, and between the ridges made by the oviducts between the extremities of the rami of the lophophore The intestine lies above the œsophagus and the great blood-vessel, but beneath the oviduct. It is exceedingly delicate in structure, and can scarcely be made out except by its contents. It is not ciliated. The fæces are voided by jerks, in fusiform pellets connected by slender filaments, and frequently equal in length the whole exposed portion of the body.

The only organs to which hepatic functions could be attributed were some coloured cells on the walls of the stomach.

I could detect no nervous system: but this part of the organization demands further investigation; and it is possible that the two obscure organs mentioned as being present at the posterior part of the floor of the lophophore may be œsophageal ganglia. There are no eye-spots; nor does the animal show any sensibility to the influence of light.

Above the œsophagus, and attached to it by one margin, lies the great blood-vessel, which for convenience may be called the artery. Along it the blood rushes upwards in a powerful stream, until it arrives at the base of the lophophore, where it bifurcates, giving a branch to each of the rami. These branches open into sinuses which extend all round the lophophore; and a twig is given off to each tentacle. The blood pursues its course to the extremity of the tentacles, which are provided with contractile vessels, tied down on one side, free on the other. The progress of the blood is not uniform in the tentacles, as it will be frequently seen to be ascending one while it is descending another, and sometimes the stream may be observed to recede from one tentacle and then fill the adjoining one instead of falling back into the general circulation. Two venous trunks open from the sinuses above and behind the arterial branches, and then proceed downwards, half encircling the œsophagus, till they unite in a large vessel on its neural surface. The blood moves by pulsations in the artery, at the rate of from twelve to fifteen beats a minute, the vessel contracting on it as it passes upwards, and remaining empty in the intervals between the beats. The returning stream through the neural vessel is perfectly continuous. In the course of the body the neural and hæmal vessels are connected by numerous capillary loops; and when the upper portion of the body is removed, the circulation is quickly re-established through the loops nearest the point of scission, and carried on as powerfully as before.

The blood consists of a colourless liquor sanguinis, densely charged with red globules of irregular shape and size, varying from circular to elliptical, flattened and somewhat concave on one side. In length they vary from $\frac{1}{3200}$th to $\frac{1}{1700}$th of an inch. The thickness is about $\frac{1}{8000}$th. All are provided with one, many with two nuclei of granular appearance, about $\frac{1}{20000}$th of an inch in diameter. They are exceedingly flexible, and turn about, double, elongate, and flatten when pressed for room by meeting other globules in the capillaries, exactly as globules of human blood do when seen coursing about under thin glass. There are no colourless corpuscles; and very careful watching detected no *Amœba*-like movements. They coagulate in masses which appear homogeneous, the nuclei only remaining visible. Treated with acetic acid, the cell-lining contracts, and all the globules assume a perfectly spherical form. There seems no ground for supposing that any special heart-like organ is concerned in the circulation of *Phoronis*. At whatever portion of the body section was made, after the shock of separation was recovered from, the pulsations of the hæmal vessel were renewed with the same vigour as before; and this occurred in the posterior extremity of one individual which was dug out to nearly its full extent.

The ovary lies below the stomach, and is, I believe, single. It is a long cylindrical vessel, pyriform at its base, perfectly transparent, and scarcely distinguishable except by its contained eggs, which appear to be attached to the inner surface. The ova are slightly elliptic, granular, about $\frac{1}{1000}$th of an inch in diameter: the individuals of which the ovaries were examined were all young; and there was no difference in the size or development of the ova. No specimen was observed without an ovary; but in only one spermatozoa were found. The body of these measured from $\frac{1}{1600}$th to $\frac{1}{1100}$th of an inch, with a filiform tail of equal length.

The ova when deposited are white, spherical, about $\frac{1}{200}$th of an inch in diameter, and not ciliated. The oviduct lies above the rectum, on the hæmal surface, immediately under the integument, and is not ciliated. The ova lie in its upper and visible portion for some hours, vibrating backwards and forwards under the influence of the wave of blood in the hæmal vessel. They are driven slowly upwards, till they arrive between the two ducts which appear as ridges under the rami of the lophophore. The oviduct here seems to contract in its dimensions; and the ova assume a cylindrical form. They pause here for about half an hour; but at length the upper end of the cylinder dips suddenly downwards, passes into the hollow ridge, and then mounting through it, is discharged in a spherical form into the space between the inner tentacles, to which the ova adhere by a glutinous exudation. They are voided alternately through each ridge, and form a compact white mass, separable only with considerable difficulty, on each side of the space in the concavity of the horseshoe, shadowed over by the interlacing extremities of the inner tentacles. They vary in number from 10 to 80. When first extruded, they are granular with a clear margin, and show the usual germinal spot on pressure. In a few hours, cilia are developed all over the surface; and two depressions appear on the circumference, indicating a circular groove. This groove rapidly deepens; and within twenty-four hours the young exhibit distinctly a cephalic and an abdominal segment; anteriorly the line of separation deepens; and the abdominal portion becomes concave on the upper surface, alternately receding from and embracing the convex surface of the cephalic portion which lies above it. The cilia increase in length and power; and very soon, in certain positions, the alimentary canal becomes distinguishable. The cephalic segment divides into three lobes, of which the lateral are the longest and anterior, the central highest and posterior. The larva has now great power of locomotion, and quits the parent-nest when about forty-eight hours old.

The principal point of interest in the *Phoronis* is the indubitable presence of blood-corpuscles in proper closed vessels of the circulatory system. Von Siebold[*] is obscure and brief on this subject, and simply says—“the blood of the Annelids . . . is composed of a liquid containing globules . . . which are always colourless and of a spherical form.” Milne-Edwards[†] says that, in the Vertebrata, “la couleur rouge du sang est due aux globules que ce liquide charrie; chez les Vers à sang rouge, c’est en dissolution dans le liquide lui-même, que se trouve la matière colorante. . . . Les globules ne jouent dans cette coloration aucun rôle essentiel, et d’ordinaire ces corpuscules paraissent même manquer complétement dans ce liquide. . . . M. de Quatrefages a été même conduit à penser que dans l’immense majorité des cas, le sang rouge des Annélides est complétement privé des globules quelconques. Il n’a rencontré qu’une exception à cette règle, et elle lui a été fournie par une espèce de Glycère des côtes de la Manche, chez laquelle il a trouvé des globules rouges et de forme discoïde, nageant dans un liquide incolore. Mais M. Williams[‡], qui a publié récemment une série nombreuse d’observations sur le fluide nourricier des animaux invertébrés, affirme que cette exception n’existe pas; que les globules rouges décrits par M. de Quatrefages se trouvent dans le liquide de la cavité générale du corps, et non dans les vaisseaux sanguins, et que dans aucun Annélide le sang proprement dit (ou sang coloré)

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[*] Von Siebold, Comp. Anatomy, translated by Burnett, vol. i. p. 168.

[†] Leçons sur la Physiologie, tome i. pp. 106–108 et note.

[‡] On the Blood proper and Chylaqueous Fluid of Invertebrate Animals.—Philosophical Transactions, 1852, p. 632.

ne renferme des éléments 'morphotiques' quelconques, c'est-à-dire des globules." And Mr. Huxley* says, "it may be considered an established fact that, whatever the functions of the varied vascular system and its contents in different classes of the Annuloida, they have nothing to do with the blood or the blood-vessels. The latter are entirely absent in the Annuloida at present known, the blood being simply contained in the perivisceral cavity and its processes." Nothing short of the most patient observation would have induced me to state a fact which is incompatible with the opinions and observations of Mr. Huxley and Milne-Edwards; but while my own investigations leave no room for doubt that the proper fluid of the vascular system in *Phoronis* consists of a colourless liquor sanguinis densely crowded with red corpuscles, I am confirmed in the probability of the fact by the discovery of globules in the vascular system of *Glycera* by M. de Quatrefages, against whose accuracy I do not think the sweeping statement of Dr. Williams is a sufficient balance. Not only is it easy to define the vessels which contain the corpuscles in the living worm, but I have several times, under the compressorium, succeeded in isolating a capillary loop with its string of globules.

There are one or two other points in which the *Phoronis* deviates very remarkably from the Annelidan type. In the position of the anus at the anterior extremity in close proximity to the mouth, it stands, I believe, alone, though Mr. Busk has reminded me of the analogy which this presents to the arrangement in *Sipunculus*, the annulose form of the Echinoderms. The development of the nervous system is very small—indeed at present, as before remarked, I cannot do more than guess at the presence of two œsophageal ganglia, —while there is no trace of eye-spots, nor does the creature, like *Serpula* and *Sabella*, exhibit any appearance of sensibility to light. Negatively, Dr. Wright confirms this view inasmuch as he makes no allusion to the nervous system, while Professor Allman† distinctly says he could perceive none. In all the Capitibranchiate Annelids the pharynx is short and muscular, while in *Phoronis* it is long and presents no appreciable trace of muscular structure. In the same division, the alimentary tube has numerous dilatations corresponding to the somites, while in *Phoronis* it is a simple canal, and there exist neither external segments nor internal septa, and there is no approach to pedal lobes, hooks, paleæ or bristles. I believe that in *Phoronis* there is no perivisceral cavity; at all events, there are no corpuscles such as are present in the perivisceral fluid of other Annelida.

I am indebted to my friend Mrs. Brett for the figures, which she has translated into beauty from my rough diagrams.

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* Lectures on Natural History, Medical Gazette, vol. xxxiv. p. 385.

† Freshwater Polyzoa (Ray Society), p. 55. note.

EXPLANATION OF THE PLATE.

TAB. XLIV.

Figs. 1, 2, 3. Side, vertical, and front views of *Phoronis hippocrepia*.

Fig. 4. *a.* Lophophore.
- *b.* Œsophagus.
- *c.* Hæmal vessel overlying œsophagus.
- *d, d, d.* Ova overlying hæmal vessel.
- *e, e.* Branches of hæmal vessel opening into sinus of lophophore.
- *f, f.* Venous branches uniting beneath the œsophagus, and forming neural vessel.
- *g, g.* Ridges forming terminations of oviduct.
- *h, h.* Uncertain organs.

Fig. 5. View of vascular system.
- *a.* Lophophore.
- *b.* Venous branches.
- *c.* Neural vessel.
- *d.* Hæmal vessel.
- *e, e.* Capillary loops connecting neural and hæmal vessels.
- *f.* Œsophagus.
- *g.* Mouth with crescentic lip.
- *h.* Tentacula with twigs opening into sinus of lophophore.

Fig. 6. Diagram of lophophore seen from above.
- *a.* Lophophore.
- *b.* Bases of tentacula.
- *c.* Mouth covered with crescentic lip.
- *d.* Anus.
- *e.* Terminations of oviduct.

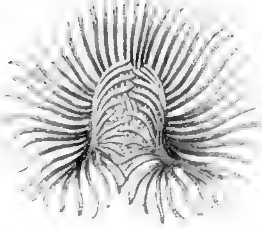
Fig. 7. Blood-corpuscles, magnified 460 diameters.

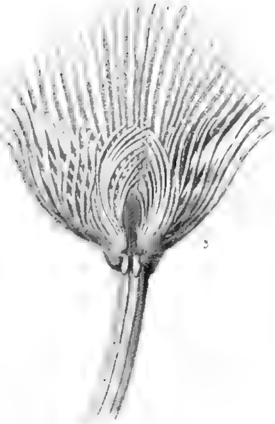
Fig. 8. Ovary.

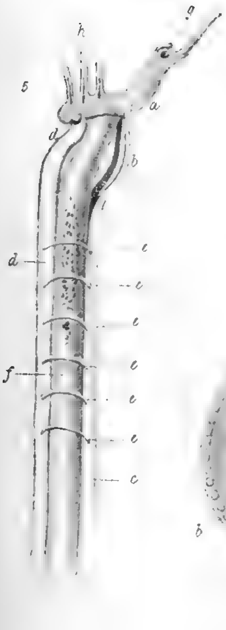
Fig. 9. Spermatozoa, magnified 460 diameters.

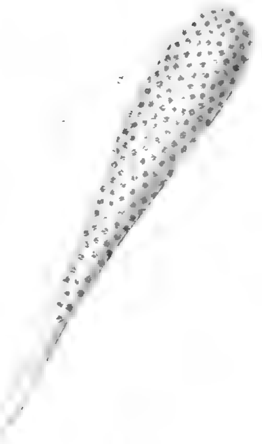
Fig. 10. Ovum just separated.

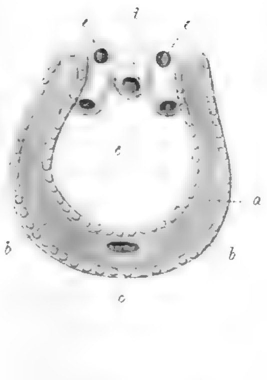
Figs. 11, 12, 13. The same in more advanced stages of development, the last about 48 hours old.

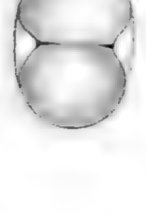












Mrs Brett del.

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XX.—*Synopsis of the Fructification of the Compound* Sphæriæ *of the Hookerian Herbarium.* *By* FREDERICK CURREY, *Esq., M.A., F.R.S., F.L.S.*

Read March 4th, 1858.

THE title of this paper discloses the source from which the materials for it have been derived; and before proceeding with it, I am desirous, in the first place, to record my great obligations to Sir William and Dr. Hooker, through whose kindness and liberality I have been enabled to carry out those detailed examinations, the results of which, so far as they are completed, are embodied in the following pages.

Amongst the numberless treasures of the unrivalled Hookerian herbarium is a large collection of fungi belonging to the genus *Sphæria.* This genus, as originally limited, is the most extensive in the fungal alliance.

Its magnitude may be inferred from the fact, that in the second volume of Fries's 'Systema Mycologicum,' published thirty-five years ago, no less than 528 species are described; and since that time vast numbers of new species have been added, which are to be found in Fries's 'Elenchus Fungorum;' in the papers published from time to time in the 'Annales des Sciences Naturelles,' by M. Desmazières; in the 'Sylloge Plantarum Cryptogamarum' of Dr. Montagne; in the "Notices of British Fungi," by Messrs. Berkeley and Broome, contained in the different volumes of the 'Annals of Natural History;' in the 'Micromycetes Italici' of De Notaris, and in other scattered and less accessible sources of information.

In so extensive a genus it will necessarily follow that, for the correct determination of species, many aids must be necessary; and accordingly in the 'Systema Mycologicum' the genus is broken up into two great divisions, viz. the "Compositæ," in which the perithecia are united by a common stroma; and the "Simplices," in which the perithecia are solitary. These divisions again are separated into sections, and the sections into subsections, the details of which, so far as relates to the *Compositæ*, which are the subject of the present paper, will be given hereafter.

These details are necessary, because in the Hookerian herbarium the *Sphæriæ* are arranged in accordance with the 'Systema Mycologicum;' but it should be observed that in his subsequent work, the 'Summa Vegetabilium Scandinaviæ,' published in 1849, Professor Fries has abandoned his former arrangement, and formed or adopted several new genera instead of the subdivisions of the 'Systema Mycologicum.' These new genera have been generally adopted by Continental mycologists; and there is an evident tendency to increase their number. The present, however, is an epoch of transition in the classification of fungi, as may be inferred from the fact that within the last year two rearrangements of the family have been proposed—one by Dr. Bail in Germany, the other by Mr. Henfrey in this country. Neither of these authors professes to enter into minute details: but their systems, as far as they go, have very little in common; and the latter of them is quite subversive of existing notions. Whether either of them will have any permanence, it would be premature to speculate, especially in the face of Dr. de Bary's observations on the ascigerous fructification of *Agaricus melleus*, lately communicated to the meeting of German naturalists at Bonn*. If these observations should be confirmed, it is hardly likely that the case of *Ag. melleus* should be a solitary one; and if ascigerous fructification should be proved to exist in the Agarics generally, one great line of demarcation in the classification of fungi, and upon which all systems are more or less founded, will be almost obliterated.

In the tribe of the *Pyrenomycetes*, to which the genus *Sphæria* belongs, the limits of genera are far from settled: for the researches of Tulasne and others have gone far to show that many of the existing genera are only stages of growth or abnormal conditions of other well-known plants of the same tribe; and it remains to be seen whether future mycologists will confirm the numerous genera into which the original genus *Sphæria* has been split up, or whether their judgment will not eventually favour the adoption of the arrangement of the 'Systema Mycologicum.'

However this may be, there is no doubt that many, if not most, of the later genera are exceedingly well defined; and I have therefore thought it advisable in the following descriptions, whilst adhering to the earlier arrangement as being that in use at Kew, to notice in each case the genus to which, according to more recent views, each particular plant would belong.

The present paper is the commencement of an attempt to render the discrimination of species in this extensive and intricate genus more certain and easy than it has hitherto been, by means of drawings and detailed descriptions of the fructification of each particular plant.

It will have been observed by all who have consulted the 'Systema Mycologicum' that no notice is taken of the nature of the fruit as distinctive of species: nor could such notice be expected; for at the time of the publication of that work, microscopical appliances were quite insufficient to render the necessary observations inviting, or even feasible.

The 'Summa Vegetabilium Scandinaviæ' contains some general allusions to the nature of the sporidia; but detailed descriptions were not within the scope of that work, which professes only to be a Syllabus of Scandinavian vegetation.

For some time past, however, the importance of the fructification as distinctive of species has been fully recognized; and any details of new plants would at the present day be considered imperfect which did not afford full descriptions of the fruit.

Figures of the sporidia of a number of species are to be found in the pages of the 'Annales des Sciences Naturelles,' in the works of Dr. Montagne, De Notaris and others; and the "Notices" in the 'Annals of Natural History' above referred to, and which relate to new species discovered in this country, are illustrated by excellent drawings. After all, however, the whole mass of the older species remain, so far as regards their fructification, almost entirely undescribed; and I have long thought that good service might be rendered to Mycology by any botanist who would undertake the description and illustration of the fruit of any considerable number of these plants. The opportunity of

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* See Bot. Zeitung, No. 45, 1857.

doing so having been kindly accorded to me, I have done my best to avail myself of it, and have now the honour of laying before the Linnean Society a "Synopsis of the fructification of the compound *Sphæriæ* of the Hookerian herbarium." In describing the nature of the fruit, the points to be particularly attended to are, 1st, the number of sporidia in each ascus; 2ndly, their mode of arrangement in the ascus, *i. e.*, whether in one row, in two rows, or in a crowded and irregular manner; 3rdly, the shape of the sporidia; 4thly, their colour; 5thly, their structure, *i. e.*, whether unicellular and simple, or divided by septa, which latter may be transverse, or transverse and longitudinal, or even oblique; and 6thly, the length of the sporidia. The shape of the asci varies so much, not only in the same species, but in the same specimen, that I do not think it a character to be relied upon.

In the great majority of cases the number of sporidia is eight, very rarely it is less, in a few instances the number is sixteen, and in a few others the number is unlimited.

The mode of arrangement in the ascus, although tolerably constant, is not a very certain characteristic. There are many species in which uniseriate and biseriate sporidia may be found even in the same perithecum.

The shape and colour of the sporidia are very constant, and sure marks of distinction. With regard to colour, however, it must be remarked that it is different at different periods in the growth of the plant. For instance, in a very common species, *S. stercoraria*, Sow., the sporidia are colourless at first, they then assume a rich sea-green sort of colour, and eventually become quite black and opaque. It might be supposed that the darker colour evidenced the maturity of the plant, but I doubt if this is so, for I have seen the sporidia of *S. stercoraria* when in their colourless state germinate as actively as those of the darker shade.

The structure of the sporidia when perfect is also a very safe guide, but it is to be observed that there are many species in which the sporidia rarely attain their perfect state. This is particularly to be seen in some species of the division "Villosæ," where the sporidia when perfect are of a dark brown colour, and divided by numerous septa, but where the sporidia (although attaining their full size) more frequently remain simple, continuous, and colourless. *Sphæria Corticis* one of the *Obtectæ* is another striking instance of this peculiarity. The sporidia in this species are almost always colourless and simple, whereas in the perfect state (to which as far as my observations go they seldom attain) they are of a dark rich brown colour and divided by several septa.

I may here observe, that it is important to distinguish between real and apparent septa; it is not uncommon in unicellular sporidia to find the endochrome divided into two or more portions, and if these portions of the endochrome touch one another, the line of contact often appears so like a real partition that it is not always easy to ascertain whether in fact any septum exist or not.

The presence of nuclei is a point of structure which should be noticed in describing sporidia, but it is a characteristic of no great certainty, the sporidia in the same species being often found indifferently either with or without nuclei, and the number of them also is variable. In some plants, however, as in the sporidia of *S. verrucæformis*, and of some *Hypoxyla*, they are invariably to be met with.

Micrometric measurements of length should always be given. The size of sporidia is of course subject to variations dependent upon the circumstances of growth of the plant producing them, but as a general rule these variations take place within narrow limits. It not unfrequently happens that the sporidia increase in size after their escape from the ascus, so that measurements taken from specimens in which the asci have disappeared, will often be found to exceed the mean lengths of the sporidia when measured in the interior of the ascus.

I will conclude these introductory observations with a caution, superfluous to practised microscopists, but which may not be without its use to others who may consult the measurements here given; viz., that it is indispensable for correctness of observation to ascertain with accuracy the magnifying power of their object-glasses. Opticians, as is well known, always furnish tables giving estimates of the magnifying powers, but the tables are not (nor do the opticians profess that they are) minutely accurate. They express, in fact, the magnifying power aimed at, not that actually attained; and it will be found in practice that in object-glasses of the same focal length, no two will magnify exactly the same number of diameters. In the measurement of objects so minute as the sporidia of many of the *Sphæriæ*, great accuracy is indispensable for avoiding erroneous conclusions. I need hardly add that the correct determination of the value of the micrometer divisions is equally necessary. The arrangement of the "Sphæriæ compositæ" according to the 'Systema Mycologicum' is subjoined, with the essential characters of the genus, sections and divisions.

SPHÆRIA, Hall.

CHAR.—*Perithecia* rounded, entire, perforated at the apex. *Asci* mixed with paraphyses, convergent, deliquescent. Sporidia various.

A. COMPOSITÆ.

SECTION I. PERIPHERICÆ.—*Perithecia* more or less divergent, situated in the periphery of the stroma; ostiola even, destitute of a neck.

DIV. 1. CORDYCEPS.—*Stroma* club-shaped, erect, simple or branched, stipitate.

DIV. 2. PORONIA.—*Stroma* marginate, cupshaped, open. *Perithecia* ovate, situated in the disk of the cup only, destitute of a neck; ostiola even and prominent.

DIV. 3. PULVINATÆ.—*Stroma* sessile, convex, more or less hemispherical, immarginate. *Perithecia* in the periphery of the stroma.

DIV. 4. CONNATÆ.—*Stroma* widely effused, indeterminate, immarginate, plane, surrounding the perithecia, or arising from their confluence. *Perithecia* destitute of a neck, immersed in the stroma, or protruding.

SECTION II. HYPOPHERICÆ.—*Perithecia* vertical, immersed, covered with the stroma, and having an attenuated neck.

DIV. 5. GLEBOSÆ.—*Stroma* more or less effused, determinate, glebose, distinct from the matrix, at length rigid and brittle. *Perithecia* ovate, large, at first buried and mouthless, at length attenuated into a short neck; ostiola even.

DIV. 6. LIGNOSÆ.—*Stroma* effused, thin, plane, more or less determinate, connate with the matrix; circumscribed with a black line. *Perithecia* sunk down to the bottom of the stroma, crowded, with prominent ostiola.

DIV. 7. VERSATILES.—*Stroma* immersed, at length emergent, determinate, but confluent with the matrix, not circumscribed (as in the Lignosæ) with a black line. *Perithecia* vertical, irregularly scattered through the stroma, their necks at first included in it, but at length exserted.

Div. 8. Concrescentes.—*Stroma* thin effused, indeterminate, never circumscribed, innate, not erumpent, formed from the matrix or from the confluence of the perithecia. *Perithecia* subglobose, vertical, irregularly aggregated, at first solitary, then confluent, emergent, attenuated into a short neck. No erumpent disk.

Section III. Amphiphericæ.—*Perithecia* with elongated necks, convergent, circinating, surrounded by a spurious pustulate stroma.

Div. 9. Circumscriptæ.—*Stroma* formed from the matrix, more or less rounded, included in a proper black ventricose conceptaculum which is compressed at the apex. *Perithecia* scattered in the stroma, irregularly circinating, decumbent, with rather long, converging, ultimately umbilicate necks, bursting out from the conceptaculum.

Div. 10. Incusæ.—*Stroma* formed from the matrix, rounded, included below in a proper open dimidiate conceptaculum, covered above with the subcomate epidermis, through which it bursts, forming a somewhat waxy, more or less flat disk. *Perithecia* collected in the centre of the stroma, irregularly circinating, their necks perforating the disk, but less protruded than in the former tribe.

Div. 11. Obvallatæ.—*Stroma* cortical without any proper conceptaculum. *Perithecia* immersed in the inner bark, collected in a circle; ostiola collected into a disk.

Div. 12. Circinatæ.—*Stroma* none, or formed of the corroded matrix. *Perithecia* covered, simple, aggregated, arranged in a circle, more or less decumbent. Necks of the perithecia elongated, united, and perforating the epidermis, at length free. No conceptaculum or heterogeneous disk.

Section IV. Epiphericæ.—*Perithecia* naked, destitute of a neck, collected upon a stroma (which is often spurious) at first covered by the matrix.

Div. 13. Cæspitosæ.—*Stroma* rounded, determinate, convex. *Perithecia* superficial, simple, free, without elongated necks.

Div. 14. Confluentes.—*Stroma* thin rounded or effused, indeterminate, innate, arising principally from the confluence of the perithecia. *Perithecia* simple, connate, at first innate, then erumpent.

Div. 15. Seriatæ.—*Stroma* thin, effused, indeterminate, formed from the corroded parenchyma of the matrix, sometimes altogether wanting. *Perithecia* seated on the stroma, covered at first with the adnate epidermis, at length almost naked, disposed in parallel rows, often connate; ostiola short.

Div. 16. Confertæ.—*Stroma* when present effused, formed from the parenchyma of the leaf, more often wanting. *Perithecia* aggregate, nestling under the epidermis of dead or dying leaves.

In the 'Summa Vegetabilium Scandinaviæ,' the *Sphæriæ* included in the above divisions are thrown into distinct genera, the main characters of which, such of them at least as include the plants to which this paper relates, are given in that work as follows :—

1. Cordyceps.—*Stroma* vertical, clavate or capitate, fleshy; *perithecia* pale-coloured; *sporidia* very numerous, arranged in moniliform rows.
2. Xylaria.—*Stroma* vertical, clavate, between fleshy and corky, or leathery; *perithecia* horny, black, at first immersed in the stroma. *Sporidia* eight in an ascus, usually uniseptate*.

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* This last character is by no means to be relied on; the sporidia are very frequently not septate. They have sometimes two nuclei, and when these latter are large and close to one another, there may be an appearance of a septum where none really exists.

3. Poronia.—*Stroma* between vertical and horizontal, suberoso-fibrous; *perithecia* collected in a marginate disk. *Sporidia* black.
4. Hypocrea.—*Stroma* horizontal, sessile. The genus is intermediate between *Cordyceps* and *Nectria*, and differs from *Hypoxylon* precisely as *Cordyceps* does from *Xylaria**.
5. Hypoxylon.—*Stroma* horizontal, sessile, homogeneous, discrete from the matrix, covered at first with a floccose furfuraceous veil. *Sporidia* opaque. Intermediate between *Xylaria* and *Sphæria.*
6. Diatrype.—*Stroma* formed (in part at least) from the matrix: *perithecia* sunk in the stroma; necks of the perithecia elongated and often prolonged into a beak. *Sporidia*† pellucid, simple, not opaque or bilocular, as is common in the *Hypoxyla.*
7. Valsa.—*Perithecia* circinating with long converging necks; ostiola connate or united into a disk.
8. Nectria.—*Stroma* none. *Perithecia* pallid, free, but often seated on a tuberculate mycelium of a variable nature, membranous, flaccid, brightly coloured. *Sporidia* 8 in an ascus, pellucid (very often, I may add, uniseptate).
9. Sphæria.—*Perithecia* carbonaceous, black, superficial and bicorticate, or immersed and then of a thinner texture; papillate, sometimes beaked. *Asci* octosporous, mixed with paraphyses, sporidia normally septate or cellular, but often simple, ejected like powder.

Div. I. Cordyceps.

1. S. (Cordyceps) Gunnii, Berkel. Decades. The asci produce long filamentous sporidia, which probably eventually break up into joints, as is the case with other *Sphæriæ* of this division: the sporidia have an alga-like appearance, with an undulating or horned outline; the transverse divisions are sometimes very indistinct; each division measures about 0·0002 inch. Tab. XLV. fig. 1 represents an ascus × 225 diameters; and fig. 2 a somewhat smaller ascus ruptured, with the sporidia protruding, × 450. The undulating outline may be caused by the shrinking of the fruit in drying. Robin, in his 'Végétaux Parasites,' describes the spores as "courtes, tronquées, cylindriques."
2. S. (Cordyceps) militaris, L.; Fr. S. M. p. 323. The asci produce long sporidia, which break up into minute joints. Tab. XLV. fig. 3 *a* shows an ascus × 220; and *b* a portion of some of the filaments with the joints into which they divide, more highly magnified.
3. S. (Xylaria?) pileiformis, Berkel. Tab. XLV. fig. 4, ascus and sporidia, and free sporidia, × 325. Sporidia uniseriate, dark reddish brown, irregularly almond-shaped, 0·0003 inch long.
4. S. (Xylaria) pedunculata, Dicks.; Sow. t. 437. Tab. XLV. fig. 5, ascus with sporidia, and free sporidia, × 225. Sporidia biseriate or uniseriate, clear brown and granular at first, eventually quite black, almond-shaped or elliptical, at or before maturity surrounded by a gelatinous envelope, 0·0015 to 0·0018 inch long.
5. S. (Cordyceps) entomorrhiza, Dicks.; Fr. S. M. p. 324. Tab. XLV. fig. 6, × 225.

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* Fries remarks (*l. c.*), that *Hypocrea* is hardly distinguishable from *Cordyceps,* except by its stroma, but that the sporidia are often uniseptate. I may add, that in many species of *Hypocrea* the sporidia consist of squarish or subglobose hyaline bodies, 16 in each ascus, exhibiting a marked departure from the fruit of any other division.

† This description of the sporidia, although correct for a good many of the species, is by no means universally applicable, as will be seen by reference to the figures here given of the fruit of *Diatrype lanciformis, quercina,* &c.

The asci produce colourless jointed sporidia, which divide at the joints. The latter are rod-shaped or cylindrical, 0·0003 inch long, and are shown separately at *b*, *a*, being an ascus with its contained sporidia.

6. S. (CORDYCEPS) OPHIOGLOSSOIDES, Ehrh.; Fr. S. M. ii. p. 324. TAB. XLV. fig. 7 *a*, an ascus × 225, *b* and *c* joints of the filaments more highly magnified. The asci produce jointed sporidia, which divide at the joints, each joint measuring about 0·0001 inch in length. I find them cylindrical, not oval or elliptical as figured by Robin and Berkeley. When free they often appear quite circular (see fig. 7 *c*), and to consist of an outer membrane and a very highly refractive nucleus. This circular appearance may arise from a change in the line of sight, although I think it probable that the joints, when freed from their mutual pressure, may assume a globular form.

7. S. (XYLARIA) INVOLUTA, Kl. TAB. XLV. fig. 8, ascus with sporidia, × 325. Sporidia uniseriate, dark brown, elliptical or sub-reniform, 0·0007 inch long. The surface of this plant, when dry, breaks away from the flesh like a shell, carrying the perithecia with it, and the same thing occurs in *S. Guianensis*, post.

8. S. (XYLARIA) GUIANENSIS, Mont. Syll. p. 202. TAB. XLV. fig. 9, ascus and sporidia, × 325. Sporidia uniseriate, brown, rather dark, elliptical or slightly curved, 0·0006 inch long.

9. S. (CORDYCEPS) CAPITATA, Holmsk. Fr. S. M. p. 324. TAB. XLV. fig. 10 *a*, ascus with sporidia; *b*, free joints, × 225. The asci produce jointed colourless sporidia, as in *S. militaris*, &c. The joints are rod-shaped or cylindrical, 0·0006 to 0·0008 inch long.

10. S. (HYPOXYLON) CŒNOPUS, Mont. TAB. XLV. fig. 11, sporidia, × 325, sporidia clear brown, curved, elliptical or plano-convex, 0·001 inch long. This plant is from Guiana, from Leprieur and Montagne's collection. I doubt if it is distinct from *S. deusta*, Hoff. It should, I think, be arranged in the Glebosæ.

11. S. (XYLARIA) POLYMORPHA, Pers. Fr. S. M. p. 326. TAB. XLV. fig. 17, ascus with sporidia, and a free sporidium, × 325. Sporidia uniseriate, dark reddish brown, curved slightly, 0·0003 to 0·0004 inch long.

12. S. (HYPOXYLON or PORONIA) HELISCUS, Mont. Syll. p. 209. TAB. XLV. fig. 13, sporidia, × 325. Sporidia uniseriate, I think (but there were no complete asci), dark brown, irregularly almond-shaped or pyriform, 0·0003 to 0·0004 inch long. This plant was described by Montagne in Cent. ii. No. 44. t. 10. f. 5, under *Hypoxylon*; but in the 'Sylloge' it is transferred to *Poronia*.

13. S. RHOPALOIDES, Mont. TAB. XLV. fig. 14, ascus with sporidia, × 325. Sporidia uniseriate, dark (rather reddish) brown, elliptical, but irregular in shape, 0·0003 inch long. *Hypoxylon*, Fr.

14. S. (HYPOXYLON) CRENULATA, Berkel. TAB. XLV. fig. 15, sporidia, × 325. Sporidia biseriate, greenish, slightly curved, endochrome usually divided into four portions, giving a triseptate appearance, 0·0007 to 0·001 inch long. Sporidia occasionally uniseriate and overlapping, endochrome sometimes divided into 3 portions only.

15. S. (XYLARIA) DIGITATA, Pers. Fr. S. M. p. 326. TAB. XLV. fig. 16, ascus with sporidia, × 325. Sporidia uniseriate, dark brown, curved, 0·0007 inch long. When unripe, transparent with one or two nuclei.

16. S. (XYLARIA) HYPOXYLON, Linn.; Fr. S. M. p. 327. TAB. XLV. fig. 17, ascus and sporidia, × 325. Sporidia uniseriate, dark brown, elliptico-acuminate, but often subcymbiform, 0·0004 inch long, usually with two nuclei, sometimes with one.

17. S. (XYLARIA) MICROCERAS, Mont. TAB. XLV. fig. 18, ascus with sporidia, × 325. Sporidia uniseriate, brown, elliptical, rather irregular, 0·0004 inch long.

18. S. (XYLARIA) MULTIPLEX, Kze. Linn. vol. v. p. 536. TAB. XLV. fig. 19, ascus with sporidia, × 325. Sporidia uniseriate, dark brown, plano-convex or irregular elliptical 0·0004 inch long.

19. S. (XYLARIA) CORNIFORMIS, Mont. TAB. XLV. fig. 20, ascus with sporidia, × 325. This plant is marked in Hook. Herb. "*Hypoxylon corniforme, an Sphæria corniformis*, Fr." The sporidia are uniseriate, almond-shaped, double- or plano-convex, rather dark brown, 0·0004 inch long. In fig. 21 I have drawn an ascus with sporidia (× 325) of *S. corniformis*, Fr. The sporidia are considerably larger than the above, and are furnished with one or two nuclei in each. There are many species, however, in which the size of the sporidia varies even to as great an extent as is shown in the difference between figs. 20 and 21; and the existence or non-existence of nuclei depends upon age and other circumstances to such an extent that they afford no safe characteristic. I think *S. corniformis*, Fr. and *Hypoxylon corniforme*, Mont., must be the same. Mr. Berkeley thinks they may possibly be distinct, the former being European, the latter tropical. Dr. Montagne's plant is rather a *Xylaria* than a *Hypoxylon*.

20. S. (XYLARIA) IANTHINO-VELUTINA, Mont. Syll. p. 204. TAB. XLV. fig. 22, sporidia, × 225. Sporidia uniseriate (I think, but there were no perfect asci), brown, irregularly almond-shaped or pyriform, 0·0005 long. The perithecia are rather larger, with velvety hair between them.

21. S. (XYLARIA) CARPOPHILA, Pers.; Fr. S. M. ii. p. 328. TAB. XLV. fig. 23, ascus with sporidia, × 325. Sporidia uniseriate, clear, light brown, elliptical or slightly reniform, with one or two nuclei, 0·0004 inch long.

22. S. (CORDYCEPS) ALUTACEA, Pers. The fructification of this plant is not distinguishable from that of *S. rufa* (see post). It is a *Cordyceps* with the fructification of *Hypocrea*.

23. S. (HYPOXYLON) SAGRÆANA, Mont. TAB. XLV. fig. 24, sporidia, × 450. Sporidia obtusely elliptical, sometimes slightly incurved in the middle, clear (rather dark) brown, obtuse or almost square at the ends, 0·0004 inch long.

24. S. (CORDYCEPS) PURPUREA, Fr. TAB. XLV. fig. 25 *a*, ascus with sporidia, × 325; *b*, free sporidia more highly magnified. Sporidia colourless, filiform, attenuated at each end, variable in length, 0·002 to 0·003 long, or even more. It is difficult to count the sporidia, but I should guess them at eight; I found them always entirely filling the ascus, which is very long and narrow, and in my specimens not so clavate as the figures in the Micrographic Dictionary, which are reduced from Tulasne's figures in the 'Ann. des Sciences.'—This and the following plant are placed in a distinct genus (*Claviceps*) by Tulasne. They differ altogether in fructification from the moniliform fruit of *Cordyceps*.

25. S. (CORDYCEPS) MICROCEPHALA, Tul. The fruit in my specimens differs in no respect

from that of *S. purpurea*, except that the hyaline knob at the apex of the ascus is very distinct in each ascus; one ascus which I measured was 0·002 inch, another 0·0034 inch long; so that their length is very variable. The sporidia entirely fill the ascus, as in *S. purpurea*, but I think they sometimes, if not always, overlap one another, so that their length is not always equal to that of the ascus.

26. S. (CORDYCEPS) ROBERTSII, Hook. TAB. XLV. fig. 26, ascus with fruit, × 425. The fruit here, as in the other true species of *Cordyceps*, consists of long colourless sporidia, which break up into joints. At least, the sporidia are divided by septa into a number of small portions, which probably separate from one another at the partitions, as in *S. militaris*, *capitata*, &c. The septa are sometimes very indistinct.

26*a*. S. (CORDYCEPS) TYPHINA, Pers. Fr. S. M. ii. p. 553, under *Dothidea*. The fructification is almost identical with *S. militaris*, although the asci are smaller.

DIV. 2. PORONIA.

27. S. (PORONIA) PUNCTATA, Sow. TAB. XLV. fig. 27, ascus with sporidia, × 325. Sporidia uniseriate, brown when young, and then slightly granular, quite black and opaque when ripe, elliptical, varying in length from 0·0008 to 0·0012 inch.

DIV. 3. PULVINATÆ.

28. S. (HYPOXYLON) MULTIFORMIS, Fr.! S. M. ii. p. 334. TAB. XLV. fig. 28, ascus with sporidia, × 450. Sporidia uniseriate, rich yellowish-brown, elliptical, but usually slightly curved, 0·0004 inch long.

29. S. (HYPOXYLON) DURISSIMA, Sz.; Fr. S. M. ii. p. 335. TAB. XLV. fig. 29, ascus with sporidia, × 325. Sporidia uniseriate, clear dark brown, elliptical, but frequently slightly curved, 0·0003 to 0·0004 inch long. This plant is marked with a ?; and it seems doubtful whether it is not a form of *S. multiformis*. The perithecia are blacker and rather more dome-shaped than in my specimens of *S. multiformis*, and they have a decided nipple-shaped ostiolum. The sporidia have usually one good-sized nucleus, sometimes two, or even more.

30. S. (HYPOXYLON) FRAGIFORMIS, Pers.; Fr. S. M. ii. p. 332. TAB. XLV. fig. 30, sporidia, × 325. Sporidia uniseriate ?, dark opaque brown, elliptical or arcuate, with sometimes one or two nuclei visible, but mostly too opaque for the nuclei to be seen; 0·0006 inch long.

31. S. (HYPOXYLON) ANNULATA, Mont. (β. *depressa*). Mont. Syll. p. 213. TAB. XLV. fig. 31, sporidia, × 450. Sporidia light brown, elliptical, 0·0003 inch long.

32. S. (HYPOXYLON) CONCENTRICA, Bolt. Fr. S. M. ii. p. 331. TAB. XLV. fig. 32, sporidia, × 325. Sporidia uniseriate, dark brown, sometimes with a large elliptical or reniform nucleus, elliptical, but sometimes of irregular shape, 0·0005 inch long.

33. S. (HYPOCREA) GELATINOSA, Tode; Fr. S. M. ii. p. 336. TAB. XLV. fig. 33, ascus with sporidia, × 325. Sporidia uniseriate, colourless, squarish in the ascus, more nearly round when free, with one or many, or with no nuclei, 0·0002 inch in diameter when free. Almost precisely similar in fructification to *S. rufa* (see *post*), and like that,

probably not a true *Sphæria*. In specimens in my own herbarium from Tunbridge Wells, each pulvinulus is seated upon a dense white byssoid subiculum, which becomes brown with age.

34. S. (Hypoxylon) vernicosa, Schwein. Tab. XLV. fig. 34, ascus with sporidia, × 315. Sporidia uniseriate, dark brown, elliptical, 0·0005 to 0·0006 inch long. Perhaps only a form of *S. concentrica*; but Mr. Berkeley considers it distinct in the structure of the stroma.

35. S. (Hypoxylon) argillacea, Fr. Obs. i. t. 2. f. 5. Tab. XLV. fig. 35, ascus with sporidia, × 325. Sporidia uniseriate, opaque black-brown, irregularly elliptical; sometimes one, two, or three nuclei, or a number of small nuclei, are visible.

36. S. (Hypocrea) rufa, Pers. Fr. S. M. ii. p. 335. Tab. XLV. fig. 36, ascus with sporidia, × 325. The sporidia are squarish colourless bodies usually 16 in each ascus, quite unlike the usual fructification in the Pulvinatæ. This plant agrees in its fructification with *S. citrina* and *S. lobata*, and, like *S. gelatinosa* and some others, comes very near to *Dothidea*; for the perithecia, as far as I can make out, have no walls distinct from the flesh of the stroma; so that the fructifying mass is in fact a "nucleus" in the sense in which that word is used in *Dothidea.*

37. S. pruinata, Kl. Linn. vol. viii. p. 489. Tab. XLV. fig. 37, ascus with sporidia, × 325. Sporidia uniseriate, dark brown, elliptical, with 1 to 4 nuclei, or with a dark curved band across, arising, I think, not from a septum, but from the approximation of the nuclei; varying slightly in length, but on an average 0·001 inch long. Perithecia crowded, dome-shaped, with mammillate ostiola, mostly, but not always covered with a white farinaceous powder.

38. S. (Hypoxylon) fusca, Pers. Fr. S. M. ii. p. 332. Tab. XLV. fig. 38, asci with sporidia, × 325. Sporidia elliptical or almond-shaped; when young pale brown, with one or two large nuclei, and sometimes small nuclei also; when ripe very dark and opaque, normally uniseriate, but occasionally crowded as shown in fig. 39, which represents the fruit (× 225) of a *Sphæria* not differing materially from *Sphæria fusca,* except that the sporidia are larger and more irregular than usual. The latter plant occurred at Eltham, in Kent, in June, 1855. The ordinary length of the sporidia in *S. fusca*=0·0005 inch.

39. S. (Hypoxylon ?) parmularia, Berkel. Tab. XLV. fig. 40, sporidia × 225. Sporidia rather dark brown, clear, with mostly one nucleus, irregularly elliptical or almond-shaped, 0·0004 inch long. The specimens are in a bad state; and I had some doubt whether the plant ought not to be referred to the *Connatæ* or *Confluentes.* There is, however, some appearance of the *débris* of a *Pulvinulus.*

40. S. (Hypoxylon) cohærens, Pers. Fr. S. M. ii. p. 335. Tab. XLV. fig. 41, ascus with sporidia, × 325. Sporidia uniseriate, rather dark brown, irregularly elliptical, frequently rather curved, often with one or two nuclei, 0·0003 to 0·0004 inch long.

41. S. (Hypoxylon) rubricosa, Fr. Fl. 2. p. 63. Tab. XLV. fig. 42, ascus with sporidia, × 325. Sporidia uniseriate, dark brown, eventually opaque, elliptical, uniseptate, with frequently a nucleus in each division, 0·0004 to 0·0006 inch long.

Div. 4. CONNATÆ.

42. S. (HYPOXYLON) RUBIGINOSA, Pers.; Fr. S. M. ii. p. 340. TAB. XLV. fig. 43, ascus with sporidia × 325. Sporidia uniseriate, dark brown, elliptical, but slightly irregular, usually with one, sometimes with two or even three nuclei, 0·0004 inch long.

43. S. (HYPOXYLON) ATRO-PURPUREA, Tode; Fr. S. M. ii. p. 340. TAB. XLV. fig. 44, sporidia × 325. Sporidia dark brown, paler when young, usually with two, sometimes one nucleus, 0·0004 to 0·0005 inch long.

44. S. (HYPOXYLON) PERFORATA, Sz.; Fr. S. M. ii. p. 340. TAB. XLV. fig. 45, sporidia, × 325. Sporidia I think uniseriate, like those of *atro-purpurea*, but rather lighter-coloured, 0·0004 inch long. The plant is easily known by the rusty-coloured perithecia, and the white flat ostiola.

45. SPHÆRIA BOTRYOSA, Fr. S. M. ii. 342. TAB. XLVI. fig. 46, ascus with sporidia, × 225. Asci variable in size, clavate, with the inner membrane very distinct, the latter filled with innumerable multitudes of very minute granules; granules colourless, about 0·0001 inch, endowed with Brownian motion. I should have doubted these granules being true sporidia; but I find the fruit of the plant in the Hookerian herbarium coinciding exactly with that of authentic specimens from the *Scleromycetes Sueciæ*. Fries considers the plant a *Sphæria* with confluent perithecia, and not an *Hypoxylon*. See 'Summa Veg. Scand.' p. 383, note 3.

46. S. (HYPOCREA) LATERITIA, Fr. S. M. ii. p. 338. TAB. XLVI. fig. 47, ascus with sporidia, × 325. Sporidia uniseriate elliptico-acuminate, colourless, 0·0006 to 0·0007 inch long. I had some doubt whether the plants were ripe, and whether the sporidia may not become brown in age. The specimens in Hook. herb. are from Mr. Stephens's herbarium. I have seen no other specimens of this species.

47. S. (HYPOXYLON) SERPENS, Pers.; Fr. S. M. ii. p. 341. TAB. XLVI. fig. 48, ascus with sporidia, × 325. Sporidia similar in colour to those of *S. atro-purpurea*, and of about the same size.

48. S. (HYPOCREA) HYALINA, Schwein.; Fr. S. M. ii. p. 339. TAB. XLVI. fig. 49, ascus with sporidia and free sporidia, × 325. Sporidia uniseriate, colourless or greenish, elliptico-acuminate but rather irregular, 0·0006 to 0·0008 inch long.

49. S. (HYPOXYLON) SASSAFRAS, Sz.; Fr. S. M. ii. p. 343. TAB. XLVI. fig. 50, ascus with sporidia, × 325. Sporidia uniseriate, elliptical, clear brown, rather dark, 0·0004 inch long. Very like *S. atro-purpurea*; but the perithecia are of a rather darker colour, and the ostiola obtuse or depressed, not mammillate.

50. S. (HYPOCREA) CITRINA, Pers.; Fr. S. M. ii. p. 337. TAB. XLVI. fig. 51, ascus with sporidia, × 325. Sporidia squarish, irregular in shape, colourless, normally 16 in an ascus. Hardly distinguishable in fructification from *S. rufa*, &c., but easily known by the yellow colour, and effused condition of the stroma. It may be only a peculiar condition of *S. gelatinosa*, Tode.

51. S. (HYPOCREA) LOBATA, Sz. Wormsk.; Fr. S. M. ii. p. 343. TAB. XLVI. fig. 52, ascus with sporidia, × 325. Not distinguishable in its fruit from the last, except that the asci and sporidia (in the Kew specimens at least) are smaller.

52. S. (HYPOCREA) LUTEO-VIRENS, Fr. S. M. ii. p. 339. TAB. XLVI. fig. 53 *a*, ascus with sporidia; *b*, free sporidia; *c*, stylospores, all × 325. Sporidia uniseriate; overlapping, colourless, very narrowly almond-shaped, 0·0008 to 0·0010 inch long. Perithecia dull-yellow orange colour, imbedded in a woolly subiculum which produces the yellow stylospores on the left of the figure.

Div. 5. GLEBOSÆ.

53. S. (HYPOXYLON) REPANDA, Fr. S. M. ii. p. 346. TAB. XLVI. fig. 54, ascus with sporidia × 325. Sporidia uniseriate, dark brown, elliptical, 0·0004 to 0·0005 inch long. Stroma rather undulating in surface, ostiola depressed, the whole plant very like *S. stigma*, except in its fruit, which is quite different.

54. S. (HYPOXYLON) TUBULINA, A. and S.; Fr. S. M. ii. p. 346. TAB. XLVI. fig. 55, ascus with sporidia and free sporidia, × 325. Sporidia usually, I think, uniseriate, but sometimes biseriate, clear, rather dark brown, elliptical, 0·0002 to 0·0003 inch long.

55. S. (HYPOXYLON) LUTEA, A. and S.; Fr. S. M. ii. p. 347. TAB. XLVI. fig. 56, ascus with sporidia, × 325. Sporidia minute, uniseriate, brown, elliptical, but rather irregular, generally with two nuclei, which sometimes give an appearance of a septum; sometimes there is one nucleus, sometimes none. Sporidia 0·0002 to 0·0003 inch long.

56. S. (HYPOXYLON) DEUSTA, Hoffm.; Fr. S. M. ii. p. 345. TAB. XLVI. fig. 57, sporidia, × 325. Sporidia biseriate I think (the asci were imperfect), rather dark brown, usually somewhat curved, with an inner membrane sometimes visible, 0·0012 to 0·0016 inch long.

57. S. (HYPOXYLON ?) FUSCOSPORA, Schwein. TAB. XLVI. fig. 58, sporidia, × 325. Sporidia biseriate I believe, at first colourless, then clear dark brown, arcuate, 0·0014 inch long.

58. S. (HYPOXYLON) NUMMULARIA, Bull.; Fr. S. M. ii. p. 348. TAB. XLVI. fig. 59, asci with sporidia, × 325. Sporidia uniseriate, brown when young, black when ripe, round or elliptical, 0·0004 to 0·0006 inch long.

59. S. (HYPOXYLON) MARGINATA, Fr. El. ii. 69. TAB. XLVI. fig. 60, ascus with sporidia, × 325. Sporidia uniseriate, with one, two, or no nuclei, elliptical or subreniform, 0·0002 inch long, pale clear brown.

Div. 6. LIGNOSÆ.

60. S. HYPOXYLON) UDA, Pers.; Fr. S. M. ii. p. 358. TAB. XLVI. figs. 61 and 62, asci with sporidia, × 325. Fig. 63, free sporidia, × 325. Sporidia at first of a rich olive-green colour, eventually dark, clear, transparent brown, sometimes with nuclei, sometimes obtusely elliptical (fig. 61), sometimes almond-shaped (fig. 62). 0·0006 to 0·001 inch long.

61. S. (DIATRYPE) DISCIFORMIS, Hoffm.; Fr. S. M. ii. p. 353. TAB. XLVI. fig. 64, sporidia, highly magnified. Sporidia biseriate or crowded, yellowish in a mass, almost colourless when detached, slightly curved; 0·0002 to 0·0003 inch long.

62. S. (DIATRYPE) FLAVOVIRENS, Hoffm.; Fr. S. M. ii. p. 357. TAB. XLVI. fig. 65, ascus with sporidia, × 450. Sporidia crowded, yellowish, curved, 0·0003 inch long.

63. S. (DIATRYPE) PLATYSTOMA, Schwein.; Fr. S. M. ii. p. 351. TAB. XLVI. fig. 66, sporidia, × about 450. Sporidia colourless or with a slight yellow tinge, less curved and rather smaller than in *Sphæria stigma*; about 0·0003 inch long. The plant is distinguishable from *S. stigma* by its rimose stroma, and by its larger, more protruding Pezizæ-form ostiola.

64. S. (HYPOXYLON) VOGESIACA, Pers. in Litt. TAB. XLVI. figs. 67 and 68, sporidia, × 325. Sporidia uniseriate (I believe), at first pale brown, eventually almost opaque with granules and nuclei, elliptical, but rather irregular, sometimes almost pyriform, 0·0007 to 0·0008 inch long. "*Ad truncos emortuos Aceris pseudo-platani*; *affinis Sphæriæ serpentis sed distincta*," is the note attached.

65. S. (HYPOXYLON) VIRGULTORUM, Fr. S. M. ii. p. 351, El. xi. 71. TAB. XLVI. fig. 69, sporidia, × 450. Sporidia sometimes uniseriate, sometimes biseriate, lageniform, colourless, or with an almost imperceptible yellowish tinge, 0·0004 inch long.

66. S. (DIATRYPE) ATRO-PUNCTATA, Schwein.; Fr. S. M. ii. p. 351. TAB. XLVI. fig. 70, ascus with sporidia and free sporidia, × 325. Sporidia uniseriate, overlapping, brown, with granular nucleate contents, broadly almond-shaped, 0·0010 to 0·0012 inch long. Easily known by the small punctiform ostiola penetrating the white upper surface of the stroma.

67. S. (DIATRYPE?) RHOIS, Schwein.; Fr. S. M. ii. p. 356. TAB. XLVI. fig. 71*a*, sporidia; *b*, stylospores. The specimens are in bad condition; but one perithecium produced the sporidia *a*, which are yellowish like those of *Sphæria verrucæformis*; another produced the stylospores or spermatia *b*, which were colourless and produced on sporophores attached to the wall of the perithecium. Length of *a* about 0·0003 inch, of *b* from 0·0010 to 0·0014 inch, measured on the chord of the arc.

68. S. (DIATRYPE) LIRIODENDRI, Schwein.; Fr. S. M. ii. p. 356. TAB. XLVI. fig. 72, asci with sporidia and free sporidia, × 325. Sporidia very crowded, quite filling the asci, brown, just like the sporidia of *Sphæria favacea* and *S. aspera*, 0·0002 inch long, or rather more. Possibly the plant is only a state of *Diatrype aspera*.

69. S. (DIATRYPE) CAPNODES, Berkeley. TAB. XLVI. fig. 73, ascus with sporidia and free sporidia × 325. Sporidia uniseriate, at first a clear brown, ultimately quite opaque, uniseriate, elliptical, 0·0004 to 0·0005 inch long. This species is allied to *Sphæria stigma*; but the stroma is of a blackish grey colour, and the ostiola more prominent. The fruit, as will be seen, is totally different from that of *S. stigma*.

70. S. (HYPOXYLON) MELANASPIS, Mont. Sylloge, p. 215. TAB. XLVI. fig. 74, ascus with sporidia and free sporidia, × 325. Sporidia uniseriate, overlapping at the ends, almost colourless, but with a faint tinge of yellow or rather straw colour, fusiform, but wider at one end than at the other, 0·001 inch long. Forming round black stains, with the ostiola slightly protruding in the middle of the stain.

71. S. (DIATRYPE) DRYOPHILA, n. s. TAB. XLVI. fig. 75, asci with sporidia and free sporidia, × 325. Sporidia uniseriate, narrowly elliptical, subacuminate at each end, at first of a pale greenish brown, then darker, and eventually almost black, when young with two or more nuclei in each sporidium, 0·0004 to 0·0005 inch long. Perithecia ovate or sub-globose surrounded by a dirty green stroma, rather deeply buried,

piercing the bark by their long converging necks, forming compact scattered black pustules on oak-branches. On dead and decaying branches of oak at Weybridge, September, 1856. Much resembling *Sph. verrucæformis* in its external form, and in the very glutinous nature of the contents of the perithecia.

72. S. (Diatrype) nucleata, n. s. Tab. XLVI. fig. 76, ascus with sporidia, × 325. Sporidia linear-acuminate, but constricted in the middle, colourless, 0·0007 to 0·0008 inch long. Perithecia ovate or globose, with rather short ostiola, collected in elongated irregular patches surrounded by a dark line. Weybridge, January, 1856, on furze.

73. S. (Diatrype or Valsa) varians, n. s. Tab. XLVI. fig. 77, ascus with sporidia, × 325. Sporidia biseriate, obtuse, constricted in the middle, colourless, with granular endochrome, uniseptate, 0·0006 inch long. Perithecia subglobose; ostiola conical, sometimes umbilicate at the apex. The masses of perithecia penetrate the bark in long parallel lines. This plant unites the characteristics of the Circumscriptæ and Lignosæ, some specimens having a conceptaculum, and others being scattered, with a black line and without a conceptaculum. Eltham, June 1855.

74. S. (Diatrype or Valsa) denigrans, n. s. Tab. XLVI. fig. 78, ascus with sporidia, × 325. Sporidia uniseriate, often partly overlapping, dark olive-brown, elliptical, bi-, tri-, or multi-nucleate, sometimes quite simple, 0·0005 inch long. Perithecia conical or depressed, with long ostiola, deeply set in the wood; ostiola penetrating the bark and raising the wood into minute but prominent black tubercles. When a nest of perithecia is cut transversely, there is a black line round them which is very well defined.

75. S. (Diatrype) inæqualis, n. s. Tab. XLVI. fig. 79, ascus with sporidia, × 325. Sporidia uniseriate, almost colourless, but rather of a green tinge, obtuse, constricted in the middle, uniseptate, 0·0006 inch long or a little over; contents granular and nucleate. Perithecia subglobose; ostiola short and rugose. The surface of the wood (beneath the epidermis) under which the perithecia lie is blackened and rugged; the perithecia are sometimes scattered. Masses of perithecia surrounded by a black line. Nearer to the Lignosæ than to any other division. On furze, Weybridge, January 1856.

76. S. (Diatrype) Badhami, n. s. Tab. XLVI. fig. 80, ascus with sporidia and free sporidia, × 325. Sporidia biseriate, colourless, usually 4-nucleate, with a minute hyaline appendage at each end (which, however, is invisible in the ascus), narrowly almond-shaped, 0·0005 to 0·0006 inch long without the appendages. The perithecia occur singly and in masses; they are deeply imbedded in the wood; the surface of the inner bark is much blackened. The plant in habit and appearance resembles *S. inæqualis*, supra; but the sporidia are altogether different.

77. S. (Diatrype) verrucæformis, Ehr.; Fr. S. M. ii. p. 355. Tab. XLVI. fig. 81, ascus with sporidia and free sporidia, × about 225. Sporidia very numerous, crowded, yellowish in the mass, almost colourless when single, curved, rounded at the ends, with usually a nucleus at each end, 0·0004 inch long. The asci are usually, but not always, fusiform.

78. S. (Diatrype) favacea, Fr. S. M. ii. p. 354.

79. S. (Diatrype) aspera, Fr. S. M. ii. p. 354. The only difference between the fructification of these plants and that of *S. verrucæformis* is that their sporidia are somewhat smaller and without nuclei, and their asci are clavate, not fusiform.

80. S. (Diatrype) stigma, Hoffm.; Fr. S. M. ii. p. 350. Tab. XLVI. fig. 82, sporidia, × 450. Sporidia yellowish in the mass, almost colourless when single, slightly curved, 0·0004 inch long.

81. S. (Diatrype) bullata, Ehr.; Fr. S. M. ii. p. 349. Sporidia just like those of *S. platystoma* (see fig. 66), 0·0002 to 0·0003 inch long.

82. S. undulata, Pers.; Fr. S. M. ii. p. 350. Sporidia biseriate, yellowish, slightly curved, rounded at each end, 0·0004 inch long. The perithecia break through the bark in an undulating manner. The sporidia are just like those of *Sphæria stigma* (see fig. 82), of which this species is probably only a variety, as was long since remarked by Fries.

83. S. (Hypocrea) lenta, Tode; Fr. S. M. ii. p. 349. Tab. XLVI. fig. 83, ascus with sporidia, × 325. The fructification of this plant is precisely similar to that of *S. rufa*; and I would refer to the remarks appended to that plant. The square-shaped, irregular, colourless sporidia, after escaping from the ascus, become round or nearly so, their average diameter being less than 0·0002 inch. I have retained the plant in this division, as it is so arranged in the Herbarium, and by Fries in the 'Syst. Myc.' In the 'Summa Veg. Scandinaviæ' it is placed (strange to say) in the genus *Diatrype*; according to the arrangement in that work, it ought certainly to be a *Hypocrea*.

Div. 7. Versatiles.

84. S. (Diatrype) scabrosa. Dec.; Fr. S. M. ii. p. 360. Tab. XLVI. fig. 84, ascus with sporidia and free sporidia, × 450. Sporidia uniseriate, clear brown (one had a hyaline tip at each end), subcylindrical, rounded at each end, triseptate, slightly constricted at the septa, 0·0006 inch long. In this specimen the perithecia are very slightly immersed, and look like large specimens of *Sphæria pulvis-pyrius*, which, although belonging to the Denudatæ, is often subcuticular in its growth. The fruit also is the same as in *S. pulvis-pyrius*, except as regards size. The plant, however, being marked *S. scabrosa* by Mr. Berkeley, I have described it as such, but with some doubt.

85. S. (Diatrype) podoides, Pers. Syn. p. 22, excl. syn. Tab. XLVI. fig. 85, ascus with sporidia and free sporidia, × 225. Sporidia biseriate or crowded, clear, rather pale-brown, 7-septate, with a hyaline joint at each extremity, often slightly curved, 0·0024 to 0·003 inch long. Quite distinct from *S. scabrosa*, Dec., under which it was placed by Fries as a variety.

86. S. podoides, var. lævis, does not differ from the above, as far as the fruit is concerned, but only in the smoothness of the tubercles, arising from the ostiola of the perithecia not penetrating the stroma.

87. S. (Diatrype ?) petiginosa, Fr. in litt. Tab. XLVI. fig. 86, ascus with sporidia and free sporidia, × 450. Sporidia biseriate or crowded, yellowish, rounded at each end, narrow, slightly curved, 0·0004 to 0·0006 inch long.

88. S. (Diatrype) leprosa, Pers.; Fr. S. M. ii. p. 365. Tab. XLVI. fig. 87, ascus with

sporidia and free sporidia, × 325. Sporidia biseriate or crowded, colourless or yellowish, slightly curved, 0·0004 to 0·0005 inch long, rounded at each end, narrow.

89. S. (Diatrype) strumella, Fr. S. M. ii. p. 365. Tab. XLVII. fig. 88, sporidia, × 450. Sporidia biseriate, colourless, elliptico-acuminate, triseptate, or, I think, pseudo-triseptate from the division of the endochrome into four parts, 0·0005 to 0·0006 inch long, sometimes slightly curved and slightly constricted in the middle, and frequently only biseptate.

90. S. (Diatrype) radicalis, Fr. El. ii. p. 73. Tab. XLVII. fig. 89, sporidia highly magnified. Sporidia biseriate or crowded, elliptical or subturbinate, colourless, hyaline very minute, 0·0002 to 0·0003 inch long, always, I think, with one, sometimes with two or three septa. The perithecia are deeply buried and surrounded by an orange-coloured stroma, through which the ostiola penetrate in the form of little, round, black, disc-like spots.

91. S. (Diatrype) quercina, Pers. Tab. XLVII. fig. 90, ascus with sporidia and free sporidia, × 325. Sporidia biseriate, endochrome 4-, sometimes 6-partite, oleaginous, but sometimes granular, 0·0020 to 0·0028 inch long. This plant has been much misunderstood. The above description is from a specimen lent to me by Mr. Berkeley. I doubt whether any of the specimens at Kew are the true species. Some of them are certainly *S. leiphæmia*; and the others are not in a sufficiently good condition to decide upon.

92. S. (Diatrype) lanciformis, Fr. S. M. ii. p. 362. Tab. XLVII. fig. 91, ascus with sporidia, × 325. Sporidia usually biseriate, but occasionally (when the sporidia are small, I think) uniseriate, pale clear brown, when ripe flatly elliptical, rather obtuse at the ends, the extreme tips frequently, if not always, pellucid, and the sporidium of a darker colour in the part immediately adjoining the pellucid tips. Length very variable, ordinarily 0·002 inch.

93. S. (Diatrype) hystrix, Tode; Fr. S. M. ii. p. 364. Tab. XLVII. fig. 92, asci with sporidia, × 325. Sporidia uniseriate or biseriate, elliptical, slightly constricted at the septa, 3- or 4-septate with frequently longitudinal and oblique septa, pale clear brown, 0·0006 to 0·0008 inch long. Described from a specimen out of Mr. Berkeley's herbarium, the plant at Kew not having perfect fruit.

94. S. (Diatrype) ceratosperma, Tode; Fr. S. M. ii. p. 364. Tab. XLVII. fig. 92, ascus with sporidia, × 325. Sporidia biseriate, colourless, simple, curved, 0·0003 to 0·0004 inch long. Described from a specimen of Mr. Berkeley's, the plant at Kew not being the true species.

95. S. (Diatrype) ferruginea, Pers.; Fr. S. M. ii. p. 363. Tab. XLVII. fig. 94, asci with sporidia, × 325. Sporidia very long, linear, acuminate at the ends, colourless, with many nuclei.

96. S. (Diatrype) nigerrima, Bloxam, MSS. Sporidia biseriate, closely packed, very irregular in shape (arcuate, subelliptical or lozenge-shaped), with a number of circular nuclei, colourless, but with a greenish tinge, 3-, 4-, or 5-septate. Perithecia irregularly ovate or conical, sometimes arranged in tiers, raising the matrix into a

black pulvinate tubercle, through which the densely crowded ostiola penetrate and cause a scabrous appearance; ostiola somewhat elongated and rounded. Communicated by Mr. Bloxam, from Leicestershire.

97. S. (DIATRYPE) IRREGULARIS, Sow.=*S. gastrina*, Fr. S. M. ii. p. 379. TAB. XLVII. fig. 96, ascus with sporidia, × 450. Sporidia at first colourless or pale green, at last dark brown, uniseriate; average length a little over 0·0004 inch. The sporidia have one, two, or three nuclei, and sometimes the nuclei are so close as to give a septate appearance to the sporidium; but I do not think there is ever any real septum.

98. S. (DIATRYPE) MOUGEOTII, Pers. in litt. Tab. XLVII. fig. 97, ascus with sporidia, × 325. Sporidia biseriate, yellow (the same colour as in *S. herbarum* and *S. siparia*), irregularly oblong, constricted in the middle, multi-septate, with frequently longitudinal septa (or rather pseudo-septa; for all the septa are, I think, only apparent, arising from divisions of the endochrome), 0·0012 inch long. Perithecia with deciduous (?) ostiola. Arranged in the herbarium with the *Cæspitosæ*, but clearly belonging to the *Versatiles*. On dried branches of *Acer Pseudo-platanus*.

DIV. 8. CONCRESCENTES.

99. S. FIBROSA, Pers.; Fr. S. M. ii. p. 384. TAB. XLVII. fig. 98, ascus with sporidia, × 420. Sporidia uniseriate, obtusely elliptical, but slightly constricted in the middle, colourless; endochrome bipartite, 0·0005 inch long.

100. S. DEPRESSA, Fr.; Montagne, Sylloge, p. 232. TAB. XLVII. fig. 99, ascus with sporidia, × 325; detached sporidia, × 450. Sporidia curved, of a pale yellowish colour, each ascus containing a great number. Asci with their sporidia much resembling *Sph. favacea*; sporidia 0·0004 inch long.

101. S. PARALLELA, Fr. S. M. ii. p. 373. TAB. XLVII. fig. 100, sporidia highly magnified. Sporidia pale clear brown, straight or slightly curved, rounded at each end, 0·0004 to 0·0005 inch long.

102. S. (DIATRYPE) LEIOPLACA, Fr. S. M. ii. p. 370. TAB. XLVII. fig. 101, sporidia highly magnified. Sporidia biseriate, curved, of a pale yellowish tinge, just like the colour in *S. stigma*, 0·0004 inch long. Very like *Sph. stigma*, only there is no dark-coloured stroma.

103. S. FIMETI, Pers., var. EQUINA. TAB. XLVII. fig. 102, ascus with sporidia, and a free sporidium, × 325. Sporidia uniseriate, broadly ovate, sometimes slightly acuminate, sometimes obtuse at the ends, of a deep brown colour, or almost black, quite opaque when ripe, 0·0008 inch long. When immature, the sporidia are pale brown, with large nuclei.

104. S. (DIPLODIA) DIOSPYRI, Schwein.; Fr. S. M. ii. p. 372. This specimen is not in good condition. I could find no asci, and am doubtful whether or not the sporidia are produced on sterigmata as in *Diplodia*. The sporidia are dark brown, uniseptate, obtuse, slightly constricted in the middle, 0·0006 to 0·0007 inch long.

105. S. VELATA, Pers.; Fr. S. M. ii. p. 375. TAB. XLV. fig. 104, ascus with sporidia, × 325, and two free sporidia more highly magnified. Sporidia crowded, quite colour-

less, pseudoseptate by division of the endochrome into 2 or 4 partitions, narrowly almond-shaped, 0·0005 inch long.

106. S. (DIATRYPE) DISCINCOLA, Schwein.; Fr. S. M. ii. p. 368. TAB. XLVII. fig. 105, sporidia, × 325. Sporidia uniseriate, I think (at least it seemed so from what appeared to be the remnants of the asci), dark opaque brown, almost black, globular or elliptical, 0·0006 inch long.

107. S. (DIATRYPE) MILLIARIA, Fr. S. M. ii. p. 370. TAB. XLVII. fig. 106, sporidia, × about 450. Sporidia crowded, curved, colourless, 0·0003 inch long. Resembling *S. eutypa* both in habit and fructification; but the ostiola are more prominent, and the perithecia more crowded.

108. S. (SPHÆRIA) LIMÆFORMIS, Schweinitz; Fr. S. M. ii. p. 369. TAB. XLVII. fig. 107, sporidia, × about 450. Sporidia, crowded, colourless when separate, yellowish when the asci are in a mass, curved, usually rounded at the ends, 0·0002 inch long. On oak, very black, very crowded, well-named "limæformis." Fries considers it a form of *Sphæria spinosa*.

109. S. (SPHÆRIA) SPINOSA, Pers.; Fr. S. M. ii. p. 368. TAB. XLVII. fig. 108, sporidia, × 325. Sporidia yellowish in the mass, almost colourless when single, curved, rounded or acute at the ends, 0·0003 inch long.

110. S. ELEVATA, Berk. TAB. XLVII. fig. 109, asci with sporidia, and free sporidia, × 325. Sporidia numerous, crowded, closely packed, dull yellowish brown in a mass, almost colourless when separate, curved, rounded at the ends, 0·0006 to 0·0007 inch long. From Swan River, Mr. Drummond.

111. S. (DIATRYPE) LATA, Pers.; Fr. S. M. ii. p. 369. TAB. XLVII. fig. 110, sporidia, × 325. Sporidia crowded, yellowish in a mass, almost colourless when single, curved, obtuse at each end, 0·0002 to 0·0004 inch long.

112. S. (SPHÆRIA) SPICULOSA, Pers.; Fr. S. M. ii. p. 369. TAB. XLVII. fig. 111, sporidia, × 325. Sporidia narrowly almond-shaped, acuminate, quite colourless, with the endochrome divided into four portions, 0·0004 to 0·0005 inch long. Easily known by its black appearance and hair-like ostiola.

113. S. (VALSA) MONADELPHA, Fr. S. M. ii. p. 382. Fructification not distinguishable from that of *S. stigma*. The contents of the perithecia are glutinous, as in that species.

114. S. (DIATRYPE or VALSA) ÆQUILINEARIS, Schwein.; Fr. S. M. ii. p. 374. In this plant the fructification is not distinguishable from that of the last.

115. S. (SPHÆRIA) DISCUTIENS, Berk. Engl.; Fr. p. 245. TAB. XLVII. fig. 112, sporidia, × highly. Sporidia biseriate or crowded, 1- 2- or 3-septate, or apparently so from division of the endochrome, colourless, almond-shaped, 0·0005 inch long. Perithecia deeply buried; ostiola long and protruding.

116. SPHÆRIA STIPATA, Currey; Phil. Trans. 1857. TAB. XLIX. fig. 197, asci with sporidia, × 225. Sporidia biseriate, pale clear brown, very transparent, slightly curved, sometimes with a nucleus at each end, but usually without; 0·0008 to 0·001 inch long. Perithecia ovate, crowded; ostiola sulcate, often exactly resembling those of *S. stellulata*. This plant might be placed either here or in the Confluentes with

almost equal propriety; but the ostiola are somewhat elongated, and the perithecia immersed in the matrix. Eventually, however, the bark is thrown off, and the perithecia form rough, naked, scabrous masses. A dark line often surrounds the masses of perithecia; but the area it includes is very irregular, and the line itself not always present. It might be taken for a coarse abnormal form of *S. stellulata*; but the sporidia are more than double the size of those of *S. stellulata*, and of a different colour. It is very common in this country, principally on elm.

Div. 9. CIRCUMSCRIPTÆ.

117. S. (VALSA) ENTEROLEUCA, Fr. S. M. ii. p. 381. TAB. XLVII. fig. 113, ascus with sporidia, × 325. Sporidia biseriate, colourless, oblong, acuminate at each end, constricted in the middle, often slightly curved, 4-nucleate, uniseptate (I think, but the septum very difficult to make out), 0·0006 to 0·0007 inch long. On *Robinia Pseudacacia*. Perithecia very numerous in each pustule, deeply imbedded in a very white stroma; when cut across horizontally, a very well-defined black line is seen, which arises from the wood surrounding the perithecia being blackened, thereby causing the appearance of the existence of a conceptaculum; but there is not really any. I have received a plant from Mr. Bloxam marked as *S. enteroleuca*, Fr., of which fig. 114 represents an ascus with sporidia × 325, and free sporidia more highly magnified. The sporidia are very numerous, crowded, brownish yellow in the mass, almost colourless when single, curved, 0·0003 inch long. I suspect, from the habit of the latter plant upon its fruit, that it is a form of *Diatrype aspera*.

118. S. (VALSA) ANOMIA, Fr. S. M. ii. p. 381; El. ii. p. 77. Sporidia (spermatia?) colourless, slightly curved, very minute, about 0·0002 inch long. A very doubtful specimen; but the fruit does not differ very materially from that figured in Sturm's 'Deutschland's Flora.'

119. S. (VALSA) EXTENSA, Fr. S. M. ii. p. 381. TAB. XLVII. fig. 116, ascus with sporidia, × 325. Sporidia uniseriate, colourless, obtuse, slightly constricted in the middle; endochrome bipartite, smooth, and refractive, but doubtless sometimes granular.

120. S. (VALSA) DETRUSA, Fr. S. M. ii. p. 382. TAB. XLVII. fig. 117, ascus with sporidia, × 325, and a free sporidium, × 450. Sporidia biseriate, colourless; endochrome divided into four, sometimes apparently into only two portions, elliptic, subobtuse or subacuminate at the ends; 0·0006 inch long.

121. S. (VALSA) PRUASTRI, Pers.; Fr. S. M. ii. p. 380. Sporidia biseriate, almost colourless, but brownish yellow in the mass; minute, curved, 0·0003 inch long. Hardly distinguishable from the fruit of *Diatrype stigma*.

122. S. (VALSA) CARPINI, Pers.; Fr. S. M. ii. p. 384. TAB. XLVII. fig. 118, sporidia, × 325. Sporidia curved, colourless, highly refractive, 0·0006 to 0·0008 inch long. There is another specimen in the Herbarium, marked *Sph. Carpini*; but as the sporidia are just like those of *Sph. syngenesia*, it probably belongs to the latter species.

123. S. (VALSA) SYNGENESIA, Fr. S. M. ii. p. 382. TAB. XLVII. fig. 119, sporidia, ×

325. Sporidia biseriate or crowded, colourless, elliptic-acuminate; endochrome 4-partite, sometimes only 2-partite; 0·0005 to 0·0006 inch long.

124. S. (VALSA) CELLULATA, Fr. Syst. Myc. ii. p. 380. TAB. XLVII. fig. 120, sporidia, × 450. Sporidia biseriate, very pale yellowish brown, simple, slightly curved, rounded at both ends, 0·0004 inch long.

125. S. (DIPLODIA ?) JUGLANDICOLA, Schwein.; Fr. S. M. ii. p. 385. TAB. XLVII. fig. 121, fruit, × 325. Sporidia (? stylospores) uniseptate, dark brown, 0·0009 to 0.001 inch long. To the naked eye the plant resembles *S. pulvis-pyrius.*

Div. 10. INCUSÆ.

126. S. (VALSA) ANGULATA, Fr. S. M. ii. p. 390. TAB. XLVII. fig. 122, ascus with sporidia, and free sporidia, × 225. Sporidia uniseriate, very seldom biseriate, colourless or pale sea-green, obtuse, constricted in the middle, furnished with 4 (? sometimes 5) cilia, one proceeding from each pole and one from the middle of each side; endochrome usually granular; 0·0008 to 0·0012 inch long. The above is the usual form of the sporidia; but sometimes, when the endochrome is oleaginous and not granular, the appearance of the sporidia is so different that they might almost be taken for a second form of fruit. A second form of fruit does exist in this species, as to which I would refer to my paper "On the Fructification of certain Sphæriaceous Fungi," read before the Royal Society, in June 1857. See Phil. Trans. 1857.

127. S. (VALSA) MELASPERMA, Fr. S. M. ii. p. 389. TAB. XLVII. fig. 123, ascus with sporidia, and free sporidia, × 325. Sporidia very numerous, slightly curved, of a pale-yellowish tinge, 0·0002 to 0·0003 inch long.

128. S. (VALSA) TALEOLA, Fr. S. M. ii. p. 390. TAB. XLVII. fig. 124, ascus with sporidia, and free sporidia, × 450. Sporidia biseriate, colourless or very pale green, elongate-acuminate, frequently or usually slightly curved, 0·0007 to 0·0008 inch long. I think there is no real septum. I find not the slightest difference between the sporidia of *Sphæria taleola* and those of *S. leiphæmia*, and have little doubt that the two plants are not distinct. I feel sure that the conceptaculum which is said to distinguish *S. taleola* is a characteristic not to be relied upon; for there are some species of *Sphæria* which sometimes have a conceptaculum and sometimes not. The plants marked *S. taleola* at Kew have no conceptaculum; and I have seen other specimens marked *S. taleola* also without a conceptaculum.

129. S. (VALSA) FULVO-PRUINATA, Berk. TAB. XLVII. fig. 125, asci with sporidia, × 325. Sporidia uniseriate, sometimes slightly acuminate at each end, but sometimes obtuse at the ends, slightly constricted in the middle, uniseptate, dark brown, paler at first (and then an inner membrane and sometimes nuclei are visible), 0·0006 to 0·0007 inch long. Easily recognized by the tawny colour of the protruded bark surrounding the ostiola.

130. S. (VALSA) NIVEA, Hoffm.; Fr. S. M. ii. p. 386. TAB. XLVII. fig. 126, asci with sporidia, and free sporidia, × 325. Asci crowded with sporidia; sporidia colourless, slightly curved, 0·0002 to 0·0003 inch long.

131. S. (VALSA) FORAMINULA, Pers. in litt. TAB. XLVII. fig. 127, ascus with sporidia, and

free sporidia, × 325. Sporidia biseriate, elliptical, sometimes acuminate, sometimes obtuse at the ends, colourless, 0·0011 to 0·0016 inch long. In some sporidia the endochrome was broken up into two, three, or six portions, but, I think, only from being dry.

132. S. (VALSA) PROFUSA, Fr. S. M. ii. p. 392. TAB. XLVII. fig. 128, sporidia, × 450: *a*, a young sporidium almost colourless or very slightly greenish; *b*, a sporidium more advanced; *c*, a ripe sporidium. The sporidia when young have a gelatinous envelope, which disappears in age, the asci frequently containing only four sporidia arranged in one continuous series; I believe, however, the normal number to be eight, and that they are sometimes arranged biseriately. The asci are absorbed at a very early period, so that usually only free sporidia are to be found. These when ripe are of a clear rich olive-brown colour with a very slight greenish tinge, oblong-elliptic, 0·001 to 0·002 inch long. One of the most beautiful *Sphæriæ* in point of fructification.

133. S. (DIPLODIA ?) RUDIS, Fr. El. ii. p. 98. TAB. XLVII. fig. 129, fruit, × 325. No asci; sporidia (? stylospores) rather dark brown, broadly elliptical, but slightly constricted in the middle, 0·0010 to 0·0011 inch long.

134. S. (VALSA) MICROSTOMA, Pers.; Fr. S. M. ii. p. 388. TAB. XLVII. fig. 130, ascus with sporidia, and free sporidia, × 325. Sporidia biseriate, colourless, transparent, curved, obtuse at the ends, 0·0005 to 0·0007 inch long.

135. S. (VALSA) DISSEPTA, Fr. S. M. ii. p. 392. TAB. XLVIII. fig. 131, asci with sporidia, and free sporidia, × 325. Sporidia biseriate, colourless, linear-acuminate or almond-shaped; endochrome bi- or quadripartite; 0·0004 to 0·0005 inch long.

136. S. (VALSA) CIRCUMSCRIPTA, Fr.; Mont. Syll. p. 220, under "Valsa." TAB. XLVIII. fig. 132, sporidia, × 325. Sporidia biseriate, colourless, linear, pointed at the ends; endochrome bipartite, sometimes quadripartite; 0·0006 inch long. This agrees with Montagne's description, except that he calls the sporidia obtuse.

137. S. (VALSA) KUNZEI, Fr. S. M. ii. p. 388. TAB. XLVIII. fig. 133, ascus with sporidia, and free sporidia, × 325. Sporidia biseriate, brownish yellow in the mass, almost colourless when single, curved, 0·0004 inch long. Described from a specimen of Mr. Berkeley's, that at Kew having no fruit.

138. S. (VALSA) CONCAMERATA, n. s. TAB. XLVIII. fig. 134, ascus with sporidia, × 325. Sporidia crowded, colourless, curved, 0·0004 inch long; perithecia raising the inner bark into a dome-shaped conceptaculum, nests of perithecia united by white woolly fibres. On oak; *quære*, a form of *S. ceratosperma*?

139. S. CINCTA, n. s. TAB. XLVIII. fig. 185, ascus with sporidia, × 325. Sporidia uniseriate, dark rich brown, obtuse, constricted in the middle, 0·0007 inch long, uniseptate; perithecia irregularly ovate, closely packed in a compact leathery conceptaculum; ostiola bursting through the bark and forming round dark pustules: under a lens the ostiola seem surrounded with a dirty-olive-green stroma. Blackheath Park, March 1855.

140. S. (VALSA) SORBI, Schmidt; Fr. S. M. ii. p. 380. Sporidia not distinguishable from those of *S. stigma*.

141. S. (Valsa) sacculus, Schwein.; Fr. S. M. ii. p. 378. In the sphæropsoid state, spermatia colourless, delicate, slightly curved, obtuse or subobtuse at the ends, 0·0002 to 0·0003 inch long.

142. S. enteroxantha, Berk. Fructification exactly similar to that of *S. stigma*, as well in the glutinous nature of the contents of the perithecia as in the size, shape, and colour of the asci and sporidia. From British Guiana.

143. S. (Valsa) Cratægi, n. s. Tab. XLVIII. fig. 135 *a*, sporidia, × 425. Sporidia biseriate, oblong or elliptical, sometimes curved; endochrome 4-, sometimes 2-partite, colourless, 0·0006 to 0·0010 inch long; perithecia irregularly globose; ostiola rather short. Very common on thorn near Blackheath and elsewhere.

144. S. (Valsa) dryina, n. s. Tab. XLVIII. fig. 135 *b*, ascus with sporidia, and free sporidia, × 325. Sporidia biseriate or crowded, colourless, strongly curved; both asci and sporidia very delicate and hyaline; 0·0003 inch long. On dead oak-branches at Weybridge. Perithecia pyriform, imbedded in a dirty-brown stroma; ostiola rather shorter than the body of the perithecia, and somewhat thickened towards the apex.

Div. 11. Obvallatæ.

145. S. (Valsa) coronata, Hoffm.; Fr. S. M. ii. p. 395. Tab. XLVIII. fig. 136, ascus with sporidia, × 325. Sporidia colourless, biseriate, elliptic-acuminate, constricted in the middle, 0·0007 to 0·0008 inch long.

146. S. (Valsa) leiphæmia, Fr. Syst. Myc. ii. p. 399. Tab. XLVIII. fig. 137, sporidia, × 450. Sporidia biseriate, colourless or pale green, elongate-acuminate, slightly curved; endochrome refractive or granular, consisting of two distinct portions with a clear space (not, I think, a septum) between them; the outer membrane is so delicate that it is frequently not visible. I have found specimens in which the sporidia have oozed out of the perithecia and formed round rose-coloured tubercles at the apices of the ostiola, looking like *Tubercularia vulgaris* (see remarks under *S. taleola*). Length of sporidia about 0·0007 inch.

147. S. (Valsa) ambiens, Pers. Syn. p. 44.; Fr. S. M. ii. p. 403. Tab. XLVIII. figs. 138, 138 *a*, asci with sporidia, and free sporidia, × 325. Sporidia colourless, crowded, curved, rounded at each end, 0·0006 inch long.

148. S. (Valsa) turgida, Pers.; Fr. S. M. ii. p. 400. Tab. XLVIII. fig. 139, ascus with sporidia, and free sporidia, × 325. Sporidia uniseriate, at first a pale clear greenish brown with two or more nuclei, eventually a very dark opaque brown without (or with hardly visible) nuclei, elliptical, subacuminate, 0·0003 to 0·0004 inch long.

149. S. (Valsa) stilbostoma, Fr. S. M. ii. p. 403. Tab. XLVIII. fig. 140, ascus with sporidia, and free sporidia, × 325. Sporidia biseriate, colourless, acuminate-elliptic but constricted in the middle; the endochrome divided into two portions (not, I think, septate), sometimes smooth, glossy, and highly refractive, sometimes granular; 0·0007 inch long. The variety *Platanoides* (see fig. 140 *a*) has triseptate or pseudo-triseptate sporidia, which are 0·0010 to 0·0011 inch long, and sometimes mucronate.

150. S. (VALSA) QUERNA, n. s. TAB. XLVIII. fig. 141, ascus with sporidia, × 325. Sporidia slightly curved, simple, linear, colourless, subhyaline, crowded at the apex of the ascus as in many *Pezizæ*, 0·0002 to 0·0003 inch long. Weybridge, 1856. Not in a sufficiently good condition to describe the perithecia accurately. The fruit differs from that of any of the allied species with which I am acquainted.

151. S. (VALSA) BICONICA, n. s. Weybridge, January 7, 1856. TAB. XLVIII. fig. 142, ascus with sporidia, and free sporidia, × 220. Sporidia biconical; endochrome granular or oleaginous, greenish; 0·0011 to 0·0012 inch long; perithecia globose or depressed, few together, arranged in circles, penetrating the bark with their rather short ostiola and forming small pustules.

152. S. (VALSA) PULCHRA, n. s. TAB. XLVIII. fig. 143, ascus with sporidia, × 225. Sporidia biseriate, elliptical but slightly constricted in the middle and slightly acuminate at each end, uniseptate, greenish; perithecia imperfect.

153. S. (VALSA) SUFFUSA, Fr. S. M. ii. p. 399. TAB. XLVIII. fig. 144, sporidia, × 225. Sporidia variously curved from their great length, colourless, granular, biseriate or crowded.

154. S. (VALSA) JUGLANDIS, Schwein., non Fries. TAB. XLVIII. fig. 145, sporidia, × 450. Sporidia biseriate, yellowish, as in *S. stigma*, 0·0003 to 0·0004 inch long.

155. S. (VALSA) ABIETIS, Fr. S. M. ii. p. 398. TAB. XLVIII. fig. 147, ascus with sporidia, and free sporidia, × 325. Sporidia biseriate, colourless, curved, 0·0003 to 0·0006 inch long. This I believe to be the true *S. Abietis* of Fries. Fig. 146 represents the fruit of a *Sphæria* also occurring on Fir and resembling *S. Abietis* in general appearance. The sporidia in this latter plant are biseriate, colourless, subhyaline, curved, acuminate at each end, 1-septate or pseudo-septate, 0·0007 inch long. It is possible that the species may not be really different from *S. Abietis*, and that the latter may, in its perfect state, have septate sporidia. There are, as stated above, several *Sphæriæ* in which the normal state of the fruit is septate, but in which that state is often not attained.

156. S. (VALSA) TETRASPORA, n. s. Weybridge, January 1856. TAB. XLVIII. fig. 148, ascus with sporidia, and free sporidia, × 325. Sporidia simple, slightly curved, rounded at each end, colourless, *only* 4 *in each ascus*, biseriate, 0·0008 inch long; perithecia globose; ostiola surrounding or scattered through a white disk. The plant hardly differs from *S. ambiens*, except in its tetrasporous fructification.

157. S. (VALSA) SALICINA, Pers.; Fr. S. M. ii. p. 401. TAB. XLVIII. fig. 149, ascus with sporidia, and free sporidia, × 325. Sporidia biseriate, colourless, uniseptate, with granules and small nuclei, the septum often very difficult to make out, elliptical, but usually slightly curved, and often slightly constricted in the middle, 0·0009 inch long.

158. S. (? VALSA) INTEXTA, n. s. TAB. XLVIII. fig. 169, ascus with sporidia, × 325. Sporidia interwoven, generally nearly as long as the ascus, filiform and flexuous. This plant was not in a state to enable me to describe the perithecia. It appears to belong to the Circinatæ, and occurred on oak at Weybridge. The paraphyses were very long and numerous, and septate. I know of no species to which it can be referred, although the sporidia somewhat resemble those of *S. suffusa*, Fr.

Div. 12. CIRCINATÆ.

159. S. (VALSA) PULCHELLA, Pers.; Fr. S. M. ii. p. 406. TAB. XLVIII. figs. 150–153, asci with sporidia, and (in fig. 152) free sporidia, × 325. Sporidia biseriate or crowded, colourless, slightly curved or nearly straight; normally uniseptate, but the septum sometimes not distinguishable; varying much in size, 0·0005 inch in length being about the average. The sporidia are sometimes rounded at the ends, sometimes slightly acuminate.

160. S. (VALSA) FURFURACEA, Fr. S. M. ii. p. 409. TAB. XLVIII. fig. 154, sporidia, × 450. Sporidia colourless or pale green, uniseriate, 0·0008 inch long.

161. S. (VALSA) CONVERGENS, Tode; Fr. S. M. ii. p. 410. TAB. XLVIII. fig. 155, fruit, × 325. Sporidia dark brown, subcymbiform but irregular in shape, frequently constricted in the middle; length variable. On *Platanus occidentalis*, the perithecia being under the bark so as not to be seen above, except by the undulations of the bark. I found that some of the perithecia produced, in lieu of the regular sporidia, numbers of the small diplodioid bodies shown in the figure, below the sporidia. One of the sporidia has commenced germination.

162. S. (VALSA) HYPODERMIA, Fr. S. M. ii. p. 407. TAB. XLVIII. fig. 156, asci with sporidia, × 325. Sporidia colourless, granular, narrowly oblong, obtuse or slightly acuminate at each end, sometimes with two or more large globose nuclei, biseriate.

163. S. (VALSA) THELEBOLA, Fr. S. M. ii. p. 408. TAB. XLVIII. figs. 157, 158, and 159, asci with sporidia, and free sporidia, × 325. Sporidia biseriate, greenish or colourless, slightly arcuate, obtuse at both ends; usually with a cilium at each end, which is not visible whilst the sporidia are in the ascus. These cilia require care, to be rendered visible even when the sporidia are detached; they are sometimes absent. Length of the sporidia and size of the asci variable, the sporidia sometimes reaching 0·0017 inch. These figures show in a marked manner the difference in the appearance of the sporidia when the endochrome is oleaginous and refractive, and when it is granular.

164. S. (VALSA) XANTHOSTROMA (or CHRYSOSTROMA), Mont. Sylloge, p. 221. TAB. XLVIII. fig. 160, ascus with sporidia, and free sporidia, × 350. Sporidia uniseriate or biseriate, more often the former, colourless or greenish, almond-shaped, pseudo-septate from the division of the endochrome, 0·0007 inch long. Perithecia small, hardly visible above the bark, but (like all the Circinatæ) very visible when the epidermis is stripped off. Easily known by its yellow stroma. Endochrome smooth and refractive. In another specimen of the same species I found the sporidia not septate, and reaching nearly 0·0009 inch in length.

165. S. (VALSA) VESTITA, Fr. S. M. ii. p. 410. TAB. XLVIII. fig. 161, ascus with sporidia, × 425. Sporidia clear brown, multicellular, having transverse, longitudinal, and oblique septa, 0·0006 to 0·0009 inch long. As to the fructification of this species, see my paper in the 'Phil. Trans.' 1857, above referred to.

166. S. (DIPLODIA?) MELLÆ, Fr. El. ii. p. 85. TAB. XLVIII. fig. 162, sporidia, × 325. Sporidia clear dark brown, some margined, some (not many) with a central nucleus,

elliptic, rather irregular, varying much in length, the average being about 0·0008 inch. I could find no asci.

167. S. (Valsa), ? sp. Tab. XLVIII. fig. 163, ascus with sporidia, × 225. This plant is one of the "*Fungi Pyrenæi,*" and is marked "*S. cohærens, Pers.*" in that collection. It has, however, no affinity with *S. cohærens*, but belongs to the Circinatæ. The fruit differs from that of all other species of the division Circinatæ with which I am acquainted. The sporidia are uniseriate, of a rich brown colour, obtusely elliptical, uniseptate, 0·0014 inch long.

168. S. (Valsa) quaternata, Pers. Syn. p. 45. Tab. XLVIII. figs. 164 and 165, asci with sporidia, and free sporidia. In fig. 164, *a* is × 220, *b* about 325 diameters. Fig. 165 is × 450. Sporidia biseriate, almost colourless when separate, but in a mass of dull-brownish yellow, like the colour in *S. stigma*, *S. stellulata*, &c., curved, 0·0004 to 0·0006 inch long.

169. S. (Valsa) Innesii, n. s. Tab. XLVIII. fig. 166, sporidia, × 325. Sporidia biseriate, colourless, acute at each end, and constricted three times; endochrome 4-partite; 0·0010 to 0·0012 inch long. Sporidia frequently, if not always, with a delicate appendage at each end. Perithecia irregularly globose; ostiola elongated and frequently thickened at the apex. Externally much resembling *S. pulchella*, but smaller and differing altogether in fructification from that species.

170. S. (Valsa) arcuata, n. s. Tab. XLVIII. fig. 167, asci with sporidia, and free sporidia, × 325. Perithecia globose, arranged in circles; ostiola penetrating the bark and forming a dark-coloured, sometimes dirty-white disk. Sporidia biseriate, pale green, 4–5-septate, very flexible, sometimes constricted at the articulations, sometimes not, variable in length, somewhat resembling *S. quercina*, Pers. in its sporidia; but *S. quercina* belongs to the Versatiles, and this plant to the Circinatæ.

171. S. (Valsa) faginea, n. s. Eltham Grove, October 1856. Tab. XLVIII. fig. 168, sporidia, × 420. Sporidia biseriate, colourless, elliptic-acuminate, but constricted in the middle, and irregular, 0·0005 inch long. Perithecia conical; ostiola penetrating the bark, normally long and protruding, but mostly broken off; when the long ostiola are rubbed off, the plant looks just like *S. quaternata* or *S. turgida*. On beech.

Div. 13. Cæspitosæ.

172. Sphæria cupularis, Pers.; Fr. S. M. ii. p. 416. Tab. XLVIII. fig. 170, asci with sporidia, and free sporidia, × 325. Sporidia biseriate, colourless, curved, 0·0004 inch long, sometimes rather longer.

173. S. Pseudo-bombarda, Mont. Sylloge, p. 228. Tab. XLVIII. fig. 171, ascus with sporidia, and free sporidia, × 225. Sporidia biseriate or crowded, colourless, irregular, 0·002 inch long. This plant was in a young state; the spores when ripe are described by Dr. Montagne as 6-septate and "olivaceo-fuliginosas."

174. S. (Nectria) examinans, Berk. Tab. XLIX. fig. 172, ascus with sporidia, and free sporidia, × 325. Sporidia uniseriate or biseriate, clear dark brown, elliptical, subacuminate, 0·0008 inch long. Perithecia forming long black lines. The contents of the sporidia were mostly clear, sometimes multinucleate, and sometimes granular.

175. S. (Nectria) coccinea, Pers.; Fr. S. M. ii. p. 412. Tab. XLIX. figs. 174 and 175, ascus with sporidia, and free sporidia, × 325. Sporidia almost always uniseriate, colourless, uniseptate, frequently with a nucleus in each septum, elliptical, subacuminate, 0·0005 inch long. In the variety "*sanguinella*" I did not find any difference in the fruit, except that the average size of the sporidia was somewhat smaller. Fig. 175 represents free sporidia of the variety "*cicatricum,*" Desm., × 450.

176. S. (Nectria) cinnabarina, Tode; Berk. Engl. Flora, No. 77, under "Sphæria." Tab. XLIX. fig. 175, sporidia, × 450. Sporidia sometimes uniseriate, sometimes biseriate, normally I believe uniseptate, frequently if not always constricted in the middle, rather pointed at each end, colourless or pale sea-green, 0·0004 to 0·0006 inch long. I found some sporidia attached to long threads; but whether they were in the nature of stylospores, or whether the threads were the product of germination, I cannot say. Several of the sporidia were biseptate. See *a*, fig. 175.

177. S. (Nectria) decolorans, Pers. Syn. p. 49. Tab. XLIX. fig. 176, ascus with sporidia, and free sporidia, × 325. Sporidia uniseptate, colourless or greenish, 0·0005 inch long. Placed by Fries under *S. cinnabarina*, from which it differs in its more compact habit and in the more broadly elliptical sporidia; the perithecia, however, are rugged as in that species, with which perhaps it ought to be united.

178. S. Berberidis, Pers.; Fr. S. M. ii. p. 415. Tab. XLIX. fig. 177, sporidia, × 325. Sporidia uniseriate, but so overlapping as to be almost biseriate, yellow when young, brown when mature, constricted in the middle, usually acuminate at the ends, 0·0011 to 0·0016 inch long. Quære if distinct from *S. Laburni*?

179. S. (Nectria) cucurbitula, Tode; Fr. S. M. ii. p. 415. Tab. XLIX. fig. 178 *a*, sporidia; *b*, spermatia; and *c*, caudate irregular bodies: all × 325. Sporidia colourless, irregularly elliptical, 0·0004 inch long. Two membranes very visible in the sporidia. Besides the normal asci and sporidia, the perithecia produce asci containing the spermatia-like bodies (*b*) on the right: and the caudate bodies on the left also appeared to proceed from the same perithecia; but of this I am doubtful. The length of the spermatia is 0·0001 to 0·0002 inch, of the caudate bodies 0·0006 inch; what the latter may be I cannot say.

180. S. Laburni, Pers. Syn. p. 50. Tab. XLIX. fig. 179, ascus, × 225, and free sporidia, × 450. Sporidia, when perfect, multicellular, dark clear brown. I find in different perithecia in the same stroma every gradation from colourless minute unicellular spores (mostly with a nucleus at each end), through septate, biseptate, and triseptate forms, up to the multicellular. The colour varies by degrees, being at first colourless, then green, and eventually dark clear brown.

181. S. pulicaris, Fr. S. M. ii. p. 417. Tab. XLIX. fig. 180, ascus with sporidia, and free sporidia, × 325. Sporidia biseriate, colourless, elliptical, sometimes pyriform, pseudo-triseptate from division of the endochrome, 0·0006 to 0·001 inch long.

182. S. (Nectria) Purtoni, Grev. Tab. XLIX. fig. 181, ascus with sporidia, × 325. Sporidia uniseriate, colourless, acuminate, elliptical, 0·0004 inch long. Fries joins this species with *S. Abietis*; I do not know why, as it is quite distinct in habit and fructification.

183. S. (Nectria) acervalis, Moug.; Fr. El. ii. p. 83. Tab. XLIX. fig. 182, ascus with sporidia, × 325. Sporidia uniseriate, rarely biseriate, colourless, elliptical, uniseptate or pseudo-uniseptate, 0·0005 inch long.

184. S. (Nectria) Aquifolii, Fr. El. ii. p. 82. Tab. XLIX. fig. 183, ascus with sporidia, and free sporidia, × 325. Sporidia uniseriate, colourless, elliptical, pseudo-uniseptate by division of the endochrome, which is oleaginous or granular; 0·0005 inch long.

185. Sphæria acervata, Fr. S. M. ii. p. 416. Tab. XLIX. figs. 184, 185, ascus with sporidia, and free sporidia, × 325. Sporidia biseriate, colourless, hyaline, curved, 0·0003 to 0·0005 inch long. Very like (? different from) *S. cupularis*. Mr. Bloxam informs me that he has sometimes found the sporidia elliptical, uniseptate, or with several nuclei.

186. Sphæria conglobata, Fr. The Hookerian herbarium contains several plants marked *S. conglobata*, Fr.; but they are all specimens of *S. pulvis-pyrius*, some being subcuticular, some bursting transversely, some longitudinally, others forming a cæspitose mass, others in the usual scattered condition. They form a very instructive series of specimens, showing the Protean habit of *S. pulvis-pyrius*. The specimen of *S. dioica*, Fr., at Kew, is also a subcuticular form of *S. pulvis-pyrius*, a form by no means uncommon in this country.

187. S. Buxi. Milton, Northamptonshire, *Berkeley*. Tab. XLIX. fig. 186, ascus with sporidia, highly magnified. Sporidia uniseriate, ? colourless, acuminate, elliptical, 0·0005 inch long. Perithecia light yellow, rather longer than broad, with a small mamillate ostiolum. I doubt if the sporidia are not sometimes uniseptate. The fruit was hardly ripe, although a good many sporidia were visible.

Div. 14. Confluentes.

188. Sphæria scoriadea, Fr. El. ii. p. 87. Tab. XLIX. fig. 187, sporidia, × 325. Sporidia reddish brown, opaque, lageniform, when young with a gelatinous envelope. The tips of the sporidia are paler than the body; they are irregular in length and breadth, varying from 0·0016 to 0·0028 inch in length. There is some doubt whether this plant be not a *Verrucaria*. See Annals of Nat. Hist. vol. vi. p. 360, and Leighton's 'British Angiocarpous Lichens,' p. 39, under "*Verrucaria conferta*, Tayl."

189. Sphæria rhizogena, Berk. Tab. XLIX. fig. 190, ascus with sporidia, × 325. Sporidia uniseriate, rarely biseriate, colourless or greenish, probably brown when ripe; elliptical, sometimes slightly constricted in the middle, uniseptate or biseptate or (?) sometimes cellular, 0·0005 to 0·0006 inch long. On the roots of *Gleditschia triacanthos*, washed bare by the Ohio freshets. Perithecia seated on or immersed in a ferruginous woody or leathery stroma, producing, when young, very minute subcylindrical spermatia.

190. Sphæria Spartii, Nees; Fr. S. M. ii. p. 424. Tab. XLIX. fig. 189, ascus with sporidia, × 325. Sporidia uniseriate, frequently (if not usually) slightly overlapping, dark brown, cellular, acuminate, constricted in the middle, 0·0011 to 0·0012 inch long. This species = *S. elongata*, Fr.

191. Sphæria ? Dothidea, Fr. (? Mont.), S. M. ii. p. 423. Tab. XLIX. fig. 190, ascus

with sporidia, × 325. Sporidia crowded, colourless, broadly almond-shaped, 0·0007 to 0·0009 inch long.

192. SPHÆRIA MUTILA, Fr. S. M. ii. p. 424. TAB. XLIX. fig. 191, sporidia, × 325. Sporidia crowded, colourless, but with a greenish tinge; endochrome divided transversely, and frequently also longitudinally; sporidia irregular in shape, variable, 0·0008 to 0·0012 inch in length.

193. SPHÆRIA MEGALOSPORA, Mont. Sylloge, p. 229. TAB. XLIX. fig. 192, ascus with sporidia, × 225. Sporidia uniseriate, rich dark brown, obtusely elliptical, constricted in the middle, frequently slightly curved, 0·0016 inch long.

194. SPHÆRIA INSIDENS, Schw.? TAB. XLIX. fig. 193, sporidia highly magnified. I could find no asci. Sporidia pale clear brown, irregularly elliptical or subturbinate, 0·0003 inch long, or rather less; on rough corky elm-bark, blackening the furrows with its small perithecia.

195. SPHÆRIA MELOGRAMMA, Pers.; Fr. S. M. ii. p. 420. TAB. XLIX. fig. 194, sporidia, × 450. Sporidia biseriate, arcuate, acuminate at both ends, triseptate, pale greenish brown, probably ultimately clear dark brown, 0·0014 to 0·002 inch long.

196. SPHÆRIA CALYCANTHI, Fr. (sed qu. Schwein.), S. M. ii. p. 421. TAB. XLIX. fig. 195, ascus with sporidia, × 325. Sporidia crowded, colourless, hyaline, with one or many nuclei, or none; broadly almond-shaped, 0·0008 to 0·0011 inch long.

197. S. (DIATRYPE) DECIPIENS, Dec.; Fr. S. M. ii. p. 371. TAB. XLIX. fig. 196, sporidia highly magnified. I could find no asci. Sporidia elliptical, varying much in length and breadth, sometimes slightly curved, rather dark brown, 0·0003 inch long, crowded. Ostiola stellate, just as in *S. stellulata.*

198. S. (DIPLODIA) SUBSOLITARIA, Schwein.; Fr. El. ii. p. 86. TAB. XLIX. fig. 198, sporidia, × 325. This plant might be placed in the genus *Diplodia*, the sporidia being borne on sterigmata, not produced in asci. Sporidia of a clear brown colour, irregularly elliptical or subpyriform, pseudo-uniseptate from the division of the endochrome.

198 *a*. SPHÆRIA CHRYSENTERA, n. s. Perithecia rounded, without any neck, crowded, situated underneath the outer bark, which is thrown off sometimes irregularly, sometimes in rings. Contents of the perithecia yellow. Sporidia biseriate, bright yellow when young, then a pale clear light brown, eventually darker brown; irregular in shape, usually somewhat acuminate at each end, always constricted in the middle, the outline sometimes wavy, not (I think) septate, although the endochrome is always divided into two distinct portions, frequently into four, and occasionally into three. Length of sporidia, 0·0008 to 0·0009 inch. Weybridge, September 1856. Easily known by the bright yellow colour of the contents of the perithecia, and by its peculiar fruit. The perithecia are sometimes seated on a byssoid subiculum, which made me doubt to which division it should be referred.

Div. 15. SERIATÆ.

199. S. JUNCI, Fr. TAB. XLIX. fig. 199, sporidia, × 325. Sporidia biseriate, yellowish-brown, linear-acuminate, 3-septate, 0·0012 inch long, hardly distinguishable from the

fruit of *S. arundinacea*. *S. Junci* is placed, in the 'Summa Veg. Sc.,' after *Dothidea*, with the remark "Incerti generis, priori affinis."

200. SPHÆRIA ARUNDINACEA, Sow. TAB. XLIX. fig. 200, sporidia, × 325. Sporidia biseriate, yellowish-brown, linear, acuminate at one or both ends, 3–5-septate, 0·0010 to 0·0016 inch long.

201. SPHÆRIA NEBULOSA, Pers.; Fr. S. M. ii. p. 430. TAB. XLIX. fig. 201, ascus with sporidia, × 325. Sporidia biseriate, colourless, subacuminate, straight or slightly curved, uniseptate, 0·0003 to 0·0005 inch long.

202. SPHÆRIA GODINI, Desm. TAB. XLIX. fig. 202, ascus with sporidia, × 325. Sporidia biseriate, linear-acuminate, uniseptate, colourless, 0·0010 to 0·0012 inch long. Messrs. Berkeley and Broome state (Ann. Nat. Hist. s. 2. vol. vii. p. 137) that this species is identical with *S. arundinacea*, Sow.; but in the Kew specimens the species differ in the colour of the sporidia, and in the number of the septa. This, however, would not prove them distinct, as the number of septa varies in many species, and sporidia which are colourless when young frequently become brown in age.

203. SPHÆRIA CLARA, n. s. TAB. XLIX. fig. 203, ascus with sporidia, × 325. Sporidia biseriate, colourless, subfusiform, 4-nucleate, sometimes also with some smaller nuclei; slightly constricted in the middle, 0·0010 to 0·0012 inch long. On some reed. This fruit is described from a specimen which I had in my own herbarium, but which I have mislaid. The species is not in the Hookerian herbarium.

204. S. PARDALOTA, Mont. This plant produced only colourless, rather narrowly elliptical stylospores 0·0002 to 0·0004 inch long. The true sporidia are described as cymbiform and biseptate. See Mont. Syll. p. 235.

205. SPHÆRIA? PANTHERINA, Berk. The specimen of this plant produced no asci, but fusiform stylospores 0·0008 to 0·001 inch long, and extremely narrow.

206. SPHÆRIA LONGISSIMA, Pers. This species forms long dark spots studded with the perithecia. The specimens at Kew are imperfect; but in two of the perithecia I observed elliptical or slightly curved bodies with two nuclei, and sometimes with a septum in the middle, greenish or yellowish in colour, 0·0004 to 0·0006 inch long and about half as wide; but whether true fruit or not, I cannot say. I have seen no other specimens.

Div. 16. CONFERTÆ.

207. SPHÆRIA BIFRONS, Schm. and Kunze; Fr. S. M. ii. p. 438. TAB. XLIX. fig. 204, ascus with sporidia, and free sporidia, × 325. Sporidia biseriate, colourless, curved, 0·0005 inch long.

207 *a*. SPHÆRIA GRAMINIS, Pers.; Fr. S. M. ii. p. 434. TAB. XLIX. fig. 211, asci with sporidia, and free sporidia, × 450. Sporidia colourless, broadly elliptical, frequently with a single large globose nucleus.

208. S. (DIPLODIA?) MALORUM, Berk. Engl. Flora, vol. v., "Fungi," p. 257. TAB. XLIX. fig. 205, stylospores, × 325. Stylospores greenish, margined; contents granular; 0·0012 inch long.

209. S. GIGANTEA, Mont. Syll. 230. TAB. XLIX. figs. 206 and 207, ascus with sporidia,

and free sporidia, × 325. Sporidia usually biseriate, but sometimes uniseriate, dark brown, multiseptate (always, I think, 7-septate), and also divided longitudinally in each division except the two end ones; curved, cymbiform, surrounded by a gelatinous envelope not perceptible in the ascus, at least in the Kew specimens; 0·0018 inch long. On *Agave*. A large, black, subhemispherical mass ½ inch and more wide. The fruit is very striking.

210. S. (Hendersonia?) Yuccæ-gloriosæ, Schwein.; Fr. S. M. ii. p. 437. Tab. XLIX. fig. 208, stylospores, × 350. Stylospores colourless, linear, 0·0010 to 0·0018 inch long. Not a true *Sphæria*, or, if so, only in a secondary state of fructification.

211. Sphæria rhytismoides, Bab. in Proc. Linn. Soc. vol. i. p. 32. Tab. XLIX. fig. 209, ascus with sporidia, × 325. Sporidia crowded, colourless, hyaline, obtuse, 0·0005 inch long.

212. S. (Diatrype?) insularis, Berk. MSS. Tab. XLIX. fig. 210, ascus with sporidia, and free sporidia, × 325. Sporidia biseriate, colourless; narrowly almond-shaped, or flat on one side; 0·0005 inch long. Placed in the Herbarium with the Confertæ, but belonging, I think, to the Lignosæ. The black line is very distinct. On *Aucuba Japonica*. The endochrome is sometimes 1-, 2-, or 4-partite. It is, I think, very common on *Aucuba Japonica*, but has not, as far as I am aware, been described, unless, as Mr. Berkeley has suggested to me, it may be *S. controversa*, Desm.

213. Sphæria fimbriata, Pers. Syn. p. 36; Fr. S. M. ii. p. 436. The sporidia are, I believe, colourless and curved, similar to those of *Valsa ambiens*. Fig. 212 represents asci and sporidia, × 225; but the specimens are not quite ripe.

214. Sphæria ceuthocarpa, Fr. S. M. ii. p. 439. Tab. XLIX. fig. 213, ascus with sporidia, and a free sporidium, × 425. Sporidia lying side by side, extending in length all along the ascus, colourless, divided by numerous septa, which are not always visible except under a high power.

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[*The figures refer to the numbers affixed to each Plant, and not to the pages.*]

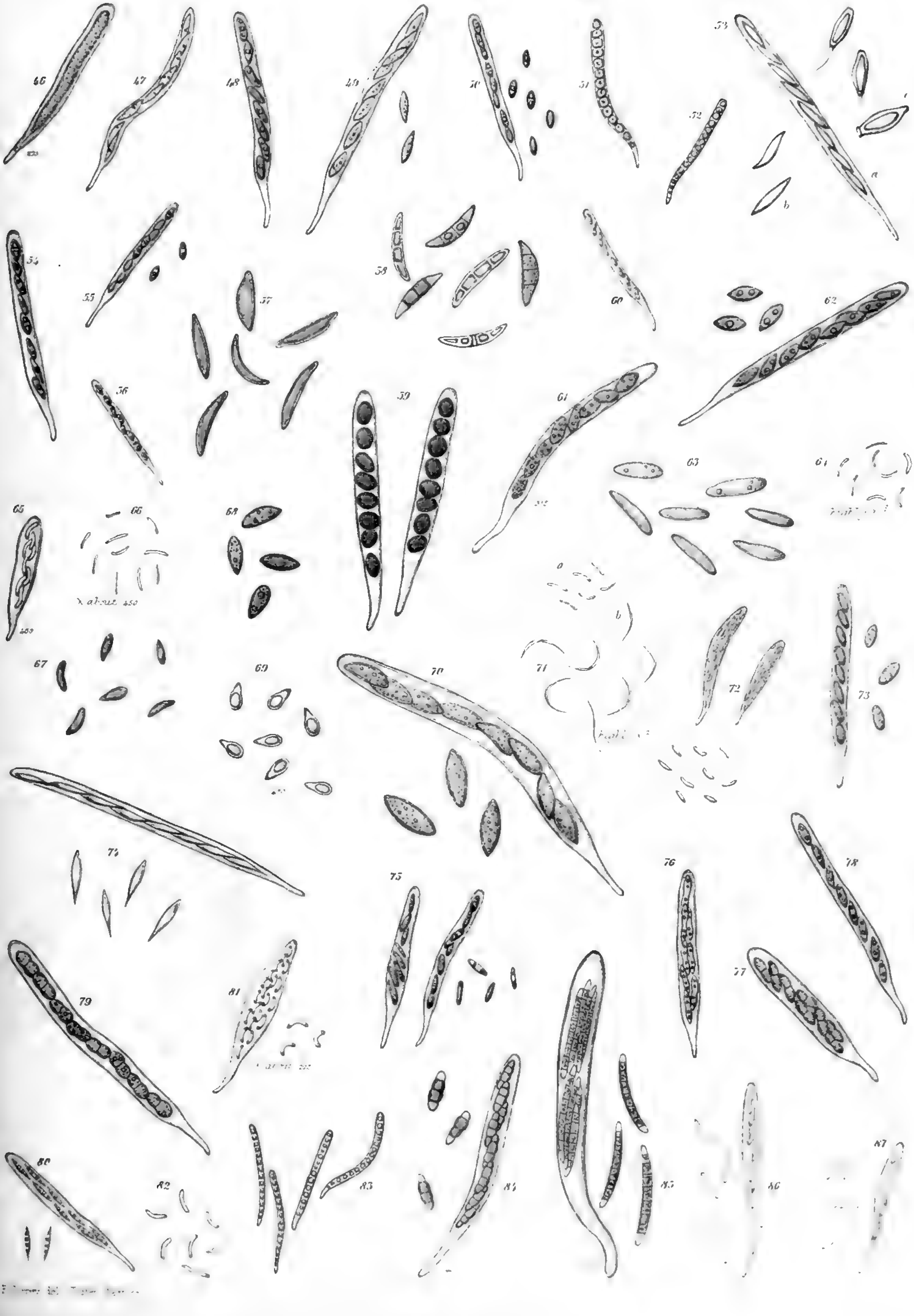
GEN. SPHÆRIA

(Figs 1 to 45

F Currey del   Tuffen West sc

All the figures magnified 325 Diameters, except where otherwise stated

GEN SPHÆRIA
(Figs 46 to 87)



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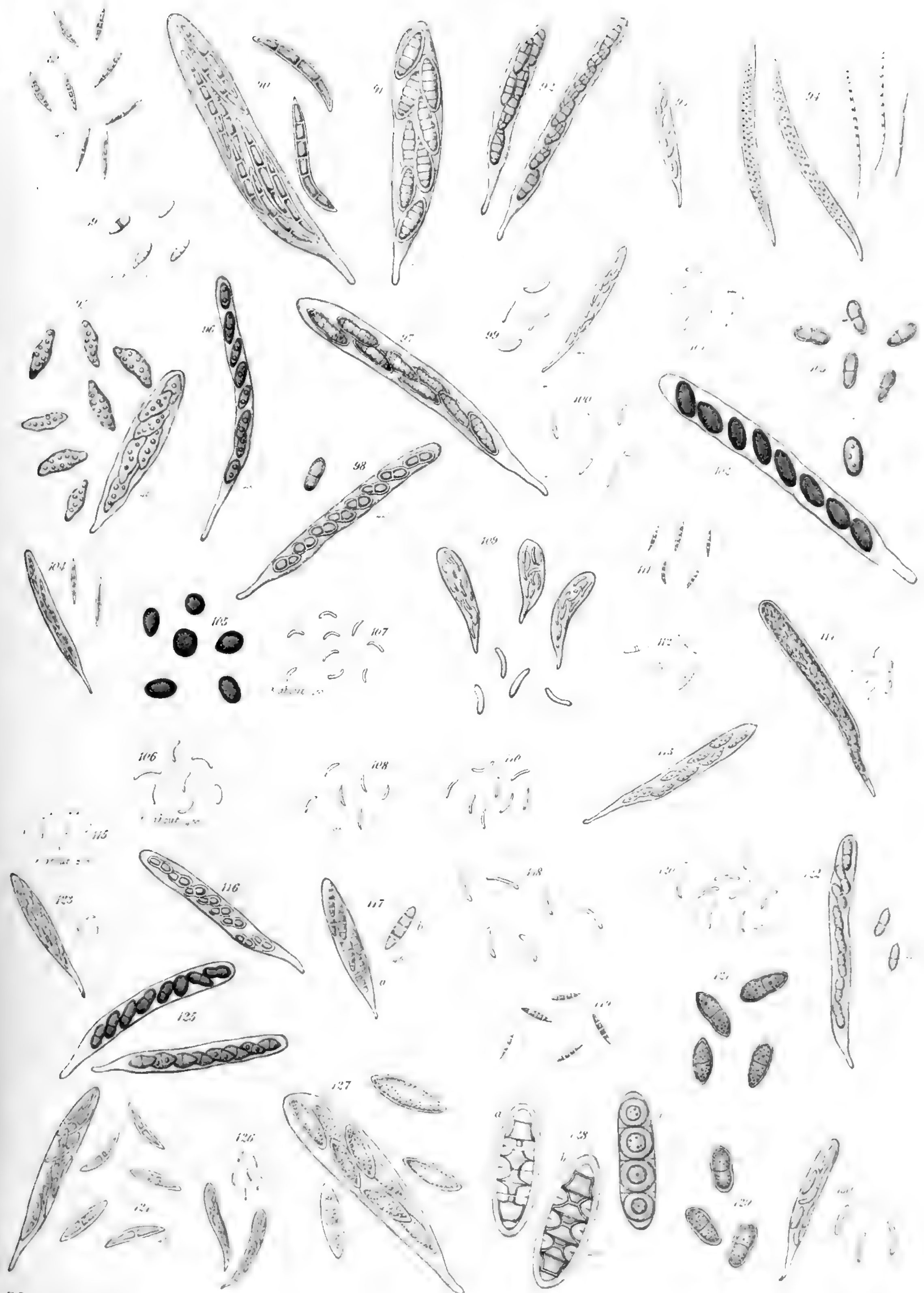

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GEN. SPHÆRIA

Figs 172 to 213

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M.DCCC.LIX.

XXI. *Observations on the Structure of the Stem in certain Species of the Natural Orders* Caryophylleæ *and* Plumbagineæ. *By* DANIEL OLIVER, Jun., *F.L.S.*

Read December 10th, 1858.

CARYOPHYLLEÆ.

THE internal structure of the stem in certain suffruticose species of the genus *Acanthophyllum* presents some interesting anomalies which appear to me to be undescribed. I venture, therefore, to communicate to the Linnean Society this brief memorandum, as a further contribution to an already accumulated store of material in our possession relating to what we are accustomed to regard as abnormal modes of arrangement in the elements of Dicotyledonous wood, furnished to us by species often widely removed in the order of their natural affinities. The time may not be distant when a careful correlation of all our facts may be seasonable, and likely to render good service, not only to systematic botany, but also in enabling us to attain to a more comprehensive perception of vegetable structure generally. At the present time, how isolated, as well as fragmentary, are the items of our knowledge upon this subject!

The points of peculiarity in the species of *Acanthophyllum* to which I wish to direct attention at this time are—1st, the general relative arrangement of the vascular and cellular tissues or 'systems' of the stem; 2nd, the histological character of some of these tissues; and 3rd, the occurrence in remarkable abundance, in some species, of frequently large concretions of oxalate of lime in the parenchyma of the stem. To the difficult and time-absorbing study of the relations subsisting between the vascular bundles and the leaves, scapes, adventitious roots, or other axial appendages, I cannot at present address myself. Their connexion, so obscure and imperfectly understood even in succulent plants with lengthened internodes, is much complicated by a dense habit and dividing woody stem, apart from the difficulties attending the examination of specimens which have been dried many years. In regard, however, to this point, I may say that I am quite unable to attribute the differences in internal structure, presented by the different species, to a varied disposal of lateral organs; the mode of arrangement of the leaves is, upon the whole, very uniform in the plants which I have had through my hands.

In this notice, I speak of the perennial, leaf-bearing, woody, and frequently branching axis of the genera *Acanthophyllum*, *Arenaria*, and *Dianthus*, as the stem: in the present terminology of these parts, there is, by the way, I think, somewhat of a vagueness and laxity, which, without multiplying technicalities, or further burdening our glossaries, might be removed.

With regard to the arrangement of the tissues of the stem:—In some of the species of *Acanthophyllum*, as also in *Dianthus* and *Arenaria*, a manifest, though often very excentric pith occurs; in the first-named genus, however, often deranged, as are also the woody bundles to a great extent, by radial processes of cellular tissue, which may, in some cases, be regarded as projections from the medulla, probably in connexion with lateral organs; in others, as induplications of the cortical parenchyma. In *Acanthophyllum spinosum* it is often impossible, from the excessively dislocated character of the vascular bundles, to determine satisfactorily a true pith. In this species, the entire stem, almost to the young and leafy annual shoots, is partitioned into numerous vascular masses by tortuous intruded plates of cellular tissue, presenting at first sight, in a transverse section, a striking similarity to the irregular structure of some species of *Combretaceæ*, *Malpighiaceæ*, or *Bauhiniæ*. The sole relation of the parts in these stems to a common centre is indicated more or less distinctly by some of the peripheral vascular bundles, which are laterally bounded and separated by lines of cellular tissue exhibiting a radial disposition. If we trace the structure by transverse sections from the young and yet green shoots, internode by internode downwards, we may observe the rapid accession of an irregular relative arrangement of the parenchyma and vascular tissues of the stem. Some of these changes are sketched in their consecutive order under fig. 3 (Pl. L.); figs. 4, 5, 6 and 7 represent also this curious and complicated structure. In the very young internodes the pith is found to be much elongated transversely, extending nearly or quite through the vascular zone, as shown by fig. 2. When dividing the wood entirely, as in fig. 4, the narrow ring of small and delicate cells, which in fig. 2 is represented as a normal 'cambium' zone surrounding the wood, penetrates the fissure and encloses separately the divided portions. Whatever may be the first determining cause of a deviation from the usual structure in this species, it is, I consider, obviously to the penetration of this belt of young and active cells that the subsequent and anomalous arrangement of the wood is due. These cells are doubtless capable of continuing the process of division and growth as under the ordinary conditions of the 'cambium' layer, though probably to a limited extent. It may be observed, that in the very young shoots the direction of the transverse elongation of the pith may be found to alter materially from one internode to another. (See reference to fig. 3.)

The surrounding, intropenetrating 'cambium zone' is more or less apparent, not only in the earlier shoots, but also in portions of the stem which exhibit a highly distorted vascular system. In *Acanthophyllum* (Griffith's Affghan Coll. no. 1562) the dislocation of the wood is by no means so marked as in *A. spinosum*, yet in this plant broad wedges of parenchyma are found to divide the vascular tissues into most unsymmetrical sectors, and sometimes extend quite across them. In *A. laxiflorum* these invasions are accompanied even to the apparent pith by cells containing the highly-coloured contents characteristic of the outer cortical layers. How far these wedges of cellular tissue may physiologically replace the medullary rays of Exogens generally, it would be interesting to inquire. Singularly enough, although it was probably in *Acanthophyllum* (Gr. no. 1562) that an irregular structure first caught my attention, I did not note or appreciate the absence in it of true medullary rays until my attention was called to it by Prof. Griesebach, to whom I showed a section. Their non-occurrence is an important circumstance, and may be a key to a better understanding of the physiology of the 'systems,' so called, of exogenous stems. Their absence I have since determined in other species of *Acantho-*

phyllum, in *Dianthus* (*D. hispanicus*) and *Arenaria* (*A. laricifolia*), as also in *Armeria* in *Plumbagineæ*. Schacht* records their absence in the 'rhizome' of *Viola* (*V. mirabilis* and *odorata*), and A. Brongniart in certain *Crassulaceæ*†. It is probable that a wood destitute of these processes may prevail through other natural orders in which a similar perennial, depressed axis is found.

In very young internodes of *Acanthophyllum spinosum*, and in the stem of *Acanthophyllum* (Gr. no. 1562), more or less regular concentric zones are apparent in the woody mass. These vary in number and width. I am unable to satisfy myself entirely as to the occasion of these alternating zones. They may, in these species, result, as might be expected, from the annual alternation of seasons; but upon this head further evidence is required. In the younger branchlets of *A. spinosum* they are often distinctly perceptible; in the older portions, from the advanced distortion of the tissues, they are nearly or quite lost.

The change, from whatever cause it may result, in the character of the vascular bundles which gives rise to these concentric rings, is of much interest, and I think important to the phytotomist. I feel tolerably satisfied that in *Acanthophyllum* (Gr. no. 1562) and *A. spinosum*, the vascular mass, which consists in great measure of very numerous 'slit-marked'‡ vessels of various calibre, traversing a prosenchymatous tissue, is interrupted by the formation of narrow annular belts of *spiral* vessels of small diameter repeated at definite (?) intervals, and that, in the young shoots of *A. spinosum* at least, the concentric zoning is due to these. In *Acanthophyllum* (Gr. no. 1562) numerous cords of a thick-walled prosenchyma occur along with the vessels, and these probably assist in determining the annular formations: in *A. spinosum* I have not observed any of the tissue to become thus thickened. This recurring deposition of spiral vessels is, I believe, a repetition periodically of that ring in which they occur, and which is so generally recognizable, in Dicotyledons, immediately, and only, around the pith, and which, from the peculiar character which the presence of these vessels confers, is usually distinguished by the special term 'medullary sheath.' It remains yet to be ascertained, and I have not leisure to follow up the investigation myself except to the neglect of other studies, whether an annular formation of spirals thus repeated is common to all species destitute of medullary rays. The inquiry is an important one, and doubtless of physiological value. In the older stems of *A. spinosum*, in which no concentric disposition of the elements of the vascular masses is apparent, I should observe that the spirals seem to be almost indiscriminately scattered amongst the wider and 'slit-marked' vessels. In the other species of *Acanthophyllum* examined, and in *Arenaria laricifolia*, I am not sure that true spirals recur in the wood, in the manner described; nor am I quite clear that they do so in *Dianthus*.

In the case of *Acanthophyllum* (Gr. no. 1562), allusion has been made to the presence of cords of much-thickened prosenchymatous cells, which traverse, with the vessels, the thinner tissues of the woody masses. In this plant these thickened cords are, I think,

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* 'Die Pflanzenzelle,' p. 280.

† Arch. Mus. i. 437 (Lindl. V. K. p. 344).

‡ I use the term 'slit-marked' as best expressing the form presented by their pits, which are transversely more or less lengthened.

sometimes considerably larger than I have represented in fig. 13. This remarkable thickening of the prosenchyma attains a maximum, however, in *Acanthophyllum* (Gr. no. 1570), in which its extensive development is the conspicuous feature of the wood. Here it is not disposed in cords or isolated masses, but is nearly continuous through each annular zone, although with many sinuosities in its cross section, traversed by the vessels, which are not very numerous, and chiefly confined to the inner portion of the rings, here and there a few of them being radially approximated. The thinner tissue which separates these annular zones is extremely narrow, and with difficulty resolvable from its ready rupture in cutting the adjacent cells, the cavities of which are nearly obliterated by secondary hardened deposits. In *A. laxiflorum* the arrangement of the thick-walled tissue is perhaps yet more curious. It is here remarkably dense, and is disposed, not in continuous belts, but in large cords, which are singularly lobed and divided in their horizontal section. The tissue filling up their winding interstices is almost entirely made up of 'slit-marked' vessels often of conspicuous diameter. The vertical continuity of these vessels through so dense a prosenchyma is interesting and readily observable in a thin longitudinal slice, the transverse septa of the cells of which they were originally constituted frequently remaining quite distinct. The irregular form of these masses does not interfere with the regular arrangement of the annular zones within which they are confined.

In respect to this thick-walled tissue, it will be apparent, from what has been stated, that *Acanthophyllum* (Gr. no. 1562), *A. laxiflorum*, and *Acanthophyllum* (Gr. no. 1570), exhibit their development in a sort of graduated series, while in *A. spinosum* they are, so far as I have observed, totally absent. The singular prevalence in some of the species of *Acanthophyllum* of an unusually large deposition of crystals of oxalate of lime is an additional item of interest worthy of remark. I am indebted to my kind friend Daniel Hanbury for the accurate determination of these crystalline concretions from, I think, *Acanthophyllum* (Gr. no. 1562). They occur abundantly scattered through the parenchyma of the stem, both in the inner cortical layers and its inversions, the irregular cellular plates which radially traverse the wood, and also in the pith.

In *Acanthophyllum spinosum* they are small, and do not probably much increase beyond the boundary of the cell in which they originate. They are very numerous, accompanying the parenchyma in its twistings through the stem-structure,—in the vertically elongated cellular tissue being often also lengthened, or rod-like. In *Acanthophyllum* (Gr. no. 1570) they are comparatively few, but chiefly very large, without doubt obliterating several cells in their increase. The concretions of *Acanthophyllum* (1562) are very variable in size and extremely numerous,—the parenchyma, laid bare by removal of the outer cortical layers, being quite gritty from their presence.

PLUMBAGINEÆ.

The stems of *Armeria maritima*, *Acantholimon diapensioides*, and, I think also, *Statice arborea*, present a wood destitute of medullary rays. Parenchymatous processes which may be accompanied by a few vessels are found very irregularly traversing the vascular bundles radially, from three or four of them to a considerable number sometimes occurring in one horizontal plane. These processes, which I consider to be in connexion often, if not at all times, with the lateral appendages of the stem, are frequently in *Armeria maritima* of considerable width, and distort the generally more or less central and readily recognizable pith materially. In the laxer parenchyma of the medulla of this plant individual cells of very irregular form are found. In *Statice arborea*, the pith, the cells of which are marked by transversely lengthened pits, is vertically traversed by cords of a rather thick-walled elongated tissue. In *Acantholimon diapensioides* the rather compact woody mass is singularly lobed in some older stems, as represented in fig. 61, cortical inversions penetrating almost to the centre; in *Acantholimon* (sp. *A. tomentello* affinis, Gr. no. 1589) and *Acantholimon* (no. 1579), also, the wood is more or less dislocated by parenchymatous radial plates or cords; in the latter species these processes contain many much-thickened apparently 'sclerogen' cells. The older wood in various species which I have examined presents more or less of a tolerably thick-walled prosenchyma. In *Acantholimon* (No. 1589) this tissue occurs in irregular dense masses, which exhibit a manifest disposition in concentric belts, as also a decided radial arrangement, as represented by fig. 24 (Pl. LI.). The tissue intervening between the conspicuous cords abounds in vessels of considerable diameter, which, as in the other species examined, present 'slit-marked' walls similar to those observed in *Caryophylleæ*, &c.

Perhaps the most interesting point in the histology of the wood of these plants is the occurrence of minute, apparently intercellular cavities in the tissue traversed by the vessels in *Statice arborea* and *Acantholimon diapensioides.* In the latter species I have more minutely examined these. In this species the cells of the wood in which the small and rather sparingly distributed vessels are immersed, are elongated, presenting a reticulated or spiral arrangement of their secondary deposits; it is between these cells, or between them and the vessels, that the very minute slit-like spaces are visible, in a sufficiently thin section of the wood, when examined with a magnifying power of 300 or 400 diameters. On the nature of these interspaces I scarcely feel myself competent to offer a positive opinion, believing it possible that the eyes of a more experienced phytotomist might differently interpret it. I regard them as either very minute intercellular cavities, corresponding in some measure to those of *Coniferæ*; or as the much-widened blind extremities of the pore-canals which traverse the thickening layers of the enclosing cells,—the primary cell-walls between each pair of opposing canals becoming absorbed.

Note.—The specimens belonging to the genera *Acanthophyllum* (Caryophylleæ) and *Acantholimon* (Plumbagineæ) which I have examined, have been derived from Griffith's extensive Affghan collections. The names of those which have been clearly determined I have obtained from the Hookerian Herbarium, in which some of the species have been examined and labelled by Boissier.

To my friend Thos. Atthey, of Cramlington, Northumberland, I desire to acknowledge myself much indebted for a valuable series of sections illustrative of these structures, which he kindly prepared for the microscope at my request.

EXPLANATION OF THE PLATES.

Tab. L.

Acanthophyllum spinosum, C. A. M.

Fig. 1. Portion of a young leafy shoot.

Fig. 2. Transverse section from a young internode: *a.* cortical parenchyma; *b.* zone of small and delicate cells (cambium region); *c.* wood which abounds in vessels of various calibre; *d.* transversely lengthened pith-cavity, the cells partly obliterated.

Fig. 3. *a.* From a young internode; *b.* from the next below; *c.* from the third—the dividing fissure has changed to an opposite direction; *d.* traces of further lobing become apparent; *e.* about $\frac{1}{10}$th of an inch lower; *f.* point from which a branchlet is given off.

Fig. 4. Semi-diagrammatic section from a young shoot of the same, showing the division of the woody mass, and a 'generative zone' surrounding each portion.

Fig. 5. Transverse section from lower portion of twig, fig. 1.

Figs. 6 & 7. Sections from older stems.

Fig. 8. Semi-diagrammatic and enlarged; the vessels often cut the horizontal plane obliquely.

Fig. 9. Vertical section showing the vessels obliquely traversing the thin-walled tissue forming the mass of the older stems.

Fig. 10. Diagram from one of the upper branchlets of the twig, fig. 1. In the wood, which is very full of vessels—more so, I think, than I have represented—four nearly equal zones are to be counted; through these the vessels are irregularly distributed. The zones are separated by lines of very narrow vessels, which, according to my observations, are true spirals.

Acanthophyllum (sp. dub., Griffith's Affghan Coll. no. 1562).

Fig. 11. Thin sections, successively removed from an older stem.

Fig. 12. Transverse section enlarged: *a.* cortical parenchyma, with numerous concretions of oxalate of lime.

Fig. 13. Portion more highly magnified, with cords of thickened prosenchyma.

Figs. 14 & 15. Vertical sections showing 'slit-marked' and spiral vessels with prosenchyma.

Fig. 16. Pith, with oxalate of lime.

Fig. 17. Tangential section dividing a radial parenchymatous cord.

Tab. LI.

Acanthophyllum laxiflorum, Boiss.

Fig. 18. Transverse and, fig. 19, vertical sections of the stem.

Acanthophyllum (sp. dub., Griffith's Affghan Coll. no. 1570).

Fig. 20. Transverse section. Fig. 21. Same more highly magnified.

Acantholimon diapensioides, Boiss.

Fig. 22. Transverse section. Fig. 23. Same enlarged.

Acantholimon (sp. *A. tomentello* aff.).

Fig. 24. Transverse and, fig. 25, vertical sections of portions of the stem.

Armeria maritima, Willd.

Fig. 26. Transverse section from lower portion of the stem (passing into the root?). Fig. 27. From about $\frac{1}{4}$th of an inch higher up. Fig. 28. Section showing numerous radial processes in the same plane.

Fig. 29. Magnified transverse section showing the distribution of the vessels and cords of thick-walled prosenchyma.

Fig. 30. Tangential section dividing a radial cord.

Fig. 31. Isolated cells from the pith.

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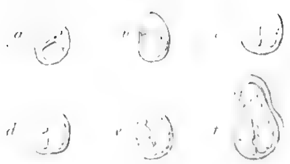

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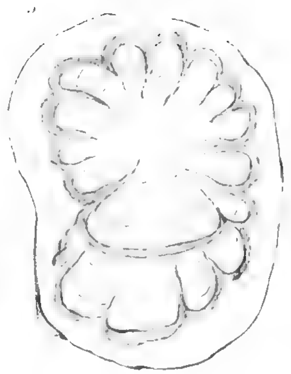

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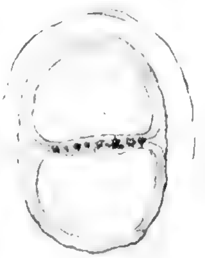

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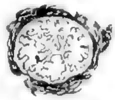

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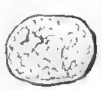

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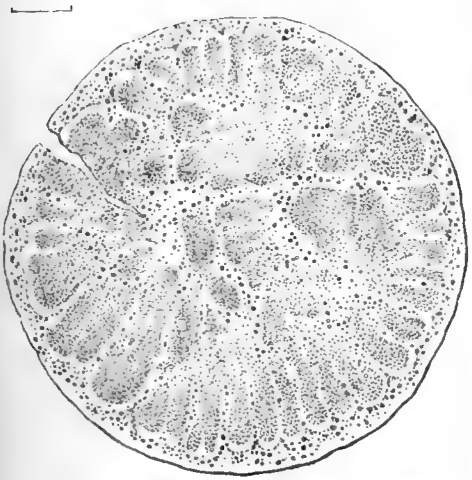

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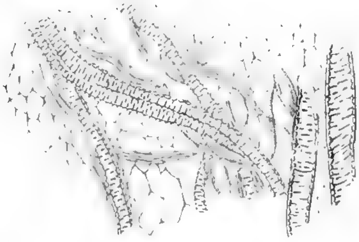

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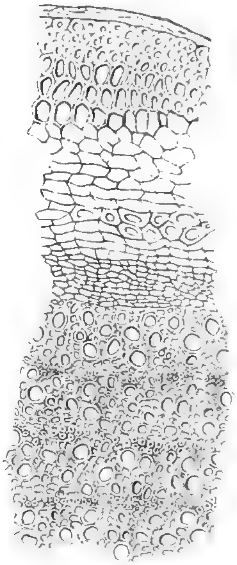

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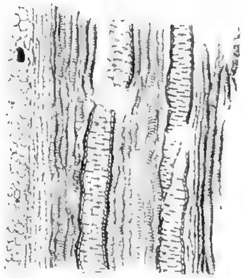

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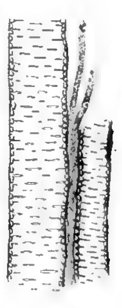

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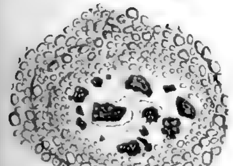

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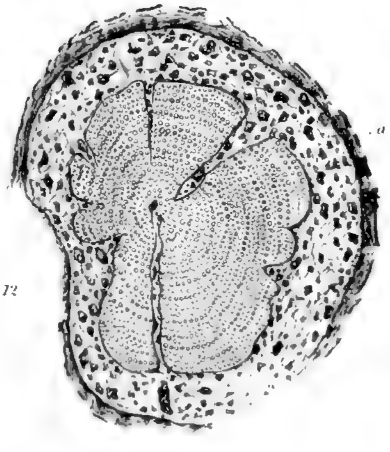

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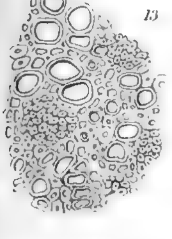

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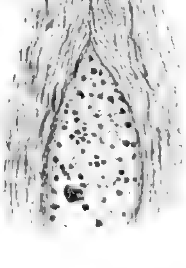

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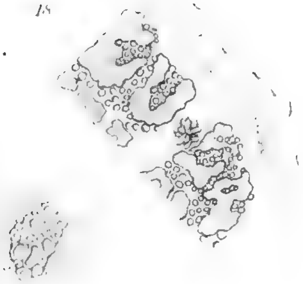

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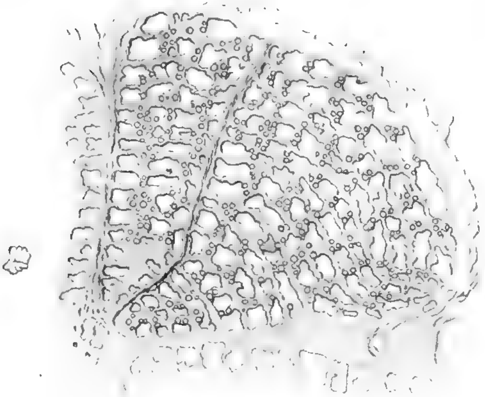

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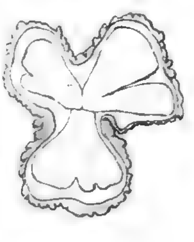

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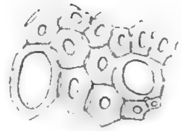

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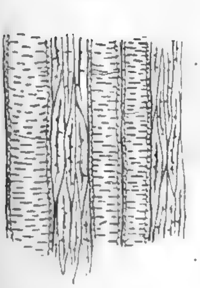

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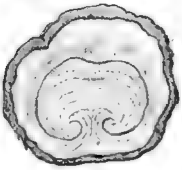

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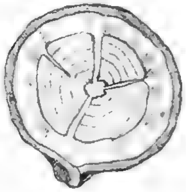

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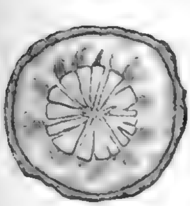

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XXII. *On the genus* Henriquezia *of Spruce.* *By* GEORGE BENTHAM, *Esq.*, *V.P.L.S.*

Read February 3rd, 1859.

THIS genus is one of the many interesting new ones discovered by Mr. Spruce in Northern Brazil and Venezuela. Some years since, I published the first species received from him, in the 6th vol. of Sir W. Hooker's Kew Journal of Botany; but at that time the fruit was not known. Since then Mr. Spruce has transmitted fine flowering specimens of a second species, and fruits of two more, which, from their foliage, appear to be distinct from the flowering ones. I am thus enabled to complete the generic character, and to lay before the Society the accompanying illustrations from the artistic and accurate pencil of Mr. Fitch.

It will be observed that these trees have stipules, an inferior ovary, and five perfect, nearly equal stamens; and yet they undoubtedly belong to the family of *Bignoniaceæ*. The affinity which I formerly alluded to, with *Platycarpum* of Humboldt and Bonpland, is fully confirmed by these specimens, as well as by one or two fruiting specimens of the true *Platycarpum* gathered on the Orenoco by Mr. Spruce, which show that that genus also has stipules, although, as in the first-received specimens of *Henriquezia*, they had not been observed, being very deciduous. In *Platycarpum* the ovary is figured as superior. I have not seen the flowers; but on the fruit there is an external scar at the base, which shows that there had been a partial adherence to the calyx. In *Henriquezia* the ovary at the time of flowering is entirely below the adherent part of the calyx. After fecundation it gradually emerges, and the ripe fruit shows about its centre a transverse convex line or scar left by the free part of the calyx on falling off. The fruit is nearly flat and hard as in *Platycarpum*, but much larger and more woody; and instead of opening out vertically in four valves which remain attached by the central line formed by the axial entire dissepiment, it opens horizontally to a little below the middle in two entire valves, down the centre of each of which, in the inside, is a raised line, being the remains of the dissepiment. In each cell are four large flat seeds, remarkable, at least in Mr. Spruce's specimens, for their tendency to germinate whilst the capsule is yet attached to the tree,—the radicle lengthening out, twisting round the seeds, and forming a kind of network, the origin of which was very puzzling till I had carefully soaked the seeds and traced it out.

The genus, as I stated in the above-mentioned article, was dedicated by Mr. Spruce to Senhor Henriquez Antonij, a native of Leghorn, but for more than thirty years settled at the Barra do Rio Negro, where he has constantly rendered every assistance to scientific and other travellers during that period. The species are all described as trees of great beauty, and some of them of considerable size. The following are the technical characters:—

HENRIQUEZIA, Spruce. Benth. in Hook. Kew Journ. Bot. vol. vi. p. 338.

(Genus e familia Bignoniacearum.)

Calyx basi turbinatus ovario adhærens, limbo supero, 4-fido v. 4-partito, circumscisse deciduo. *Corolla* oblique infundibularis, fauce ampla, limbo 5-lobo, laciniis subæqualibus, æstivatione bilabiata. *Stamina* 5, corolla breviora, 2 inferiora cæteris paullo breviora; antheræ subæquales, lineari-oblongæ, omnes fertiles. *Ovarium* per anthesin inferum, disco carnoso breviter cupulato v. annulato coronatum, biloculare, post anthesin semisuperum. *Ovula* in quoque loculo 4, axi collateraliter affixa, horizontalia v. subadscendentia. *Stylus* filiformis, apice bilobus, lobis seu lamellis lineari-oblongis, complanatis, intus stigmatosis, mox revolutis. *Legumen* compressum, lignosum, bivalve, valvulis integris, dissepimento lineari valvis contrario, maturitate diviso. *Semina* in quoque loculo 4, magna, plano-compressa, hilo lineari affixa. *Testa* tenuis, laxiuscula. *Cotyledones* subcarnosæ, basi profunde bilobæ.

Arbores Brasiliæ borealis et Venezuelæ. *Folia* 3–5-natim verticillata, coriacea, integerrima, pennivenia. *Stipulæ* lineares v. lanceolatæ, rigidæ, caducæ. *Flores* speciosi, in paniculas densas terminales dispositi.

1. HENRIQUEZIA VERTICILLATA, Spruce, *l. c.*; foliis subquinis anguste oblongis subacuminatis basi acutis, venis primariis valde obliquis subtus prominentibus, calycis 4-fidi laciniis lanceolatis, corolla extus cano-sericea.

Arbor pulcherrima, 50 ad 100 pedes alta, trunco 4 pedes crasso, ramis summis fastigiatis subquinatim verticillatis, ramulis inflorescentiaque ferrugineo-tomentellis mox glabratis. *Folia* pleraque 5-natim verticillata, petiolata, in speciminibus suppetentibus 8–10 poll. longa, 2–2½ poll. lata, inferiora verosimiliter majora, obtusiuscula v. breviter et acute acuminata, integerrima, basi cuneato-acuta, glaberrima, coriacea, supra nitidula, subtus costa media venisque primariis obliquis valde elevatis percursa, rete venularum vix conspicuo. *Petiolus* ½–1-pollicaris, basi dorso sub insertione cicatrice stipularum deciduarum signatus. *Stipulas* ipsas non vidi. *Panicula* terminalis, intra folia summa subsessilis, late thyrsoidea, ferrugineo-tomentella, ramis crassis subcompressis verticillatis et dichotome cymiferis. *Calyx* incurvus, crassus, circa 6 lin. longus, extus ferrugineo-tomentosus, intus sericeus, limbus ad medium divisus in lacinias 4 lato-lanceolatas acutas æstivatione vix imbricatas, quarum infima parum latior. *Corolla* sesquipollicaris, extus tomento sericeo appresso in sicco canescens, in vivo rosea, intus alba, glabra, exceptis laciniis puberulis et serie pilorum flavicantium secus lineam mediam labii inferioris, necnon pilis nonnullis ad basin faucis. *Stamina* glabra, infra medium tubi inserta. *Antheræ* longæ, medifixæ, biloculares, longitudinaliter dehiscentes. *Stylus* basi glaber, apice in lamellas oblongas hirto-stigmatosas divisus. *Discus* epigynus brevis, crassiusculus, pubescens. *Capsula* non visa.

One of the finest trees met with by Mr. Spruce in his voyage up the Rio Negro in December 1851. It was frequent in the Gapó, from above Barraroá to San Gabriel do Cachoeiras.

2. HENRIQUEZIA OBOVATA, Spruce, MS.; foliis quaternis obovato-oblongis obtusis retusisve basi rotundatis cordatisve, venis primariis subtransversis subtus valde prominentibus, capsula transverse oblonga.

Arbor 40–60-pedalis. *Stipulæ* lanceolatæ, juniores 4–5 lin. longæ, a foliis adultis jam deciduæ. *Folia* (sec. Spruce) constanter quaternatim verticillata, 4–5 poll. longa, 2½–3 poll. lata, venis primariis a costa multo magis divergentibus quam in *H. verticillata*. *Flores* ignoti. *Capsula* 2½ poll. longa, 4 poll. lata. *Semina* 1½ poll. lata.

A single specimen was gathered by Mr. Spruce, in June 1854, in woods along the Guiainia, or Upper Rio Negro, above the confluence of the Casiquiare.

3. Henriquezia nitida, Spruce, MS.; foliis longe oblongis obtusis crasso-coriaceis nitidis, venis vix prominulis, calycis 4-partiti laciniis subovatis acutis imbricantibus, corolla extus sericeo-villosa.

Arbor 30-pedalis, ramosissima. *Folia* (an constanter?) ternatim verticillata, 8–10 poll. longa, 2–3 poll. lata, basi angustata, utrinque viridia et nitida, costa utrinque prominula; venæ tamen primariæ parum conspicuæ et non prominentes. *Stipulæ* lineari-lanceolatæ, pollicares, rigidæ, persistentes. *Paniculæ* rami ternatim verticillati, dichotome cymosi, cano-tomentosi. *Calycis* limbus usque ad ovarium divisus; laciniæ 5 lin. longæ, tomentosæ, multo latiores quam in *H. verticillata*, marginibus imbricantibus. *Corolla* sesquipollicaris, rosea maculis nonnullis cinnabarinis notata, intus præter lineam pilorum flavicantium glabra, extus mollissime sericeo-villosa, fauce latiore quam in *H. verticillata*. *Fructus* ignotus.

Collected by Mr. Spruce in October 1854, on the banks of the Casiquiare, and distributed under the number 3690.

4. Henriquezia oblonga, Spruce, MS.; foliis anguste oblongis obtusis subcoriaceis opacis subtus pallidis, venis vix prominulis, capsula suborbiculari.

Possibly a variety of the *H. nitida*; but the specimens of the one being in flower only, of the other only in fruit, I do not think it safe to unite them, as the leaves do not quite agree. In the *H. oblonga* they are scarcely 6 inches long, although with longer petioles than in *H. nitida*, not so thick, and not nearly so shining, and much paler underneath. The stipules are nearly the same. The capsule is of the same woody consistence as in *H. obovata*, but not broader than long, being about 3 inches each way; it is marked with a similar slightly-arched transverse line, being the scar left by the limb of the calyx.

A small tree of about 18 feet in height, with few spreading branches; frequent on the Rio Atabapo, an affluent of the Orenoco near the mouth of the Casiquiare. There were only two or three specimens gathered by Mr. Spruce in June 1854, and numbered 3702.

EXPLANATION OF THE PLATES.

Tab. LII.

Henriquezia verticillata.

Fig. 1. Calyx and style.
Fig. 2. Corolla cut open.
Fig. 3. Ovary, transverse section.
Fig. 4. Ovary, vertical section.
Fig. 5. The same shortly after flowering.

Tab. LIII.

Henriquezia obovata.

Fig. 1. Ripe fruit seen from one side.
Fig. 2. The same, end view.
Fig. 3. The same with one valve removed, showing the seeds entwined by the young roots.
Fig. 4. A seed.
Fig. 5. The same seen edgewise.
Fig. 6. Embryo with the growing root.
Fig. 7. The same with one cotyledon removed, showing the growing plumula.

Tab. LIV.

Henriquezia nitida.

Fig. 1. Calyx and style.
Fig. 2. Corolla cut open.
Fig. 3. Calyx and base of the style after the calyx-lobes have fallen off.
Fig. 4. Ovary, transverse section.
Fig. 5. Ovary, vertical section.

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XXIII. *Remarks on* Gnetum. *By the late* WILLIAM GRIFFITH, *Esq., F.L.S., Madras Medical Service. Communicated by* A. HENFREY, *Esq., F.R.S., F.L.S., Professor of Botany, King's College.*

Read April 21st, 1859.

PREFATORY NOTE BY PROF. HENFREY.

THE following paper is the original from which were derived the particulars communicated by Dr. Lindley, in the article *Gnetaceæ,* in his 'Vegetable Kingdom;' and it is now brought forward under the following circumstances.

My curiosity was excited by Mr. Griffith's account, quoted by Dr. Lindley, of the existence of a long convoluted suspensor in the ovule of *Gnetum.* It appeared to me that this indicated an additional affinity between the *Gnetaceæ* and the *Coniferæ* and *Cycadaceæ*, and that this would be still more striking if it were accompanied by the phenomena of polyembryony, such as are met with in the undoubted Gymnosperms. On examination of some specimens, I found that the lower end of the long convoluted suspensor does divide into a number of distinct processes, as in Conifers, and that the embryo is developed at the end of one of these. I now became anxious to examine some flowers in an early stage of development with a view to ascertain if *Gnetum* produced *corpuscula*; which I thought might have been overlooked by Mr. Griffith, his Memoir having been written before the publication of Mr. Brown's celebrated Memoir on the Plurality of Embryos in the *Coniferæ.*

Through the kindness of Dr. Hooker, I obtained from the Kew Museum a supply of specimens of *Gnetum* in various stages of growth. From the same friend I learnt that the original Memoir of Mr. Griffith was in the hands of the Secretary of the Society, and, with the consent of Dr. Lindley, Mr. Bennett placed the paper in my hands. The study of this paper, under the light of my own observations, has led me to attach great importance to it, and I have recommended its publication before communicating the results of my investigations, on account of the author's having forestalled me in the greater part of the facts important in the history of development of this genus, and rendered it unnecessary for me to do more than supplement his observations in a few points, before entering upon the general conclusions I have drawn from his and my own studies.

I hope shortly to offer a paper on this subject for the consideration of the Linnean Society, and shall merely say at present, that my investigations lead me to look very favourably upon the opinion expressed by Prof. J. G. Agardh, in his new 'Theoria Systematis Plantarum,' that the *Gnetaceæ* are related even more closely to the *Loranthaceæ* than to the *Coniferæ.*

London, January 7, 1859.

This paper owes its existence to Dr. Lindley, who with his usual kindness pointed out to me this, among several other genera, as an interesting subject for study. In glancing over the history of this genus, we find that very little additional information had been acquired upon its structure from the period of its original publication by Linnæus, from whose character all the subsequent ones have been more or less derived, until the appearance of Dr. Brown's Memoir relative to the character and description of *Kingia* appended to King's Voyage*. Previous to the appearance of this important publication, all botanists who had noticed this genus had ascribed to the female flower the ordinary structure. It will hereafter be seen that all those who have formed this opinion of the structure of *Gnetum* have examined the female flowers at a rather late period.

Dr. Brown, in the Memoir above referred to, p. 23, gives it as his opinion, that in *Cycadeæ*, *Coniferæ*, *Ephedra*, and *Gnetum*, the ovarium is either altogether wanting, or so imperfectly formed that the ovulum itself becomes directly exposed to the action of the pollen. He further states that "the similarity of the female flower in *Cycadeæ* and *Coniferæ* to the ovulum of other phænogamous plants, as I have described it, is indeed sufficiently obvious to render the opinion here advanced not altogether improbable; but the proof of its correctness must chiefly rest on a resemblance, in every essential point, being established between the inner body in the supposed female flower in these tribes, and the nucleus of the ovulum in ordinary structures, not only in the early stage, but also in the whole series of changes consequent to fecundation. Now, as far as I have yet examined, there is nearly a complete agreement in all these respects."

After repeated examinations of *Cycas*, *Gnetum*, and *Agathis*, in their growing states, it may perhaps not be considered presumptuous in me to add my feeble testimony to the extreme accuracy of this statement of Dr. Brown †.

Professor Lindley, in his valuable 'Introduction to the Natural System of Botany,' while he admits to the fullest extent Dr. Brown's notions on *Cycadeæ* and *Coniferæ*, appears to entertain the old opinion as to the structure of *Gnetum*; and here it is again evident that this truly philosophical botanist has only examined somewhat advanced female flowers. I find, however, that in his remarks on *Garrya* (Bot. Register, vol. vii. new series, t. 1686), this author has adopted the opinion of Dr. Brown, and speaks of *Gnetaceæ*, a naked-seeded order.

Having thus briefly alluded to the opinions entertained on the structure of this singular genus, I shall now proceed to the consideration of the structure and development of the female flower, which consists of a single naked ovulum.

At a period long before the exsertion of the anthers, the ovula, which lie upon the male flowers, are generally of an oblong form, and consist of a central cellular solid body, enclosed in two envelopes. The outermost of these is fibro-cellular, and divided longitudinally on the upper face, or that nearest the axis, the fissure extending nearly to the base of the ovulum ‡. The inner or second envelope is cellular, and is divided irregularly

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* Of this Memoir I have seen only an 8vo copy, in the possession of Dr. Wallich.

† At the same time, Dr. Brown's observations refer only to a period subsequent to the appearance of the additional membrane. (See *Kingia*, p. 25.)

‡ This division is perhaps similar to that which Dr. Brown states to take place in *Dacrydium*.

towards its apex. This envelope does not at this period entirely enclose the nucleus: the points of some of the laciniæ or divisions project occasionally beyond the apex of the outer envelope. The nucleus is an oval or oblong cellular body, rounded off at its apex, which is composed of lax cellular tissue. The next change consists in the commencement of the obliteration of the longitudinal fissure existing along the posticous face of each outer envelope, and of an extension of the inner coat over the nucleus, the apex of which becomes more or less depressed,—the centre of the depression, however, projecting in the form of a cone of a very slight elevation. At the time of flowering, or of the exsertion and dehiscence of the anthers, the fissure originally existing along the upper face of the outer coat has disappeared, with the exception of a small portion at the apex of the ovulum which remains unclosed throughout: the ovula are at this period in some species oblique. The inner envelope is generally entirely enclosed within the outer; the points of its laciniæ reach, however, to the opening existing in the apex of this latter, and occasionally, but by no means universally, project beyond it to a short distance. This coat has undergone scarcely any change, and corresponds in shape to the cavity of the outer envelope. The nucleus is completely covered by both integuments, and its apex, which continues of the same form, is occasionally tinged with brown. Within its substance, which is entirely cellular, and towards its centre, there exists a small cavity, lined with a membranous sac, attached apparently to the apex of the cavity, and containing a number of minute grumous-looking brown masses, arranged without any obvious regularity. This sac* exists at a rather early period, and is developed within a cavity formed by some excavating process.

A short time after the fall of the male flowers an extraordinary change will be found to have occurred, consisting of the very rapid and apparently sudden development of a new membrano-cellular envelope between the second coat and the nucleus. This new formation, which I may term the additional coat, envelopes the nucleus pretty closely, and is continued upwards beyond the apex of the nucleus into a cylindrical tubular process, the mouth of the tube being laciniate or fimbriated. At the period now referred to, its apex barely projects beyond the outer envelope. During its development, no particular change has taken place either in the original integuments or nucleus. At a somewhat later period, the ovula (except in the instance quoted below †), hitherto concealed by the involucrum, will be found exposed, and the outer coat to have become of a green colour: the opening through its apex is distinct, and its direction vertical. The second envelope continues unchanged. The tubular prolongation of the additional or third envelope now projects through the openings in the original coats to a considerable distance. The mouth of the tube is also rather dilated, and the fimbriæ of its margin spread out irregularly and to various extents. The whole of the tubular prolongation has become tinged with brown, in some cases approaching to black.

It is to this stage or period that the descriptions of those authors who attribute a style and stigma to this genus apparently refer. Both Dr. Brown and Prof. Lindley

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* This sac I consider to be the amnios, with which it agrees in its development and subsequent disappearance.

† In one species, *G. Brunonianum*, the ovula are at an early period exposed, owing to the obsoleteness of the annulate involucrum.

must likewise advert to this period when they state the nucleus to be surrounded with three envelopes.

The nucleus, which up to the present time continues free from adhesion, has now undergone a slight alteration in figure, consisting in a tendency to constriction towards its apex, which is now invariably more or less brown: its cavity has become enlarged. This constriction may possibly be only apparent, since it may originate in the greater growth of the elevated part of the depression, stated to exist at the apex.

As the young seed progresses in its development, the two outer coats increase in size. The base of the additional membrane adheres to the corresponding portion of the nucleus, the adhesion continuing to increase in extent until it has reached upwards to the commencement of the constriction. The projecting tubular prolongation does not appear to have any regular term of existence; its coloration or sphacelation increases, and at a variable period the exserted portion becomes detached at the situation of the opening of the outer coat. The cavity existing in the nucleus undergoes a corresponding enlargement, and its walls are more irregular. It will be found to contain, about the period of detachment of the exserted portion of the tubular process, a pendulous body of a similar form, attached by a rather broad cellular band to the apex of the cavity. This is the rudimentary amnios, developed originally within the sac, stated to line at a prior period the cavity of the nucleus. As the development proceeds, this body increases in size; it appears to be developed from below upwards, and as it enlarges, the lax cellular attachment undergoes a corresponding diminution, chiefly, I imagine, by pressure. As this body, in which the albumen becomes deposited, increases, the substance of the nucleus gradually disappears, and subsequently merely forms a thin covering to the large and fleshy albumen. The last change which I have traced in the albumen consists in the formation of a cavity within its substance, commencing at its apex, and gradually extending downwards. The corresponding changes consist in the development of pulp and increase of the fibres of the outer coat; in an induration (rather in an induration of the second envelope depending upon the development of fibrous tissue) and development of fibrous tissue in the second envelope, which subsequently becomes brown, subosseous, and fragile. The originally large and distinct openings through both these become narrowed, but never completely filled up—not, at least, by an extension of their own substance. The additional envelope is now membranous and thin, united throughout the greater part of its extent to the thin remains of the nucleus. The included (and permanent) portion of its originally tubular prolongation has become filled up, and is embraced closely within the constricted openings existing through the two outer coats. The remains of the nucleus, owing to the pressure this has undergone during the growth of the albumen (or rather of the amnios and deposition of albumen), finally assume the form of a membrane, united, except towards its apex, which is brown or black and apiculate, to the inner paries of the third coat.

With regard to the development of the embryo, I can add nothing. Although I have examined abundance of fully-formed fruits of two species, I have never observed anything towards the development of the embryo beyond the formation of the cavity in the albumen, and the very rare and partial development of the funiculus, which, moreover, in the only two cases in which I observed its partial formation laid loose in the cavity. Excepting the want of this essential portion, the seeds were, as I have since ascertained by comparison with seeds with perfect embryos, fully and completely formed.

The following description of the mature seeds is taken from exembryonate specimens, and from the examination of some embryonate seeds of *Gnetum scandens*, brought from Arracan, and communicated, with many other interesting productions, to Dr. Wallich by his late friend Captain R. R. Margrave:—

The mature seed is more or less ovate, obtuse, or acute, and of a reddish-orange colour, and either entirely smooth, or covered with appressed, peltate, silvery cellular scales. Its coats occur in the following order:—

1. *Outer and baccate. Origin: outer envelope of ovule.*—Of this the outer half is entirely cellular; the inner composed of several layers of fusiform fibres, sharp at both ends, of a yellow colour and shining appearance. They are often punctated, and occasionally marked with incomplete spiral fibres; they are pungent, and occasion considerable irritation.

2. *Drupaceous: originating from the second envelope of the ovule.*—This is externally sulcate, the innermost fibres of the outer coat being lodged in these sulci; it is of a brown colour and nearly osseous texture, composed of cells, the innermost series of which are arranged transversely, and a great number of longitudinally-disposed fibres, which are longer and of much less diameter than those of the outer baccate coat.

3. *Fibro-cellular coat. Origin: the additional envelope, and chief part of the nucleary membrane.*—The external part, which is composed of fibres similar to those of the drupaceous coat, arranged longitudinally, is terminated by the persistent and now woody portion of the originally tubular prolongation, the apiculus being lodged in the opening existing even at this period in both the outer coats: its apex is discernible exteriorly at the corresponding end of the seed, but does not, however, project beyond the level of the outer coat. The internal portion forms the

4. *Cellular and membranous envelope. Origin: the circumferential tissue of the nucleus.*—This adheres to the preceding throughout the greater part of its extent. Towards the apex, where it is thinnest, most membranous and sphacelated, it is free, and it is terminated by a conical point (the original elevated portion of the centre of the depressed apex of the nucleus): it is free from adhesion with the former coat. The point, however, always separates with the albumen, the upper portion of which it covers somewhat in the manner of a cap.

5. *Albumen. Origin: a deposition in the tissue of the amnios.*—This fills exactly the cavity of the last-mentioned envelope; it is of considerable size, fleshy, and abounds in feculent granules. Around its apex an indistinct areola is visible, and to its extreme apex are attached the remains of the originally lax, cellular attachment; its base is likewise marked with a depressed, indistinct areola. Along its centre, and occupying the *upper half** of this portion, there is a cavity of considerable size, which tapers off in-

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* With regard to the axis at least; otherwise the base of the original amnios corresponds to the apex of the nucleus.

feriorly, terminating towards the middle of the long diameter of the albumen; the tissue, however, on the same line, and between it and the apex of the albumen being more dense, and having a peculiar appearance. The walls of this cavity are rugged and irregular. To the upper portion, and to one side of the cavity, is attached the embryo by means of an enormously long, tortuous, and spirally but irregularly-twisted cellular funiculus, the cells being much elongated and twisted. Its length varies, when moderately pulled out, from 3½ to 5 inches, the length of the fruit being 1 inch. This funicle, as well as the extremely similar one of *Cycas*, has the property of contracting when immersed in water. When *in situ* it is tolerably closely packed; it is dilated towards its attachment with the embryo. The embryo itself is more or less ovate, its radicle tapering off superiorly, and being completely continuous with the apex of the funicle. The cotyledons are equal, very small, and mutually applied by their plane contiguous faces. The plumule is inconspicuous, and only indicated by a rounded, entire, very minute elevation. The lower half of the embryo is lodged in lax, apparently dislocated tissue.

[Roxburgh * describes the seed of *G. scandens* as having, besides the two outer coats, which he refers to the fruit, "two integuments: the exterior one thin and fibrous; the inner one less distinct, and adhering to the perisperm very firmly. Perisperm conform to the seed, cartilaginous. Embryo in the apex of the perisperm, straight. Cotyledons two, ensiform, unequal. Radicle superior." In his drawing of *G. scandens* the embryo is represented with a short obtuse radicle, two unequal cotyledons, and an immense plumule, consisting of a filiform stalk equalling in length the larger cotyledon, bearing at its apex two small leaflets. Nothing is said of the funiculus.]

From the foregoing account, I trust it will be seen that, with the exception of the subsequent and sudden appearance of the additional membrane †, the development of the ovula of *Gnetum* presents scarcely a single peculiarity worthy of notice. The changes that occur in the two outer coats from an early period up to the time of the maturity of the seed, I consider as of secondary importance, and as the result of modifications depending upon their anomalous situation. The sudden appearance of the additional membrane does not seem to me to be capable of any explanation: hitherto I have not met with it in any stage of development prior to that when its apex reaches to the opening existing in the outer coat. I can assert with tolerable confidence, that this coat does not originate in a separation of the circumferential tissue of the nucleus, and that hence it is not analogous to the *tercine*. I am unable to state what functions it performs, although its exsertion, its free communication with the apex of the nucleus, its dilated laciniate apex, and its subsequent sphacelation would lead us to suppose that it is connected with impregnation. If such be really the case, it is obvious, from the period at which its development is completed, that fecundation can only be effected through the agency of the pollen of anthers belonging to spikes at an earlier period of growth.

The complete agreement in development of the nucleus and albumen with that of the

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[*] Flora Indica, vol. iii. p. 519.

[†] Roxburgh, in his figure of *G. scandens*, represents the exsertion of this membrane or coat as occurring during the existence of the male flowers.

same parts in ordinary ovula, precludes the necessity of any remark; neither is there any feature in the embryo, excepting its enormously long funiculus, that would lead me to suspect any material deviation from the usual structure.

The only genera of *Coniferæ* with which I have been able to compare *Gnetum* are *Agathis* and *Thuja*, in both of which the nucleus has only one envelope, its cavity being in *Agathis* lined with a very distinct amnios. The males of neither of these genera, however, exist in the Botanical Garden at Calcutta; and neither of them appears to possess that power, which exists to such a degree in *Cycas* and *Gnetum*, of continuing the development of the ovulum independently of fecundation. With *Cycadeæ* I have had ample opportunities of comparison, so far, at least, as regards the young ovula and perfect fruit. The mutual resemblance is, indeed, so strong, that I have little hesitation in affirming that the fruit of *Cycas* differs only *materially* from that of *Gnetum* in the absence of an additional envelope, *and perhaps* in the presence of the remains of the amnios. With regard to the ovula of *Cycas*, the nucleus has, as Dr. Brown has stated in the Memoir referred to, p. 24, only one envelope; but I have no doubt, both from the difference in its tissue, in which there is, indeed, an obvious line of demarcation, as well as from the disposition of its vessels, that it consists of two, united throughout their whole extent. The nucleus is likewise united by its lower portion to the envelope,—its apex, which is conical, being free, and prolonged into a membranous point, which is engaged within the lower part of the canal formed by the opening that exists through the coat. This membranous portion is tubular, the cavity extending some distance within the actual substance of the nucleus: its walls are cellular, and not lined by any membrane.

The body of the nucleus contains a large globular cavity, in which a sac of a corresponding size and form exists. This sac (the amnios) is, at the period referred to, membranous, and is rendered tense by an abundant gelatinous fluid; it is easily detached, and appears to be merely applied to the walls of the cavity.

I hope to be able at some future period to enter into more detail on the subject of the development of the ovula of *Cycas*, which appears to promise several new and highly interesting facts, particularly as regards the first appearance of cellular tissue within the sac of the amnios, while at the same time its great size renders it peculiarly fitted for observation.

It is probable that the fruit represented by Dr. Hooker (Bot. Mag. new ser. vol. ii. t. 2827) as that of *Cycas circinalis*, belongs to another species. The true *C. circinalis* has, as Richard has stated, a fungous envelope surrounding the albumen, which is of considerable thickness towards the base of the fruit, or rather seed; a thin membrane, probably the remains of the amnios, being interposed, and adhering to the fungous envelope, except towards its apex. In this species the cotyledons are, as M. Richard has likewise stated, united, except at their bases, where a free exit is allowed for the plumule on both sides. Dr. Hooker's description, particularly as regards the *coats*, agrees much better with *C. sphærica*, Roxb. The sacs existing in the apex of the albumen, first pointed out by Dr. Brown *, are in *C. circinalis* permanent; that in which the embryo is developed

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* Prodr. Floræ Novæ Hollandiæ, vol. i. p. 347.

becoming necessarily much enlarged, and adhering firmly to the walls of the cavity it lines.

Although I have repeatedly examined the ovula of *Gnetum* with a view to the nature of their impregnation*, I am not in possession of a single fact relative to its performance. I must, however, mention, that the ovula of *Gnetum scandens* and *lepidotum* do not appear to be ever submitted to the action of the pollen derived from their *proper* male flowers. In *G. Brunonianum* this is obviated by the extreme smallness of the annulate involucrum. My residence at the Botanical Garden of Calcutta, and the great and unvarying kindness of Dr. Wallich, have put me in possession of some, I think, interesting facts relative to the impregnation of *Cycas*, which it may not be amiss to state. I may here observe, that the consideration of the mode of application of the pollen-tubes to the apex of the nucleus in some plants possessing the ordinary structure of ovarium, had led me to suppose that these productions are merely organs of communication, developed on account of the distance that necessarily exists in these plants between the stigmatic surface and ovulum, and that hence, in *Cycas* and plants of a similar simple structure, in which actual application of the pollen itself to the apex of the nucleus can obviously take place, no pollen-tubes would be produced.

In forming this view, I had not lost sight of the apparent penetration of the pollen-tubes *into* the ovula of *Asclepiadeæ*, first observed by Dr. Brown; but I supposed that it might be the result of the anomalous formation of the nucleus in these cases. Repeated observation has since, however, taught me, that not only does application of the pollen-granules to the apex of the nucleus of *Cycas* take place, but that pollen-tubes are likewise generated, although, as might be expected, much shorter than usual. Indeed, the tubular membranous portion of the apex of the nucleus becomes actually crammed with pollen-granules, from the lower and outer of which pollen-tubes are pretty generally produced.

The orifice of the envelope of *Cycas* has a callous and shining appearance; and although I have often examined pollen-grains which had been in apposition with it for some time, I have never seen any production of boyaux, except in the cavity of the apex of the nucleus.

Although I have by no means proved the *necessity* of the production of the pollen-tubes in *Cycas* to ensure fecundation, I consider the fact of their production a strong argument in favour of the idea that actual penetration does occur in every case in which the application of the tubes to the apex of the nucleus can be conceived. The fact of the production of the tubes likewise seems to me to put the nature of the bodies from which they originate out of all doubt, and to prove the truth of Dr. Brown's remark (Memoir cited, p. 30), that it would be quite gratuitous, on the grounds stated, to consider the particles contained in the thecæ to be analogous to the fovilla.

Dr. Brown, in his account of microscopical observations on the particles contained in the pollen of plants, published in the 'Edinburgh Journal of Science,' vol. ix. p. 343,

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* The opening of the outer coat never presents a shining appearance.

says, after alluding to his want of success in tracing the particles contained in pollen-grains through the tissue of the style, "Even in those families in which I have supposed the ovulum to be naked, namely *Cycadeæ* and *Coniferæ*, I am inclined to think that the direct action of these particles, or of the pollen containing them, is exerted rather on the orifice of the proper membrane than on the apex of the included nucleus; —an opinion which is in part founded on the partial withering confined to one side of the orifice of that membrane in the Larch,—an appearance which I have remarked for several years." It is, however, most probable that, from the late rapid increase of our knowledge of the process of fecundation in Phænogamous plants, chiefly indeed owing to the beautiful observations of this distinguished botanist, the opinion above cited has been modified by its author.

With regard to the two principal objections urged by Dr. Brown [*] against the opinion of the female flower of *Cycadeæ* and *Coniferæ* being a naked pistillum, the first, viz. that arising "from the perforation of the pistillum, and the exposure of that point of the ovulum where the embryo is formed to the direct action of the pollen," still holds good. The second, viz. the too great simplicity of structure of the supposed ovulum, I look upon as in a great measure destroyed by the reduction of the usual number of the constituent parts of this organ in *Loranthaceæ*[†].

Respecting the male flower, I have to add, that Linnæus was correct in referring the genus to *Monœcia Monadelphia.* Roxburgh adopts the same view in his MS. Synopsis; but in his 'Flora Indica' he refers it to the *Monœcia Monandria.* The correctness of Linnæus's view is proved by the fact that there are two filaments at an early period, or at least that their union is only partial, and by the number, situation, and distribution of the vascular fascicles.

GNETACEÆ, Lindley, in Bot. Register, vol. vii. N. S. t. 1686, sub *Garrya*.

DIAGNOSIS.—*Plantæ* gymnospermæ, dicotyledoneæ, aquosæ. *Rami* articulati. *Folia* opposita, indivisa, venis anastomosantibus reticulata.

CHAR. ESSENTIALIS.—*Flores* monoici, in spicis amentiformibus verticillatim dispositi; verticillus singulus involucro annulato integerrimo (rarius obsoleto) suffultus distans. MASCULI pluriseriati, in verticillis inferius dispositi. Perianthium tubulosum, inverse subulato-conicum fere cuneatum, mutuâ pressione angulatum, apice planiusculo vel depresso, rimâ transversâ dehiscens, carnosum. *Filamentum* unicum, monadelphum (e 2 nempe coalitis formatum), hypogynum, clavatum, per anthesin per rimam transversam exsertum. *Antheræ* duæ, uniloculares, basibus affixæ, erectæ; loculi omnino discreti longitudinaliter et centraliter secus latus utrumque dehiscentes. *Pollen* simplex, læve, oblongum.—FŒMINEI in verticillis superius dispositi, 1- vel 2-seriati. *Perianthium* nullum. *Ovula* ovata, sæpe obliqua, transverse sita, orthotropa. (*Junius.*) Tegumenta bina; exterius fibroso-cellulosum, interius cellulosum, sæpius inclusum, utrumque apice apertum. *Nucleus* cellulosus tegumento conformis, liber. (*Maturius.*) Tegumenta terna; tertium novumque nucleum cingens, supra ejus apicem in tubum cylindricum styliformem longe exsertum ore dilatato marginibusque laciniatis productum. *Fructus* (semen maturum) omnino exsertus, sessilis vel stipitatus, drupaceus, lævis vel lepidotus, ovatus, indehiscens. Sarcocarpium extus cellulosum, intus fibrosum (fibræ utrinque acutæ pungentes, diametro magno, coloratæ), apice perforatum. Endocarpium fibrosum, fragile, subosseum, sarcocarpio adnatum, e fibris longitudinaliter cellulisque transverse sitis

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[*] '*Kingia*,' p. 28.

[†] See my Paper on this subject.

formatum, apice apertum. Tegumentum tertium fibroso-cellulosum albumen amplectens, apice in apiculum subulatum induratum endocarpium et sarcocarpium perforantem sed vix exsertum productum. *Albumen* semini conforme, carnosum, copiosum, apice membranâ apiculatâ lacerâ sphacelatâ (nuclei reliquiis) incomplete tectum, intus excavatum. *Embryo* inversus, in excavatione albuminis reconditus, ope funiculi longissimi (3–5 uncialis) cellulosi, spiraliter torti, albuminis excavationi lateraliter et apicem versus affixi sustentus. *Radicula* conica, supera, cum texturâ apicis funiculi continua. Cotyledones parvæ, æquales. *Plumula* inconspicua.—Arbusculæ, fruticesve *sæpius scandentes succo aquoso fœti.* Truncus *conicus, ramosus.* Lignum *fibroso-vasculosum, zonatum; zonis concentricis maxime evolutis, e radiis medullariis inter se lateraliter confluentibus formatis; e vasis maximis glanduloso-punctatis (more* Coniferarum) *fibrisque ligneis crebre punctatis constans.* Rami *articulati ramulique virides ad articulos tumidi.* Folia *opposita, petiolata; petioli superne plani inferne convexi, basibus in annulum intrapetiolarem (fere ut in* Potaliaceis) *connati.* Limbus *indivisus, ovato- vel lanceolato-oblongus, plus minus acuminatus, sæpius repandus, integer, penninervis, nervis venis secundariis et tertiariis arcuatim coalitis, supra secus nervum centralem et bases secundariorum stomatibus donata; infra per totam superficiem venis venulisque exceptis organis iisdem donata.*—(See Note 1.) Folia *novella per vernationem paginis superioribus planis mutuo et arcte approximata.* Inflorescentia *paniculatim spicata, axillaris vel sæpius terminalis. Spicæ cylindricæ,* 3 *in quâque divisione paniculæ; laterales oppositæ pedunculatæ (pedunculi ad bases annulo obsoleto cincti); terminalis longius pedunculatus, pedunculus supra medium bracteis* 2 *ovatis alte connatis stipatus.* Involucra *annuliformia, primo approximata demum discreta vel distantia; infima spicarum præsertim lateralium biapiculata.* Flores *pilis cellulosis articulatis quasi moniliformibus immixti præsertim fœminei; utriusque sexûs arcte verticillati, radiatimque patentes.* Masculi *inferiores, et in seriebus pluribus dispositi.* Fœminei *superiores,* 1 *vel* 2 *seriales, per anthesin involucro pilisque sæpius omnino obtecti; floribus masculis delapsis cito exserti, et demum omnino nudi.*

I shall conclude with a synopsis of the species I have ascertained to be indigenous to the Tenasserim Provinces.

GNETUM, Linn., Mantissa, p. 18, no. 1278.

Character ordinis.

Sectio I. *Erecta.*

G. BRUNONIANUM, mihi; fruticosum; foliis lanceolato-oblongis (membranaceis), involucris obsoletis.

Hab. in sylvis ad Banlau, urbem antiquam anglice Tenasserim dictam prope, florens ab Aprile usque ad Februarium. Fructus non vidi. Frutex humilis, erectus; ramis divaricatis. Folia breviter petiolata, subrepanda. Spicæ axillares et terminales, sæpius solitariæ; flores fœminei *exserti*, 1-seriati, virides, pilis cellulosis albis immixti.

Sectio II. *Scandentia.*

G. APICULATUM, mihi; foliis lanceolato-oblongis, fructibus sessilibus acutis lævibus.

Hab. in Silhet, *Roxb.* Arracan, *Capt. Margrave.* Legi in sylvis circa Mergui, oræ Tenasserim. Frutex longe scandens; folia coriacea, subacuminata. Flores pilis cellulosis *brunneis* immixti, fœminei per anthesin, marium omnino obtecti. Fructus (lanceolato-ovati) apiculati, omnino læves.

G. SCANDENS, Roxb.; foliis ovato-oblongis vel ovalibus, fructibus breve stipitatis obtusis lepidotis. *Ula*, Hort. Mal. vol. vii. p. 41. t. 22 opt. *Gnetum scandens*, Roxb. MSS. Synopsis; ejusdem Icones pictæ in Horto Botanico Calcuttense asservatæ, Suppl. vol. iv. t. 73; Flora Indica, vol. iii. p. 518.

Hab. in sylvis oræ Tenasserim. Legi ad Moulmein, Amherst, et Mergui. Floret Decembre, Januario. Frutex longe scandens. Folia coriacea, obtuse acuminata, supra atro-viridia, raro pallida. Paniculæ terminales. Flores utriusque sexûs pilis cellulosis albidis immixti. Fructus (ovato-oblongi), præsertim juniores, pulcherrime argenteo-lepidoti.

Under this species Roxburgh has confounded two distinct plants. In the drawing quoted above he has figured the fruit of *G. apiculatum* and of *G. scandens* as the produce of the same plant. In his description of the fruit of *G. scandens,* he seems to advert, although obscurely, to some peculiarity of the superficies, at least before maturity. This species is at once known by the silvery scales of the fruit, which are very conspicuous before it begins to assume its orange colour; these scales are peltate, closely appressed, and composed of cells radiating from the situation of the attachment.

I have not quoted Rumph, whose figure does not at all resemble our plant. Buchanan's synonym in Rees's Cyclopædia, founded on the supposed identity of Rumph's plant with the above, is therefore not to be taken without great hesitation.

Note 1.—(*Stomata.*) The arrangement above referred to is not uncommon, but perhaps limited to those leaves in which the parenchyma is continued *over* the veins. It is remarkable that in these cases the stomata differ considerably in size; those of the upper surface I have hitherto found to be the largest. As good instances of such distribution, I may mention *Costus speciosus,* and perhaps all species of *Nymphæa.* A curious, and I believe hitherto unnoticed singularity occurs in the distribution of these organs in *Nelumbium speciosum,* in which the callous spot in the centre of the leaf, and opposite to the termination of the petiole, is crowded with stomata of a large size, to the presence of which the unusual colour of the *spot* appears to be partly owing. These organs in this plant certainly open into cavities, through which they communicate indirectly with the cavities in the petiole, from the apex of which they radiate into the limb. The remainder of the vast limb is minutely papillose, the papillæ being depressed at their apices; and its stomata are very indistinct, and indeed almost obsolete.

Note 2.—Dr. Lindley, in the 'Botanical Register' quoted above, states that the wood of *Gnetum* is zoneless. In the climbing species the zones are highly developed, but in *G. Brunonianum* no zones existed; this is, however, in all probability referable to the specimens that I examined being the growth of one season. I have much pleasure in confirming the statement of the above author respecting the presence of spiral vessels, at least in the young parts. I may add, that the proportion of vessels appears to me very considerable.

Finally, the three families characterized by having the female flowers reduced to naked ovula, agree in the following remarkable points: viz. peculiar punctation of certain parts of their tissue, unisexuality, orthotropous ovula, and in the presence of at least two, often more, opposite cotyledons.

Aug. 4th, 1835.

EXPLANATION OF THE PLATES.

Tab. LV.

Fig. 1. Very young ovule of *Gnetum scandens* viewed on its upper or posterior surface, which is observed to be cleft longitudinally.

Fig. 2. Second envelope, showing its divided apex, the laciniæ of which are connivent. This coat is visible at *a* in fig. 1.

Fig. 3. Nucleus of the same, both coats being removed.

Fig. 4. Posterior view of an ovule (long before the dehiscence of the anthers), showing the longitudinal cleft, the margins of the upper part of which are in this case, and indeed generally at a period rather later than that to which figs. 1–3 refer, in apposition; part of the second coat is visible at *a*, and another portion projects through the apex at *b*.

Fig. 5. Inferior or anterior view of the same ovule, along which no fissure is visible.

Fig. 6. View of the inner or second coat, showing its irregularly-divided apex.

Fig. 7. Nucleus highly magnified (the coats removed), showing the depression at the apex and the central conical elevation.

Fig. 8. Apex of the nucleus; the conical elevation appears emarginate.

Fig. 9. Ovule of *G. Brunonianum*; no fissure through the outer coat except at the apex.

Fig. 10. Longitudinal section; the apex of the inner coat is visible on a level with that of the outer coat. A central cavity enclosing the remains of a sac is visible within the nucleus.

Fig. 11. Transverse section of the same.

Fig. 12. The inner coat, with part of the outer remaining at the base. This figure shows the narrow, deeply-divided apex of this coat.

Fig. 13. Nucleus, with half the bases of the coats remaining.

Fig. 14. Ovule of *G. Brunonianum* some time after the fall of the male flowers; at its apex are visible several projecting processes of cellular tissue.

Fig. 15. Vertical section of the same, showing that a new coat has been developed between the inner (now second) coat and the nucleus. This coat is prolonged beyond the nucleus into a cylindrical tube, the mouth of which is divided, and projects slightly beyond the opening through the apex of the outer envelope. The second coat is now tinged with yellow.

Fig. 16. Ovule with outer coat detached; the tubular prolongation is seen to project considerably beyond the opening in the apex of the second coat. The fimbriæ of the extremity of the tube have not yet become expanded.

Fig. 17. The same with the second coat removed, showing the third coat throughout.

Fig. 18. Vertical section of an ovule of *G. Brunonianum,* showing the parts *in situ*. The apex of the second coat is preserved entire: the correspondence of the apex of the nucleus to the commencement of the tubular prolongation, the expanding fimbriæ of this, and the adhesion with the base of the nucleus, are represented. The *tube* is not much sphacelated at this period. The terminations of the vascular fascicles at the base of the nucleus are shown.

Fig. 19. Transverse section of the ovule near its apex, showing the two envelopes and a portion of the tubular prolongation.

Fig. 20. Vertical section of the whole of the third envelope and the nucleus. At the base of the nucleus appear the terminations of the vessels; but this is only apparent, the vessels being cut through as they diverge outwards to pass into the envelopes; none exist in the nucleus.

Fig. 21. Vertical section of the immature fruit of *Gnetum apiculatum,* some time after the fall of the

exserted portion of the tubular prolongation. The prolonged apex of the outer coat (*a*) is distinct, as well as the formation of the large yellowish fibres. The second coat (*b*) has become thicker towards its apex, and somewhat indurated. The inner or additional coat (*c*) is now adherent to the nucleus throughout the greater part of the extent of this latter organ. That part of it which corresponds to the constricted apex of the nucleus is thickened; its prolongation is considerably dilated after it has passed through the narrow, and now cylindrical, tubular perforation of the second coat. The excavation is large, and its margins are rugged and more or less blackened.

Fig. 22. Vertical section of an ovule of *G. scandens*; the nucleus is surrounded inferiorly by the two outer coats; the notch on either side (*a, a*) indicates the place of separation of the additional (third) coat. The cavity is much enlarged, and occupied by a clavate body, of which the outline is given in the adjoining figure 23.

Fig. 23. Body occupying the nucleary cavity; this is the rudiment of that which subsequently becomes the very copious fleshy albumen.

Fig. 24. Vertical section of a full-grown fruit of *G. apiculatum*, in which, however, no embryo had been developed: *a.* outer baccate coat, the inner half of which is composed of very large fibres; these are of a yellowish colour, shining appearance, and imbedded in a reddish-yellow pulp; *b, b.* drupaceous covering; *c, c, c.* inner or additional coat, with its woody, fragile, enclosed and prolonged apex (to this the fourth coat adheres firmly, except at its sphacelated apex, *d*); *e.* albumen, now copious and fleshy, by the great development of which the original nucleus has become reduced to a thin membrane, of which the free apex is seen at *d*; *f.* excavation at the apex of the albumen occupied by broken-up tortuous tissue, the rudiments of a funiculus. The direction of the subsequently-extended excavation may be traced lower down, and is indicated by a greater density of texture than occurs elsewhere.

Fig. 25. Albumen of the same detached, viewed on its entire surface: at *d.* is seen the apex of the nucleary membrane with its sphacelated apiculus.

Fig. 26. Vertical section of the same, showing the cap which the adhering apex of the fourth or nucleary membrane makes for it. The tortuous tissue is visible in the cavity.

TAB. LVI.

Fig. 27. Considerably advanced ovule of *G. Brunonianum*; vertical section.

Fig. 28. Vertical section of a mature and, with the exception of the embryo, fully-formed seed of *G. scandens*: *a, a, a.* the outer coat, which has become pulpy and baccate, the fibres lying rather loosely in the pulp; it is perforated by the prolonged persistent apex of the third covering (*c*); *b, b, b.* the second or drupaceous coat, shown to consist of two layers also perforated at the apex; *c, c, c.* the third membrane, composed of the additional and nuclear membranes; these are united except at their apices,—the apex of the nucleary membrane always separating with the albumen, and forming for it an irregular lacerated cap; *d.* albumen; *e.* the central apical cavity, empty.

Fig. 29. Vertical section of an immature seed of *G. apiculatum*: *a.* outer coat; *b.* second coat; *c.* nucleary membrane of albumen; *d.* albumen; *e.* sphacelated apex of albumen; *f.* apical cavity; *g.* tortuous suspensor lodged in ditto.

Fig. 30. Tortuous suspensor (*g*) in fig. 29 extracted and highly magnified.

Fig. 31. Vertical section of the separated albumen of a similar seed.

Fig. 32. Vertical section of the albumen with its cellular attachment; showing the embryo *in situ* and its lateral attachment.

Fig. 33. Embryo and funiculus extracted and highly magnified, showing the lateral attachment.

Fig. 34. Embryo with the apex of the funiculus; the cotyledons are seen to be remarkably small and equal.

Fig. 35. The same, the embryo varied in shape.

Fig. 36. The same, with one of the cotyledons removed, showing the rudimentary plumule.

Fig. 37. Portion of the centre of the funiculus, showing the spiral disposition.

Fig. 38. Portion of inflorescence of *G. apiculatum*; the ovules are totally concealed and surrounded by very dense brown hairs. Exsertion of the stamina has taken place.

Fig. 39. Portion of inflorescence of *G. scandens*; the ovules are totally concealed, and the filaments are exserted to a considerable length; the transverse opening through the male perianth is represented.

Fig. 40. A verticil viewed from above, showing the ovules *in situ*, and partially surrounded with hairs. In this species the ovules are arranged in about two series, and the fissure is visible at the apices of some.

Fig. 41. Portion of inflorescence of *G. Brunonianum*, including one verticil with its obsolete ring (involucre). In this species the ovules are completely exposed at this period, their bases being surrounded with hairs; they are arranged in one series: some of the stamens are exserted.

Fig. 42. Portion of the spike of *G. scandens*, representing the ovules fully exposed, and the exsertion of the tubular prolongation of the additional or third membrane.

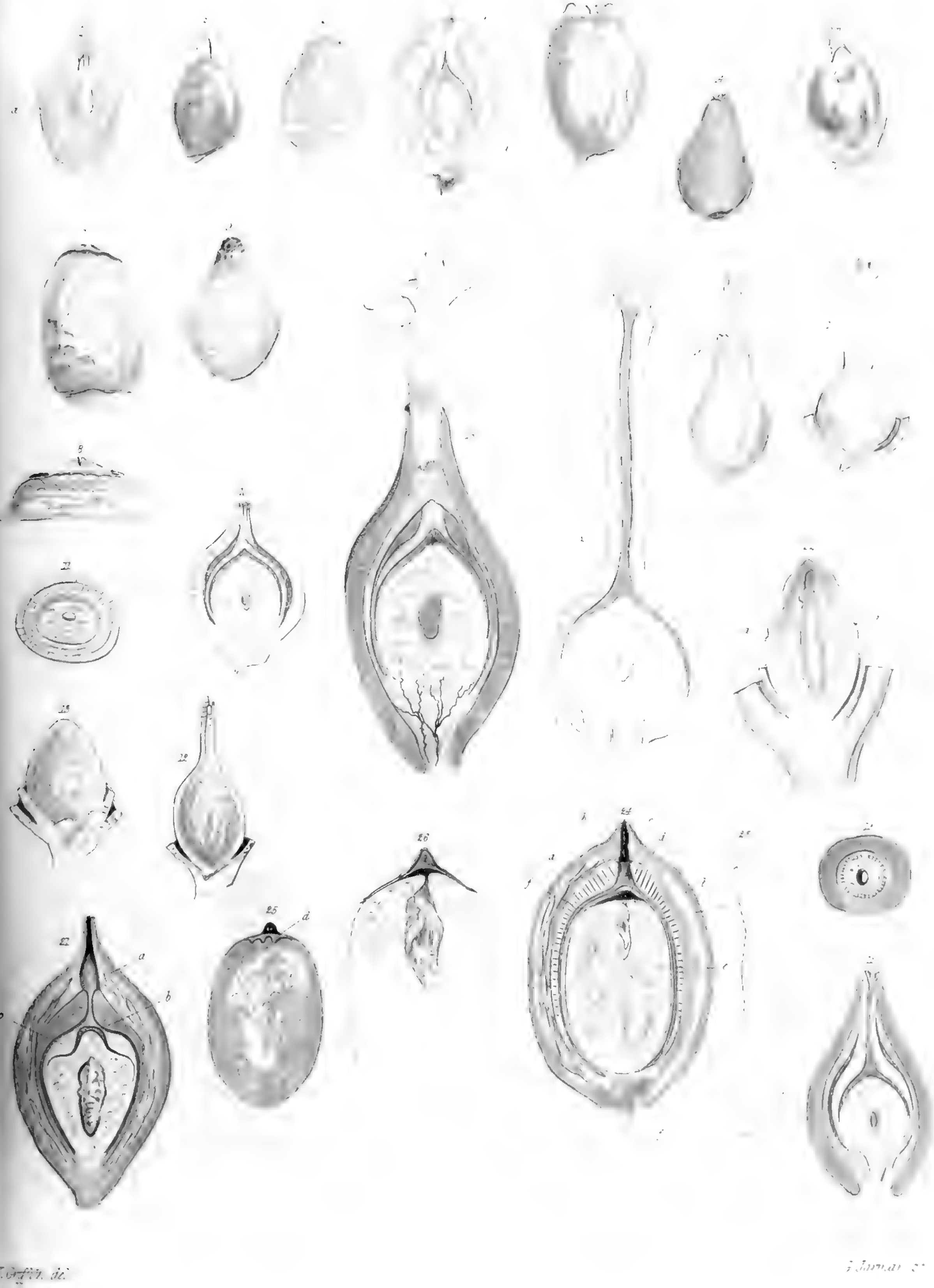
Fig. 43. Stamen of *G. Brunonianum* (?) at an early period; the filaments are still distinct at their bases; the number, direction, and termination of the vascular fasciculi are shown.

Fig. 44. Male flower of *G. Brunonianum* (?) before dehiscence.

Fig. 45. Stamen of the same, the base of the perianth partly remaining; the anthers have dehisced.

Fig. 46. Pollen of the same.

Fig. 47. The same after immersion in water.



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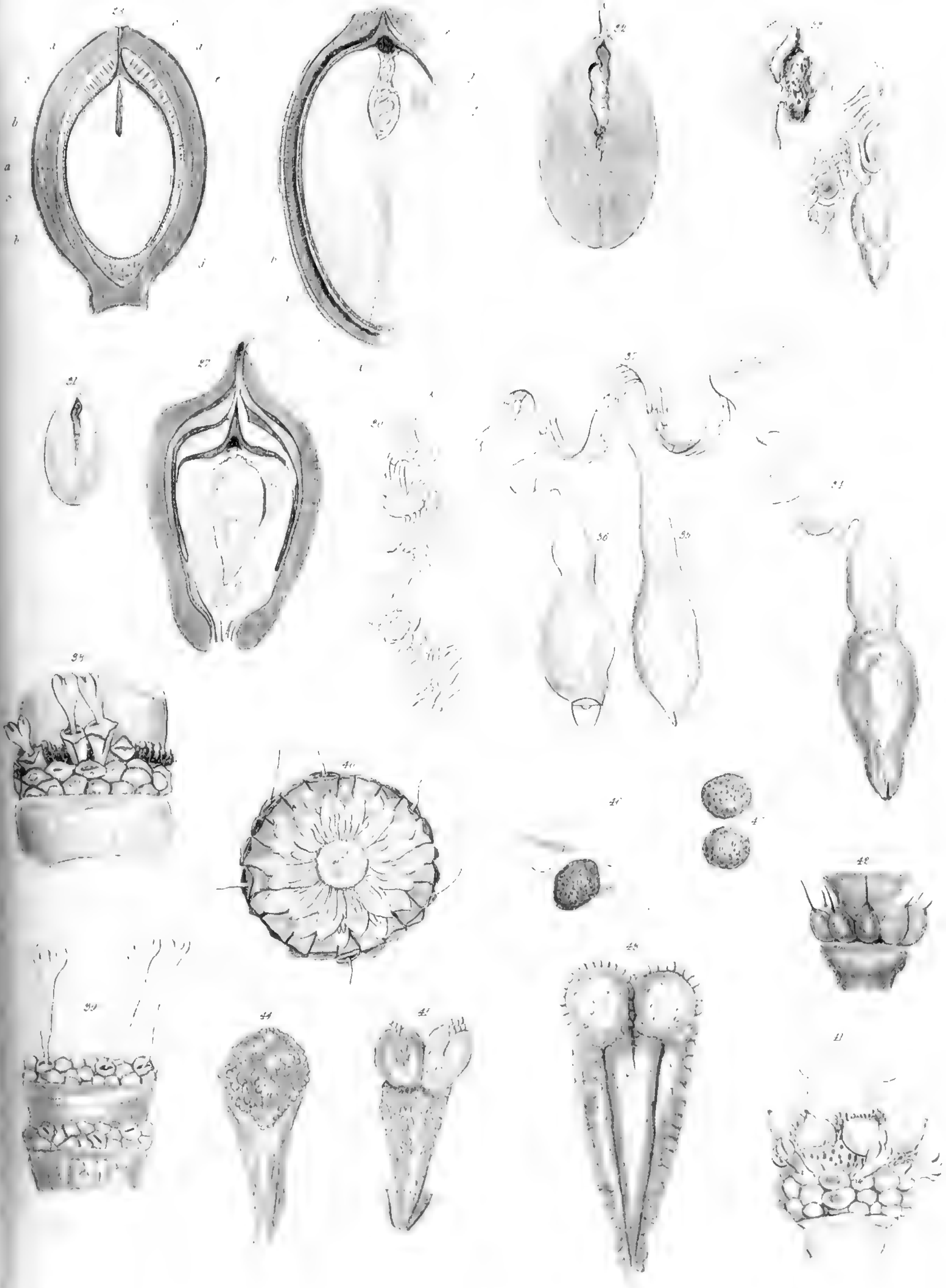

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XXIV.—*Synopsis of the Fructification of the Simple* Sphæriæ *of the Hookerian Herbarium.* *By* FREDERICK CURREY, *Esq., M.A., F.R.S., F.L.S.*

Read May 5th, 1859.

IN a paper published in the last Part of the 'Transactions' of this Society, I have figured and described the fructification of all the species of compound *Sphæriæ* contained in the Hookerian herbarium, that is to say, of all those species whose fruit was sufficiently perfect. Sir William and Dr. Hooker having kindly afforded me the same facilities for the examination of the other great division of the genus, that is the simple *Sphæriæ*, I am now enabled to lay before the Society the result of my examination of the remaining species contained in their herbarium. I adopt the course pursued in the former paper, of prefixing a short account of the characters of the sections and divisions, as given in the 'Systema Mycologicum.'

Most of the plants described in the present paper belong to the genus *Sphæria* as limited in Fries' 'Summa Vegetabilium Scandinaviæ,' but a few are referrible to some of the new genera proposed in that work, and I have noted such of the species as belong to the new genera, and have given the characters of such genera in the notes, as they occur.

The simple *Sphæriæ* commence with the 5th Section, "SUPERFICIALES."

SECTION V. SUPERFICIALES.—*Perithecia* free, bicorticate, seated on an effused villous subiculum, or altogether superficial.

DIV. 17. BYSSISEDÆ.—*Perithecia* free, glabrous, with a short subpapillæform ostiolum, seated on a tomentose subiculum, formed of densely interwoven threads.

DIV. 18. VILLOSÆ.—*Perithecia* ovate or globose, clothed with simple persistent down; ostiolum even, subpapillæform, rarely elongated or obsolete.

DIV. 19. DENUDATÆ.—*Perithecia* naked, ovate or globose, glabrous, without any subiculum; ostiolum short, subpapillæform.

DIV. 20. PERTUSÆ.—*Perithecia* naked, glabrous, flattened at the base, adnate or immersed, pierced by the falling off of the ostiolum.

SECTION VI. SUBIMMERSÆ.—*Perithecia* immersed, often erumpent; ostiolum conspicuous, dilated, or elongated into a neck.

DIV. 21. PLATYSTOMÆ.—*Perithecia* at first covered, then more or less exposed; ostiolum somewhat compressed, very broad, opening by a longitudinal fissure.

DIV. 22. CERATOSTOMÆ.—*Perithecia* at first covered, often surrounded with down, then emerging, naked, free, black, terminated by a beaked cylindrical ostiolum generally longer than the perithecium.

DIV. 23. OBTECTÆ.—*Perithecia* immersed in the perennial parts of plants, with a short erumpent neck, which is often dilated at the apex.

SECTION VII. SUBINNATÆ.—*Perithecia* innate in the epidermis of the matrix.

DIV. 24. OBTURATÆ.—*Perithecia* at first innate, covered by the epidermis, then erumpent, naked, almost superficial, glabrous; ostiolum naked, papillæform or rimosely dehiscent.

Div. 25. Subtectæ.—*Perithecia* innate, covered, at length erumpent, concrete with the matrix, often without a prominent ostiolum.

Div. 26. Caulicolæ.—*Perithecia* subinnate, at first covered, at length exposed by the separation of the epidermis, discrete from the matrix.

Div. 27. Foliicolæ.—*Perithecia* innate, covered, connate with the matrix, very rarely erumpent or free.

Div. 28. Depazea.—*Perithecia* simple, innate, seated on an arid spot on leaves which are still green.

Div. 17. Byssisedæ.

215. S. Glis, Berkel. and Currey MS. Tab. LVII. fig. 1, ascus with sporidia, × 220. Sporidia biseriate, pale brown, simple, slightly curved, 0·0009 to 0·001 inch long, rounded at each end. Perithecia rather large, round and very flat, seated on a dense subiculum, usually entirely hidden beneath the bark, not erumpent, but raising the bark into smooth, rounded, or elongated swellings; the perithecia and subiculum are usually of a dark dirty green tinge. I do not know where to classify this plant, if not with the *Byssisedæ*, although it is quite anomalous to find a *Sphæria* of this division entirely hidden by the bark. The presence of the fungus is only indicated by the smooth swelling of the small branches of oak, on which it occurs. The wood of these branches is generally somewhat decayed. The *Sphæria* is common in the neighbourhood of Weybridge, and I have also found it near Tunbridge. It grows, as far as I know, only on oak, and I am not aware that it has been hitherto described. Some of my correspondents have received it from me under the manuscript name of *S. tomentosa*; but Mr. Berkeley, to whom I sent it at first without a name, marked it in his herbarium as *Sphæria Glis*, and at his request I have adopted that name.

216. S. Desmazieri, Berk. and Br.; Ann. & Mag. Nat. Hist. 2 ser. vol. ix. p. 318. pl. 9. fig. 1. Tab. LVII. fig. 2, ascus with sporidia, and free sporidia, × 325. Sporidia uniseriate, overlapping, dark brown when ripe, with globular and irregularly-shaped nuclei, subcymbiform, somewhat flexuous, 0·0013 inch long.

217. S. (Nectria) rosella, A. and S.; Fr. S. M. ii. p. 441. Tab. LVII. fig. 3, sporidia, × 325. Sporidia fusiform, slightly constricted in the middle, colourless or greenish, with the endochrome bipartite, 0·0010 to 0·0012 inch long.

218. S. aquila, Fr. S. M. ii. p. 442. Tab. LVII. fig. 4, sporidia, × 325. Sporidia dark brown, almost opaque, almond-shaped or subcymbiform, or oblong and slightly curved, sometimes with one, two, or three nuclei, 0·0006 to 0·0008 inch long.

219. S. truncata, Sz.; Fr. S. M. ii. p. 442. Apparently not distinct in any material respect from *S. aquila*, Fr.

220. S. fulva, Fr. El. ii. 90. Tab. LVII. fig. 5, asci with sporidia, and free sporidia, × 325. Sporidia biseriate or crowded, occasionally uniseriate, colourless, broadly almond-shaped, sometimes subcymbiform, 0·0004 to 0·0005 inch long; endochrome bipartite, sometimes continuous.

221. S. (Nectria) aurantia, Pers.; Fr. S. M. ii. p. 440. Tab. LVII. fig. 6, ascus with sporidia, and free sporidia, × 325. Sporidia uniseriate, colourless or greenish, almond-shaped or flexuous, 0·0006 to 0·0008 inch long; endochrome bipartite. On

Polyporus versicolor. I have in my herbarium a *Sphæria* on *Polyporus hispidus*, not apparently distinct from *N. aurantia*, Pers., but producing the fruit shown in fig. 7, where the sporidia are elliptical, not acuminate or flexuous, 0·0005 inch long, and very different in appearance from those of the Kew plant.

222. S. THELENA, Fr. S. M. ii. p. 441. TAB. LVII. fig. 8, ascus with sporidia, × 325. Sporidia uniseriate, black-brown, opaque, elliptical or slightly curved, sometimes with a large nucleus, 0·0009 inch long. Not distinct, I should say, from *S. aquila*, Fr., although the sporidia are rather narrower.

223. S. LANATA, Fr. S. M. ii. p. 442. The specimens of this plant are in bad condition. I could find very few sporidia, and those hardly differed from the sporidia of *S. thelena*, except perhaps in being slightly more acuminate. Perithecia somewhat collapsed, without a manifest ostiolum; subiculum loose, hairy.

224. S. SUBICULATA, Sz.; Fr. S. M. ii. p. 443. TAB. LVII. fig. 9, sporidia, × 325. Sporidia broadly elliptical, with sometimes one, sometimes two nuclei; the two occasionally approaching so close as to give a septate appearance, dark brown, 0·0004 inch long. The subiculum is wanting in the Kew specimens. The plant is like *S. aquila*, but the perithecia are blacker, flatter, and much smaller.

225. S. ALLIGATA, Fr. S. M. ii. p. 445. TAB. LVII. fig. 10, ascus with sporidia, × 325. Sporidia uniseriate or biseriate, yellowish, oblong, obtuse or somewhat pointed at the ends, constricted in the middle, 0·0007 inch long. Erumpent, but furnished with a subiculum; endochrome bipartite.

226. S. TRISTIS, Tode; Fr. S. M. ii. p. 444. TAB. LVII. fig. 11, sporidia, × 450. Sporidia biseriate, linear, acuminate, usually with four nuclei, but sometimes with only two large ones, producing a spurious uniseptate appearance, colourless, 0·0003 to 0·0004 inch long.

227. S. PHÆOSTROMA, D. R. and M.; Fl. Alg. t. xxvi. f. 2. TAB. LVII. fig. 12, sporidia, × 450. Sporidia triseptate, colourless, or almost so, at each end, clear brown in the middle, with or without nuclei, 0·0014 to 0·0016 inch long. This plant is the *S. tristis* β of the 'English Flora.'

DIV. 18. VILLOSÆ.

228. S. SCABRA, n. s. TAB. LVII. fig. 13, sporidia, × 325. Sporidia biseriate, fusiform, constricted in the middle, with many (usually 6) nuclei, colourless, 0·0012 to 0·0014 inch long. Perithecia very hairy, seated on a dense subiculum, *erumpent*. On furze, Weybridge, Oct. 1857. The fruit is like that of *S. macrotricha*, B. and Br.

229. S. CANESCENS, Pers.; Fr. S. M. ii. p. 448. TAB. LVII. fig. 14, sporidia, × 450. Sporidia colourless, straight or curved, subacuminate, sometimes more pointed at one end than at the other, 0·0011 to 0·0014 inch long. See observations on the next plant.

230. S. RACODIUM, Pers.; Fr. S. M. ii. p. 449. TAB. LVII. fig. 15, sporidia, × 220. Sporidia biseriate, in the early state (as in the right-hand sporidium) not distinguishable from the fruit of *S. hirsuta*, eventually pale brown, and 7-septate, 0·002

to 0·0026 inch long. I suspect that the sporidia of *S. hirsuta*, and perhaps also those of *Sphæria ovina* and *Sphæria canescens*, are multiseptate when perfect.

231. S. OVINA, Pers.; Fr. S. M. ii. p. 446. Fructification not distinct from that of *S. hirsuta* (*post*). I have found, however, on one or two occasions specimens which I believe to be *S. ovina*, in which the sporidia exhibit under the microscope a peculiar pink tinge, each sporidium being also furnished with a clear, round, colourless spot. TAB. LVII. fig. 16, represents the fruit of this form × 325 diams.

232. S. CÆSIA, Carm. TAB. LVII. fig. 17, ascus with sporidia highly magnified. Sporidia (? always) uniseriate, colourless, elliptical, or subpyriform, about 0·0002 inch long. Perithecia white, very hairy. This specimen is marked "*S. ovina* statu juniori;" but whoever so named it, had clearly not compared the fruit of the two species.

233. S. HIRSUTA, Fr. S. M. ii. p. 449. TAB. LVII. fig. 18, ascus with sporidia, × 220. Sporidia biseriate or crowded, pale brown, long, flexuous, 0·002 to 0·0026 inch long. See remarks under *S. Racodium* (*supra*).

234. S. RHODOCHLORA, Mont. Syll. p. 227. TAB. LVII. fig. 19, ascus with sporidia, × 325. Sporidia crowded, colourless, broadly elliptical, with a reticulated appearance, but whether from the spores being multicellular, or from a number of nuclei touching one another, I cannot say; 0·0005 to 0·0007 inch long.

235. S. MUTABILIS, Sz. TAB. LVII. fig. 20, ascus with sporidia, × 325. Sporidia biseriate, colourless, curved, acuminate, endochrome 4-partite, 0·0008 inch long. Very like *S. pulvis-pyrius* to the naked eye, but under a power of 50 diams. the perithecia exhibit a very slight brownish hairiness, principally at the base.

236. S. PILOSA, Pers.; Fr. S. M. ii. p. 440. TAB. LVII. fig. 21, ascus with sporidia, × about 325. Sporidia uniseriate, colourless, elliptical, uniseptate, or with the endochrome bipartite, 0·0003 to 0·0004 inch long. A small *Sphæria*, like *S. pulvis-pyrius*, but decidedly hairy.

237. S. (CERATOSTOMA*) CHIONEA, Fr. S. M. ii. p. 446; El. ii. p. 92. TAB. LVII. fig. 22, sporidia, × 325. Sporidia elliptical or subglobose, dark brown, 0·0003 to 0·0005 inch long.

238. S. STRIGOSA, A. and S.; Fr. S. M. ii. p. 448. In my opinion not distinguishable from *S. canescens*, Pers. Fries says, "A præcedente" (that is *S. canescens*) "non facile dignoscitur."

239. S. BRASSICÆ, Kl.; Eng. Fl. p. 261. TAB. LVII. fig. 23, ascus with sporidia, × 220. Sporidia uniseriate, at first colourless, then pale brown, ultimately dark opaque brown, elliptical, with pointed ends, or lozenge-shaped, 0·0014 to 0·002 inch long. On *Brassica oleracea*. Perithecia large, hairy at the bottom, hairs white or brown; sporidia sometimes with two large nuclei, sometimes with a dark line not extending quite across the sporidium.

240. S. PULVINULUS, Berk. TAB. LVII. fig. 24, sporidia, × 325. Sporidia irregular in shape, multiseptate, ? multicellular, very dark brown, varying much in size, from

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* CERATOSTOMA, Fr. Obs. Perithecium membranaceous, soft; ostiolum subulato-rostrate, with a penicillate apex. Nucleus gelatinous, asci soon dissolving (in some species not yet discovered); spores simple, erumpent, surrounding the apex of the perithecium.

0·0010 to 0·0014 inch long. Perithecia roundish, rather pulvinate, very hairy, but the hairs are very short. On wood from Swan River.

241. S. SUPERFICIALIS, n. s. TAB. LVII. fig. 25, asci with sporidia, × 420. Sporidia uniseriate, overlapping, elliptical, or subturbinate, rarely slightly curved, colourless, 2-nucleate, 0·0003 to 0·0004 inch long. Perithecia hairy, subglobose, very small, seated on a hairy subiculum. Like some other *Sphæriæ*, combining the characteristics of the *Villosæ* and *Byssisedæ*.

242. S. CAPILLIFERA, n. s. TAB. LVII. fig. 26, ascus with sporidia, × 325. Sporidia uniseriate, slightly overlapping, rather dark brown, 1–2 nucleate, broadly elliptical, 0·0003 to 0·0004 inch long. Perithecia globose, clothed with very short, rather stiff black hairs, seated on a pale subiculum, and furnished with a mammillate ostiolum. *Quære*, if distinct from *S. crinita*, Pers.

Div. 19. DENUDATÆ.

243. S. INSPERSA, Berk. TAB. LVII. fig. 27, ascus with sporidia, × 325. Sporidia mostly (? always) uniseriate, colourless, subhyaline, elliptico-acuminate, 0·0005 to 0·0006 inch long. On wood from Swan River. Not distinguishable from *S. pulvis-pyrius*, except by the sporidia.

244. S. RHODOMPHALOS, Berk. TAB. LVII. fig. 28, ascus with sporidia, and free sporidia, × 325. Sporidia biseriate, colourless or greenish, curved, subfusiform, uniseptate or with a bipartite endochrome, 0·0007 to 0·0008 inch long. On wood. Perithecia globose, with a distinct red circle round the ostiolum, which is frequently slightly depressed. Sporidia sometimes slightly constricted at the division, and with a nucleus in each partition, as in the right-hand figures.

245. S. BOMBARDA, Batsch; Fr. S. M. ii. p. 456. TAB. LVII. fig. 29, sporidia, × 325. Sporidia crowded, colourless, intertwined, 0·0016 to 0·0020 inch long, but very variable, frequently, if not usually, with a division in the middle. Apparently varying much in the length of the ostiolum. I have seen once or twice a bead-like appearance in the sporidia, arising from the breaking-up of the endochrome into divisions. The fruit of this plant should be particularly observed, as I suspect it may sometimes be multiseptate, as in *S. Racodium, corticis*, &c.

246. S. MORIFORMIS, Tode; Fr. S. M. ii. p. 458; El. ii. p. 94. TAB. LVII. fig. 30, ascus with sporidia, and free sporidia, × 325. Sporidia crowded, uniseptate, colourless, or with a greenish tinge, linear, but slightly curved; endochrome usually granular, sometimes nucleate; asci usually broad as in the figure, but sometimes more elongated.

247. S. PUSTULA, n. s. TAB. LVII. fig. 31, ascus with sporidia, × 325. Sporidia biseriate, colourless, or greenish, subelliptical, but slightly curved, 0·0008 to 0·001 inch long; endochrome bipartite. On wood. Very like *S. pulvis-pyrius*, except in the sporidia. Bungay, Mr. Stock.

248. S. PULVIS-PYRIUS, Pers.; Fr. S. M. ii. p. 458. TAB. LVII. fig. 32, ascus with sporidia, and a free sporidium, × 325. Sporidia straight, or very slightly curved, triseptate, slightly constricted at the septa, pale brown, 0·0005 inch long. In the 'Introduction

to Cryptogamic Botany,' p. 281, Mr. Berkeley figures the sporidia of *S. pulvis-pyrius* with as many as five septa, and of a more elongated form than in my figure. In all the specimens (and they are very numerous) which I have examined, I have never found more than three septa, nor have I ever seen the sporidia so elongated as in Mr. Berkeley's figure. Mr. Berkeley himself mentions the sporidia as being *tri*septate in 'Ann. and Mag. of Nat. Hist.' ser. 2. vol. vii. p. 189.

249. S. CONGLOBATA, Fr. S. M. ii. p. 414. TAB. LVII. fig. 33, ascus with sporidia, and free sporidia, × 325. The specimens of this *Sphæria* in Hook. herb. show clearly that this species is only a crowded, subcuticular, erumpent form of *S. pulvis-pyrius*. Some of the perithecia are bursting transversely, some longitudinally, and others form cæspitose masses; others again have the ordinary scattered habit of *S. pulvis-pyrius*. They form a very instructive series of specimens.

250. S. DIOICA, Fr. S. M. The specimens of this plant in Hook. herb. show clearly that (like *S. conglobata*) this species is only a subcuticular form of *S. pulvis-pyrius*.

251. S. MOROIDES. n. s. Tab. LVII. fig. 34, ascus with sporidia, and free sporidia, × 325. Sporidia biseriate, greenish brown at first, eventually brown, subhyaline, elliptical, 0·0004 to 0·0005 inch long. Perithecia rugose, small, like very small specimens of *S. moriformis*, from which species the present differs altogether in the nature of its sporidia.

252. S. PLATEATA, Pers. in litt. TAB. LVII. fig. 35, ascus with sporidia, × 325. Sporidia crowded, yellowish brown, multipartite, subelliptical, 0·0008 to 0·0010 inch long. On wood. Very like *S. pulvis-pyrius*, except in the sporidia—possibly only a small form of *S. Spartii*, Nees, which latter does not differ essentially from *S. elongata*, Fr.

253. S. SPERMOIDES, Hoffm.; Fr. S. M. ii. p. 457. TAB. LVII. fig. 36, ascus with sporidia, and free sporidia, × 325. Sporidia biseriate, colourless, curved, endochrome sometimes bipartite, 0·0008 inch long.

254. S. MAMMÆFORMIS, Pers.; Fr. S. M. ii. p. 455. TAB. LVII. fig. 37, sporidia, × 450. Sporidia dark clear brown, subcymbiform, varying much in size, from 0·0008 to 0·0016 inch long.

255. S. STERCORARIA, Sow.; Fr. S. M. ii. p. 455. TAB. LVII. fig. 38, ascus with sporidia, × 220. Sporidia uniseriate, brown, eventually quite opaque, at first colourless, elliptical, or almond-shaped, 0·0016 to 0·002 inch long.

256. S. STERCORARIA, Sow. var.? I subjoin here a description of a *Sphæria* which I have found growing on horse-dung, and which is probably the same species as the last, notwithstanding its smaller sporidia and curious ostiola. Perithecia solitary, or few together; ostiola formed of a number of processes arranged in a penicillate manner, each consisting of a single row of irregularly-shaped cells, the upper cell being pointed. Sporidia mostly uniseriate, but sometimes biseriate, greenish at first, then darker, probably eventually black, elliptical, 0·0010 inch long. TAB. LVII. fig. 39 (*a*) represents an ostiolum broken off, × 325 diameters, and fig. 39 (*b*), an ascus with sporidia similarly magnified.

257. S. STERCORARIA, Fr. S. M. ii. p. 455; *S. stercoris*, El. ii. p. 104. TAB. LVII. fig 40, sporidia, × 325. Sporidia biseriate, dark opaque rich brown, consisting of four

joints (? at first continuous), which frequently separate when the sporidia escape from the ascus, 0·0018 inch long.

258. S. BIFORMIS, Sz., non Fries. TAB. LVII. fig. 41, fruit, × 325. I could find no asci. The perithecia are filled with balloon-shaped bodies, with granular contents, colourless, and of irregular size. There is a reddish tinge on the upper part of many of the perithecia, as in *S. rhodomphalos*, Berk. If the plant be a *Sphæria*, it would belong to the present division, but I am doubtful as to the existence of asci.

259. S. VERRUCOSA, Grev.; Fr. Index Alphabeticus=*S. moriformis*, Tode.

260. S. PULVERACEA, Ehrh.; Fr. S. M. ii. p. 459. TAB. LVII. fig. 42, ascus with sporidia, × 325. Sporidia uniseriate, clear dark brown, elliptical, subglobose, or subturbinate, 0·0003 to 0·0004 inch long.

261. S. SORDARIA, Fr. S. M. ii. 458; El. ii. p. 94. TAB. LVII. fig. 43, ascus with sporidia, × 325. Sporidia uniseriate, dark brown, elliptical, 0·0006 to 0·0007 inch long.

262. S. OBDUCENS, Schum.=*S. plateata*, Pers. *supra*.

263. S. POMIFORMIS, P.=*S. pulvis-pyrius*.

264. S. (NECTRIA) PEZIZA, Tode; Fr. S. M. ii. p. 452; El. ii. p. 92. TAB. LVII. fig. 44, sporidia, × 450. Sporidia elliptical, uniseptate (or with the endochrome bipartite), colourless, 0·0004 to 0·0005 inch long. Perithecia fawn-coloured or brown.

265. S. (NECTRIA) SANGUINEA. TAB. LVII. fig. 45, ascus with sporidia, × 325. Sporidia elliptical, colourless, uniseriate or overlapping, uniseptate, 0·0004 to 0·0005 inch long. Fig. 46 represents sporidia of the same species, × 420, at a more advanced period, after the asci have become dissolved.

266. S. (NECTRIA) EPISPHÆRIA, Tode; Fr. S. M. ii. p. 454; El. ii. p. 93. TAB. LVII. fig. 47, sporidia, × highly. Sporidia uniseriate, or overlapping, colourless, elliptical, acuminate or round at the ends; endochrome bipartite, or with two nuclei, 0·0002 to 0·0004 inch long.

267. S. RUBICOLA, n. s. TAB. LVII. fig. 48, sporidia, × 420. Sporidia biseriate, colourless, subcymbiform, or narrowly almond-shaped, with 2 or 4 nuclei, sometimes with the endochrome divided into two parts as in the lower figure, 0·0006 to 0·0007 inch long. Perithecia small, globose, or subglobose, with a mammillate ostiolum; when viewed with a strong lens, they are seen to be closely surrounded with stiff, dark-scattered hairs, sometimes springing from the perithecia, and similar hairs cover the bark where no perithecia are visible. On bramble, Weybridge, October 1857. Almost as nearly allied to the *Villosæ* as to the *Denudatæ*, but perhaps belonging to the latter by preference.

268. S. (GIBBERA*) VACCINII, Sow. t. 373. f. 1; Engl. Flora, vol. v. pt. 2. p. 254. TAB. LVIII. fig. 49, ascus with sporidia, × 325. Sporidia uniseriate, overlapping, almost colourless, but yellow in a mass, almost almond-shaped, but slightly constricted in the middle, uniseptate, 0·0006 inch long, or slightly less. Arranged in Hook. herb. with the *Cæspitosæ*, but *quære*, if not more properly belonging to the *Denudatæ*. It has quite the habit of *S. moriformis*.

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* GIBBERA, Fr. Perithecium ceraceo-corneous, free, radiato-rimose, always closed, filled with a waxy nucleus, which is at length ejected; asci linear, fixed to the base of the perithecium.

269. S. CAUDATA, n. s. TAB. LVIII. fig. 50, ascus with sporidia, × 220. Sporidia biseriate, consisting of a pointed subelliptical brown head, and an elongated colourless tail; length of the sporidia (including the tail) 0·002 inch, of the head alone 0·0008 inch. Perithecia small, scattered, or few together, conical or subglobose, with a conical ostiolum. On rotten wood, near Twycross, Leicestershire. This *Sphæria*, communicated to me by Mr. Bloxam, is very peculiar in the form of its sporidia. The perithecia are sometimes naked, sometimes almost buried in the soft rotten wood, so that I have had great doubt as to its proper division. Its sporidia resemble those of *Podospora fimicola*, Ces., figured in 'Hedwigia,' tab 14. fig. A.

270. S. COLLABENS, n. s. TAB. LVIII. fig. 51, sporidia, × 325. Sporidia biseriate, fusiform, swollen or constricted in the middle, with several nuclei, colourless, 0·0014 to 0·0016 inch long. Perithecia subglobose, with an impressed ostiolum, but the ostiolum is often furrowed, or rimose. The perithecia and sporidia agree very nearly with those of *S. macrotricha*, B. & Br., but the perithecia have no hairs. Its habitat is wood, whilst that of *S. macrotricha* is dried leaves and beech mast. The sporidia also resemble those of *S. scabra*; but, besides being smooth, the perithecia of *S. collabens* are four times the size of those of *S. scabra.*

271. S. CURREYII, Blox. MSS. I have a *Sphæria* from Mr. Bloxam under this name, which is possibly the same as the plant last described. In Mr. Bloxam's plant, however, the sporidia rarely, if ever, exceed 0·0010 inch in length, and the contents of the perithecia have a rose-red tinge. In both this and the *Sphæria* last described, the perithecia with rimose ostiola might easily be mistaken for those of a *Hysterium.*

272. S. PULVISCULA, n. s. TAB. LVIII. fig. 52, ascus with sporidia, and free sporidia, × 325. Sporidia biseriate, curved or cymbiform, colourless or greenish, when perfect with three septa, or at least with the endochrome divided into four portions, giving an appearance of three septa; sometimes the endochrome is only once divided, and in a young state the sporidia are continuous. Length of the sporidia variable, from 0·0008 to 0·0012 inch. Perithecia very small, black, rather shining, conical or subglobose, crowded or scattered, with a minute mammillate ostiolum. This species is not distinguishable by the naked eye from *S. pulvis-pyrius*, but its fruit, as will be seen, is quite different.

Div. 20. PERTUSÆ.

273. S. PERTUSA, Pers.; Fr. S. M. ii. p. 464. TAB. LVIII. fig. 53, sporidia, × 220. Sporidia biseriate, I believe; brown, usually 4-septate, broad and curved, 0·0016 to 0·002 inch long. The specimens are not in good condition.

274. S. PICASTRA, Fr. S. M. ii. p. 463. TAB. LVIII. fig. 54, sporidia, × 220. Sporidia dark brown, multicellular, very irregular in size and shape. I suspect that this plant ought to be placed in the genus *Hendersonia**. Some of the sporidia were elongated as into a foot-stalk. There was no trace of asci.

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* HENDERSONIA, Berk. Perithecium carbonaceous, subinnate, emergent, almost mouthless, bursting with a pore or irregularly. Nucleus compact, then diffluent; sporidia erect, elongate, pedicellate, multiseptate.

DIPLODIA, Fr. Sporidia clavate, uniseptate; otherwise as *Hendersonia.*

275. S. (DIPLODIA) LECYTHEA, Schwein.; Fr. S. M. ii. 460. TAB. LVIII. fig. 55, fruit, × 220. Spores colourless or greenish, elliptical, 0·0010 to 0·0014 inch long. Resembling externally the *Sphæriæ* of this division; but I think it is a *Diplodia*, although there is not any septum in the sporidia.

276. S. MERDARIA, Fr. El. ii. 100. TAB. LVIII. fig. 56, ascus with sporidia, × 420. Sporidia uniseriate, dark black-brown, elliptical or subglobose, 0·0003 to 0·0004 inch long. Arranged with the *Pertusæ* at Kew, but placed by Fries in the *Obtectæ*. I should rather consider it as belonging to the *Denudatæ*, judging from the specimens in the Hookerian herbarium, which are authentic. The perithecia are very small.

277. S. OLEARUM, Cast. TAB. LVIII. fig. 57, ascus with sporidia, × 325. Sporidia uniseriate or biseriate, rather pale brown, elliptical, 5-septate, with a nucleus in each septum, 0·0010 to 0·0012 inch long. Perithecia large, mammillate, subinnate. Apparently belonging to the *Pertusæ*.

278. S. ULMICOLA, n. s. TAB. LVIII. fig. 58, sporidia, × 450. Sporidia oblong, brown, uniseptate, 0·0009 inch long, slightly constricted in the middle. I could find no asci; but, there being no trace of sporophores, the asci had probably become dissolved: if ascigerous, the plant is certainly a *Sphæria*, belonging to this division. Perithecia large, globose, more than half-buried in the wood, furnished with a mammillate ostiolum, which drops off, leaving a large round aperture.

279. S. MICRASPIS, Berk. TAB. LVIII. fig. 59, represents the fruit of this plant, which is probably not a *Sphæria*, but a *Pertusaria*.

280. S. PUTAMINUM, Schwein.; Fr. S. M. 461. TAB. LVIII. figs. 60 & 61, sporidia, × 220. Sporidia uniseriate or crowded (I could not determine whether there were more than four in any of the asci), dark brown, 0·004 to 0·005 inch long. I am uncertain whether the bodies in fig. 60 are sporidia with gelatinous envelopes, or asci with a single sporidium.

281. S. CALLICARPA, n. s. TAB. LVIII. fig. 62, ascus with sporidia and free sporidia, × 325. Sporidia biseriate, very broadly fusiform, 0·0024 to 0·0030 inch long, usually slightly constricted in the middle, with a median septum, and from one to three other septa close together at each end of the sporidium; colour of the sporidia greenish, becoming brown in age; the sporidia have usually a hyaline tip at each end. Perithecia large, almost globose, with a small mammillate ostiolum. On a piece of old broken paling, the surface of which was decayed from exposure, Kidbrooke, Blackheath, March 12, 1859. Quære if distinct from *S. putaminum*, Schw.

Div. 21. PLATYSTOMÆ.

282. S. BARBARA, Fr. S. M. ii. 468. TAB. LVIII. fig. 63, ascus with sporidia, × 220. Sporidia linear, packed side by side along the whole length of the ascus, filiform, of great length, but probably breaking up into short joints, colourless. Fructification resembling that of many plants in the division or genus *Cordyceps*.

283. S. MACROSTOMA, Tode; Fr. S. M. ii. 469. TAB. LVIII. fig. 64, sporidia, × 425.

Sporidia biseriate (? sometimes uniseriate), yellow at first, eventually brown, 5-septate, rarely with 6 or more septa, frequently with longitudinal divisions, rendering the sporidia multicellular, 0·0010 to 0·0012 inch long. I have a plant from Mr. Bloxam marked *S. macrostoma*, Tode, the fruit of which is drawn in fig. 65, × 220 diameters. These sporidia attain a length of from 0·0020 to 0·0026 inch.

284. S. LIGNIARIA, Grev. Sc. Cr. Fl. t. 82. TAB. LVIII. fig. 66, ascus with sporidia, × 425. Sporidia uniseriate, at first pale brown, then dark brown, elliptico-acuminate, 0·0005 inch long. Perithecia somewhat flask-shaped, with a rugose, or rather velvety appearance, but not at all shining.

285. S. CRISTATA, Pers. = *S. crenata*, Fr. S.M. ii. 469. TAB. LVIII. fig. 67, sporidia, × 325. Sporidia almond-shaped, brown, 5–7-septate, 0·0016 to 0·0018 inch long. Quære if distinct from *S. macrostoma*, Tode.

Div. 22. CERATOSTOMÆ.

286. S. BREVIROSTRIS, Fr. S. M. ii. 474. TAB. LVIII. fig. 68, ascus with sporidia, × 325. Sporidia biseriate or uniseriate, pale brown, 0·0006 to 0·0007 inch long, elliptical, rather pointed at the ends.

287. S. LONGISPORA, n. s. TAB. LVIII. fig. 69, ascus with sporidia and free sporidia, (*a*) × 325, (*b*) × 425. Sporidia filiform, arranged side by side, very variable in length and in the number of septa, yellowish brown. Perithecia flattened, with a short ostiolum, mostly covered by the bark, excepting the tip of the ostiolum. This plant is marked in the herbarium "*S. rostellata*," but it differs from that species in the ostiolum.

288. S. (CYTISPORA) MICULA, Fr. El. ii. 101. TAB. LVIII. fig. 70, fruit, × 325. No asci; stylospores variable in length, colourless, fusiform, very pointed; ostiola fuscous. An imperfect state of some *Sphæria*.

289. S. (SPHÆROPSIS ?) PILIFERA, Fr. S. M. ii. 472. Not ascigerous, the perithecia producing only a mass of minute colourless spermatia. Remarkable for its beautifully fine, hair-like ostiolum. Perithecia small and globose.

290. S. CIRRHOSA, MS. TAB. LVIII. fig. 71, ascus with sporidia, × 425. Sporidia biseriate, elliptical, colourless, 0·0004 to 0·0005 inch long. Perithecia ovate or turbinate, quite buried in the wood, but piercing the surface by their very long, almost filiform ostiola. There is another plant marked *S. cirrhosa*, the fruit of which is shown in fig. 72, × 325 diameters. Here the sporidia are uniseriate or biseriate, pale greenish brown, elliptical, frequently with one, two, or more nuclei, 0·0003 to 0·0004 inch long. Perithecia subovate, ostiola about as long as the perithecia.

291. S. ROSTRATA, Fr. S. M. ii. 473. Sporidia biseriate, elliptical or slightly curved, 0·0003 to 0·0004 inch long, colourless, or with a tendency to pale brown. Probably not distinct from *S. cirrhosa*, *supra*.

Div. 23. OBTECTÆ.

292. S. EUTYPA, Fr. S. M. ii. 478. TAB. LVIII. fig. 73, ascus with sporidia and free

sporidia, × about 450. Sporidia biseriate, colourless, slightly curved, 0·0002 to 0·0003 inch long, much resembling those of *S. stigma*.

293. S. VIBRATILIS, Fr. S. M. ii. 482. Authentic specimens of this *Sphæria* exist in the Hookerian herbarium, but the fruit is not ripe. As far as I could make out, the sporidia appear to differ very little from those of *S. stellulata*. There is another *Sphæria* in the collection marked by Mr. Berkeley "*S. vibratilis*, Fr.," in which the fruit is very different. TAB. LVIII. fig. 74, represents the fruit of the latter plant, × 325, of which the following is a description:—Sporidia uniseriate or overlapping, pale brown, oblong-elliptic, but slightly curved, endochrome bipartite, 0·0005 to 0·0006 inch long.

294. S. OPERCULATA, A. & S.; Fr. S. M. ii. 479. TAB. LVIII. fig. 75, ascus with sporidia, × 325. Sporidia biseriate, brown, curved, 0·0005 inch long.

295. S. (HALONIA) CUBICULARIS *, Fr. S. M. ii. 477; El. ii. 97. TAB. LVIII. fig. 76, sporidia, × 325. Sporidia uniseriate, dark brown, elliptical, often acuminate at the ends, 0·0006 to 0·0007 inch long. Easily known by the ostiola being surrounded by a white tubercle formed from the wood. The sporidia, when free, are often surrounded by a narrow border. I have a specimen from Dr. Montagne in which the sporidia reach 0·0010 inch in length. It will be observed that the sporidia differ entirely from the generic characteristics given by Fries.

296. S. LIVIDA, Fr. S. M. ii. 479. TAB. LVIII. fig. 77, sporidia, × 325. Sporidia uniseriate, brown or yellowish-brown, normally I think triseptate, but frequently with longitudinal partial septa, and sometimes (from the breaking up of the endochrome) having a cellular appearance, elliptical, 0·0005 to 0·0007 inch long.

297. S. (SPHÆROPSIS) PRUINOSA, Fr. S. M. ii. 486. Not ascigerous, the perithecia producing only a quantity of minute curved spermatia, colourless when single, greenish brown in the mass. There are two specimens in the herbarium, one from the Scl. Suec. without fruit, and the other containing the spermatia, just mentioned.

298. S. (SPHÆROPSIS ?) OLEÆ, D.C.; Fr. S. M. ii. 489. TAB. LVIII. fig. 78, fruit, × 325. There appear to be no asci; stylospores cylindrical, colourless, rounded at the ends, 0·0008 inch long, sometimes with a border, and sometimes with nuclei.

299. S. (HERCOSPORA) RHODOSTOMA †, A. & S.; Fr. S. M. ii. 485. TAB. LVIII. fig. 79, sporidia, × 325. Sporidia dark brown when perfect, 3-septate, with constrictions at the septa, 0·0009 to 0·001 inch long. In the Kew specimens many of the sporidia are very small and uniseptate.

300. S. CERASARUM, MS. TAB. LVIII. fig. 80, sporidia, × 325. Asci long and narrow; sporidia biseriate, rather dark brown, with the endochrome bipartite, slightly constricted in the middle, acuminate at each end, 0·0009 inch long. The sporidia are

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* HALONIA, Fr. Perithecium entire, covered, membranaceous; ostiolum piercing through and surrounded by a coloured heterogeneous disk; nucleus gelatinous; asci delicate; spores fusiform, pellucid, septate.

† HERCOSPORA, Fr. Perithecium discoloured, subcarbonaceous, cup-shaped, open, covered above with a web and by the bark, breaking through a heterogeneous tubercle; asci elongated, mixed with paraphyses; spores dark-coloured, opaque, septate.

drawn from the specimen marked "*a*" in the herbarium, the other marked "*S. Cerasarum, b,*" not being in good condition.

301. S. TAMARISCINIS, Grev. TAB. LVIII. fig. 81, ascus with sporidia, × 325. Sporidia biseriate, rather dark brown, triseptate (or ? the endochrome 4-partite), usually slightly curved, 0·0008 inch long. Occasionally the sporidia have four septa, and rarely none. There is another plant in the herbarium, marked by Mr. Berkeley *S. Tamariscinis*, Grev., the perithecia of which contain no asci, but a multitude of minute, elliptical, turbinate or irregular yellowish spermatia, varying from 0·0005 to 0·0003 inch in length. It may be, and probably is, an imperfect state of the true *S. Tamariscinis*.

302. S. PINASTRI, Dec.; Fr. S. M. ii. p. 488. TAB. LVIII. fig. 82, ascus with sporidia, × 325. Sporidia crowded, colourless, elliptical, often acuminate at the ends, 0·0003 to 0·0004 inch long.

303. S. CLYPEATA, Nees; Fr. S. M. ii. p. 487. TAB. LVIII. fig. 83, sporidia, × 325. Sporidia uniseriate, rather dark brown, subelliptical or slightly curved, continuous, or with the endochrome divided into two, three, four, or even five portions, 0·0005 to 0·0008 inch long. Easily known by the rounded shining shield-like patches of the blackened epidermis which cover the perithecia. The sporidia are sometimes a good deal broader than those in the figure, and slightly constricted at the septa.

304. S. XYLOSTEI, Pers.; Fr. S. M. ii. p. 487; El. ii. 99. TAB. LVIII. fig. 84, sporidia, × 325. Sporidia uniseriate, dark brown, bordered, elliptical, 0·0006 to 0·0007 inch long. In many of the sporidia I observed a faint indication of a septum in the middle, but I could not satisfy myself that it really existed, or that the endochrome was truly bipartite.

305. S. (HENDERSONIA) MAMMILLANA, Fr. S. M. ii. p. 487. TAB. LVIII. fig. 85, sporidia on stylospores, × 325. Sporidia not contained in asci, but borne upon pedicels, bringing the plant within the genus *Hendersonia*, brown, triseptate, or with the endochrome 4-partite, irregular in shape and length, from 0·0005 to 0·0007 inch long. The sporidia are almost exactly the same as in *Sphæria pulvis-pyrius*.

306. S. (HENDERSONIA) HIRTA, Fr. S. M. ii. p. 483. Fruit not contained in asci, and differing in no respect from the fruit of *S. mammillana*, except perhaps in being slightly smaller. Slight variations in size, however, form no material distinction. In the 'Syst. Myc.' it is noted as a *Cytispora*, but would now be ranked with *Hendersonia*.

307. S. SEMI-IMMERSA, Grev. This plant does not differ in fructification from *S. Xylostei*, Pers., nor, as far as I can see, is it capable of being distinguished from the latter species.

308. S. OCELLATA, Fr. S. M. ii. p. 480. TAB. LVIII. fig. 86, sporidia, × highly. Sporidia biseriate, colourless, slightly curved, rounded or acute at the ends, 0·0004 inch long. This specimen is marked β, as if it were a variety, but I do not find any variety noticed in the 'Syst. Myc.'

309. S. TOMICUM, Lev. Ann. d. Sc. Nat. 1848. TAB. LVIII. fig. 87, sporidia, × 450. Sporidia uniseriate and overlapping, or biseriate, dark (almost opaque) brown, subcymbiform, frequently with two large nuclei, 0·0004 to 0·0006 inch long.

310. S. CONFORMIS, B. and Br. Ann. and Mag. Nat. Hist. ser. 2. vol. ix. p. 325. pl. 11. fig. 19. TAB. LVIII. fig. 88, ascus with sporidia, × 220. Sporidia biseriate, elliptical, often slightly curved, colourless, pellucid, endochrome 4-partite, 0·0007 to 0·0008 inch long. There are not, I think, any real septa.

311. S. (HALONIA) DITOPA, Fr. S. M. ii. 381. TAB. LVIII. fig. 89, asci with sporidia and free sporidia, × 450. Sporidia crowded, very numerous, colourless, oblong, narrow, rounded or somewhat pointed at the ends, 0·0006 to 0·0007 inch long. Fries, in the 'Summa Veg. Scand.,' describes the sporidia as septate. It is possible they may sometimes be so, but I have never seen them otherwise than continuous, with a nucleate or granular endochrome. They are figured so, moreover, by Messrs. Berkeley and Broome, in Ann. and Mag. N. H. ser. 2. vol. ix. pl. 10. fig. 15*. Messrs. Berkeley and Broome, however (*l. c.*), mention Dr. Roussel's specimens of *S. ditopa* as having uniseptate sporidia.

312. S. QUADRI-NUCLEATA, n. s. TAB. LVIII. fig. 90, sporidia, × 450. Sporidia biseriate, very closely packed, colourless, narrowly oblong, pointed or rounded at the ends, each sporidium with four nuclei, 0·0006 inch long. Perithecia small, subglobose, with a mammillate ostiolum, which pierces the outer bark, making a circular hole or a rimose transverse fissure in the bark. On a stick with *S. pulvis-pyrius*, Weybridge, Surrey, September 7th, 1856.

313. S. RUBI, n. s. TAB. LVIII. fig. 91, (*a*) asci with sporidia not quite ripe, × 325; (*b*) ripe sporidia, × 450. Sporidia biseriate, colourless, each with four large nuclei, subfusiform, but wide in the centre, with the sides flexuous, and mostly elongated at each end into a hyaline mucronate appendage. Perithecia very small, punctiform, just penetrating the bark with their minute ostiola. On bramble, Weybridge, Surrey, September 12th, 1856.

314. S. INQUILINA, Wallr.; Fr. El. ii. p. 100. TAB. LVIII. fig. 92, sporidia highly magnified. Sporidia biseriate, colourless, subfusiform, constricted in the middle, 4-nucleate, 0·0004 to 0·0005 inch long. On dead stems of *Smyrnium Olusatrum*. Malling, near Lewes, August 24th, 1858. I have no doubt about the species, although the contents of the perithecia in these specimens is not black, but colourless. When examined under a lens, without extracting the contents, they appear black; but if picked out on the point of a needle, they will be found to be colourless.

315. S. ACUS, Blox. MS., n. s. TAB. LVIII. fig. 93, sporidia highly magnified. Sporidia biseriate or crowded, colourless, narrowly cylindrical, with rounded ends, or acuminate at the ends and then almond-shaped, 0·0003 to 0·0004 inch long, endochrome 2–4-partite. Perithecia small, subglobose, flattened, concealed by the epidermis, which is pierced by the sharp-pointed minute ostiola.

316. S. PHOMATOSPORA, Berk. and Br. Ann. and Mag. Nat. Hist. ser. 2. vol. ix. p. 380. pl. 11. fig. 33. TAB. LVIII. fig. 94, ascus with sporidia highly magnified. Sporidia uniseriate, elliptical, colourless, 0·0003 to 0·0004 inch long, with a nucleus at each extremity, as in the spores of the genus *Phoma*.

317. S. ARGUS, Berk. and Br. Ann. and Mag. Nat. Hist. vol. ix. ser. 2. p. 322. pl. 10. fig. 9. TAB. LVIII. fig. 95, ascus with sporidia, × 220. Sporidia biseriate, straight or curved,

dark olive-green, divided into two unequal parts, in the smaller of which the endochrome is 3-partite, and in the larger 3- or 4-partite. Sporidia surrounded by a gelatinous envelope, which is not always visible in the ascus, especially where the sporidia touch one another. Length of sporidia 0·0020 to 0·0024 inch. I have ventured to place this plant in the *Obtectæ*, contrary to the opinion of Messrs. Berkeley and Broome, who consider its division to be the *Subtectæ*. Very like *S. lanciformis* in the form and nature of its sporidia.

318. S. APICULATA, n. s. TAB. LVIII. fig. 96, (*a*) ascus with sporidia, × 325; (*b*) free sporidia, × 450. Sporidia uniseriate, olive-brown, straight or very slightly curved, biseptate, each furnished with a hyaline tip, which is shut off from the rest of the sporidium by one of the septa. The hyaline tip is frequently, if not generally, invisible in the ascus, owing to the overlapping of the ends of the sporidia. The sporidia are often nucleated; the endochrome is somewhat granular. Length of the sporidia 0·0010 inch. Perithecia large, subglobose, deeply buried in the wood, above the surface of which the rather wide, circular, somewhat gaping ostiolum just protrudes. On a dry, old (? deal) fence of the South-Western Railway, not far from the Weybridge Station, 1856 and 1857. A very curious plant both in habit and sporidia. The perithecia are completely and deeply buried in the wood, and are sometimes scattered, sometimes in circles or groups of as many as five together. The perithecia seem eventually to throw off the wood above the ostiola, leaving deep depressions in the surface of the wood.

319. S. APPENDICULOSA, Berk. and Br. Ann. and Mag. Nat. Hist. ser. 2. vol. vii. p. 189. TAB. LVIII. fig. 97, sporidia, × 325. Sporidia uniseriate, overlapping, colourless, subfusiform, with a caudate appendage, 0·001 inch long with the appendage.

320. S. SIPARIA, Berk. and Br. Ann. and Mag. Nat. Hist. ser. 2. vol. ix. p. 321. pl. 9. fig. 8. TAB. LVIII. fig. 98, ascus with sporidia, × 220. Sporidia biseriate, at first golden-yellow, eventually clear brown, 0·0020 to 0·0024 inch long, without measuring the outer gelatinous envelope in which they are enclosed, and which disappears as the sporidia advance in age.

321. S. (MASSARIA) AMBLYOSPORA [*], Berk. and Br. *l. c.* p. 322. pl. 10. fig. 10. TAB. LIX. fig. 99, ascus with sporidia and a free sporidium, × 220. Sporidia biseriate, greenish-brown, eventually brown, biseptate, lageniform, the apicular cell rather lighter-coloured than the others, 0·002 to 0·0024 inch long, without measuring the gelatinous coat in which they are enveloped. In describing the fruit of this plant, I have adopted the name used by Messrs. Berkeley and Broome, who described it as a new species. I am quite convinced, however, that *S. amblyospora*, Berk. and Broome, is the *Sphæria fœdans* of the 'Syst. Myc.,' the *Massaria fœdans* of the 'Summa Veg. Scand.,' and the *Splanchnonema* of Corda, in Sturm's 'Deutschland's Flora,' t. 54.

322. S. GIGASPORA, Desm. TAB. LIX. fig. 100, ascus with sporidia, × 220. Sporidia biseriate, oblong or almond-shaped, with the sides often incurved at the centre, dark

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[*] MASSARIA, Notar. Perithecium subcarbonaceous; ostiolum papillate, attenuated. Nucleus gelatinous, filled with paraphyses and asci, which dehisce at the apex, ejecting dark septate spores immersed in gelatine, which form a dirty black stain.

brown, triseptate, or with the endochrome 4-partite, surrounded by a narrow gelatinous border. Perithecia small, conical or somewhat flattened, sometimes only just piercing the bark, sometimes protruding considerably. Sporidia ejected in vast numbers, forming wide black stains round the ostiola, 0·0026 inch long. On dead branches of (I think) maple, Blackheath Park, 1855 and 1856. This plant is the type of the genus *Saccothecium* of Fries, the characters of which seem to me most unsatisfactory, and to have been founded upon imperfect microscopical observations.

323. S. INQUINANS, Tode; Fr. S. M. ii. p. 486. TAB. LIX. fig. 101, sporidia, × 220. Sporidia dark brown, with a granular and nucleated endochrome, very variable in size, sometimes reaching 0·0030 inch in length.

324. S. BUFONIA, Berk. and Br. Ann. and Mag. Nat. Hist. ser. 2. vol. ix. p. 323. pl. 10. fig. 13. TAB. LIX. fig. 102, ascus with sporidia, × 220. Sporidia uniseriate, clear rich brown, eventually becoming very dark brown, oblong, constricted in the middle, surrounded by a broad gelatinous envelope, 0·0008 to 0·0011 inch long. Not uncommon on dead branches of oak. One of the finest *Sphæriæ* in point of fructification. The figure in the 'Annals' conveys no idea of the beauty of the sporidia, being hardly more than an outline.

325. S. FUSCELLA, Berk. and Br. *l. c.* p. 325. pl. 11. fig. 20. TAB. LIX. fig. 103, ascus with sporidia, × 325. Sporidia uniseriate, colourless at first, eventually pale brown, oblong-elliptic, rarely very slightly curved, or incurved or constricted in the middle, 0·0007 inch long; endochrome 4-partite, giving a triseptate appearance.

326. S. TILIÆ, Pers. Syn. p. 84; Fr. S. M. ii. p. 485. TAB. LIX. fig. 104, sporidia, × 325. Sporidia biseriate, dark brown, lageniform, uniseptate, 0·0018 inch long, without measuring the gelatinous coat in which each sporidium is enveloped. I am not quite certain whether this plant is the true *S. Tiliæ* of Persoon. It is not uncommon, and cannot be mistaken for any other if attention be paid to its fruit, and to its growing upon lime. In fig. 105 and fig. 106 I have represented asci with the sporidia and free sporidia of a *Sphæria* on lime, communicated to me by Mr. Berkeley as *S. Tiliæ* of Mougeot and Nestler. The sporidia of this plant are uniseriate or biseriate, colourless, acuminato-elliptical, 0·0006 inch long, with bipartite endochrome.

327. S. ASHWELLIANA, n. s. TAB. LIX. fig. 107, ascus with sporidia, × 220. Sporidia uniseriate or biseriate, colourless or greenish, elliptical, but mostly pointed at each end and slightly constricted in the middle, 1–4-septate, hyaline, 0·0010 to 0·0014 inch long. On small branches of fir, Weybridge, Surrey, October 1857. Perithecia? The specimens were in bad condition, and I have some doubt whether the plant belongs to the *Obtectæ* or the *Circinatæ*; but I know of no species in either of those divisions with similar fruit, and have therefore proposed the present as a new one.

Div. 24. OBTURATÆ.

328. S. MILLEPUNCTATA, Grev. I cannot distinguish this plant from *S. corticis*, Sow.; and this seems to be Fries' opinion (see 'Elenchus,' ii. 98).

329. S. FRAXINI, Fr. This also seems to me to be identical with *S. corticis*, Sow.

330. S. CORTICIS, Sow. t. 372. f. 5; Fr. S. M. ii. 481; El. ii. 98. TAB. LIX. fig. 108, ascus with sporidia and free sporidia, × 325. Sporidia biseriate or crowded, pale brown, but of rather a rich colour, curved, variable in length, but in good ripe specimens about 0·0008 inch long. Intermixed with the *Sphæria*, and exactly resembling it, I find other perithecia containing the bodies on the right of the figure, which were of a darker brown, and 3–5- or 7-septate, varying from 0·0006 to 0·0012 inch long, which I doubt not are perfect, free sporidia, the asci having deliquesced.

331. S. TRANSVERSALIS, Schw.; Fr. El. ii. 94. TAB. LIX. fig. 109, ascus with sporidia, × 325. Sporidia uniseriate, dark brown, elliptical, subglobose, or even quite globular, 0·0004 inch long. Arranged with the *Obturatæ*, but belonging, I think, to the *Denudatæ*, and in my opinion not distinct from *S. pulveracea*, Ehrh. Fries (El. ii. 94) considers *S. transversalis* identical with *S. myriocarpa*. I have seen no specimens of the latter *Sphæria* in fruit, but it is possibly not distinct from *S. pulveracea*.

332. S. JUGLANDIS, Fr. S. M. ii. 493. TAB. LIX. fig. 110, sporidia, × highly. Sporidia biseriate, colourless, almond-shaped or narrowly elliptical, frequently curved, usually 4-nucleate, sometimes with the endochrome bipartite (? sometimes 5-partite), 0·0004 to 0·0005 inch long. I believe this to be the perfect form of *S. Juglandis*, Fr. The Hookerian herbarium contains another form, next described, which is an authentic specimen from the Scl. Suec., but which is not a true *Sphæria*, and is perhaps an imperfect form of the species just described.

333. S. JUGLANDIS, Fr. S. M. ii. 493. TAB. LIX. fig. 111, fruit, × highly. No asci; but the perithecia contain a quantity of minute, colourless or slightly yellowish, narrowly almond-shaped stylospores, borne on rather long pedicels, which, when broken off, look like the fruit of a *Cytispora*, but are in reality only the fulcra of the stylospores. Stylospores 0·0002 to 0·0003 inch long, sometimes with two nuclei or with a bipartite endochrome.

334. S. INSPERSA, Sz. TAB. LIX. fig. 112, ascus with sporidia, × 325. Sporidia biseriate or crowded, with the endochrome 4-partite, dark brown, constricted at the partitions, usually rather more pointed at one end than at the other, 0·0010 to 0·0011 inch long. Not to be confounded with *S. inspersa*, Berk., which has very different sporidia.

335. S. (SPHÆROPSIS ?) UBERIFORMIS, Fr. S. M. ii. 491. TAB. LIX. fig. 113, fruit, × 325. I could find no asci. Perithecia filled with elongate, acuminate, colourless spores, having the endochrome 4-partite, 0·0005 to 0·0008 inch long. Easily known by its udder-shaped perithecia; but it is, perhaps, not a true *Sphæria*.

336. S. (HENDERSONIA ?) OPPILATA, Fr. S. M. ii. 493. TAB. LIX. fig. 114, fruit highly magnified. No asci. Perithecia filled with almond-shaped colourless spores with bipartite endochrome, 0·0003 to 0·0004 inch long. This would be a *Sphæria* or a *Hendersonia*, according to whether it has or has not asci.

337. S. (HENDERSONIA) PALINA, Fr. S. M. ii. 494. The fruit of this plant is not distinguishable from that of *S. oppilata*, but the spores rarely exceed 0·0003 inch in length. The endochrome also is sometimes continuous instead of bipartite, and the spores are borne on long peduncles, as in *S. Juglandis*, but which I did not observe in *S. oppilata*.

338. S. (HENDERSONIA) STROBILINA, Holl & Schm. The fruit in this species is just like that of *S. palina*, but larger, being 0·0005 inch long.

339. S. LONICERÆ, Fr. S. M. ii. 492. TAB. LIX. fig. 115, ascus with sporidia, × 325. Sporidia uniseriate, colourless, or with a greenish tinge, elliptical, 0·0004 to 0·0006 inch long; endochrome tripartite.

340. S. PISIFORMIS, Pers. *in lit.* Incorrectly arranged in this division; it belongs to the *Obvallatæ*, and is probably the Sphæropsoid form of *S. leiphæmia.*

341. S. (SPHÆROPSIS) OBTUSATA, Fr. S. M. ii. 495. Spermatia colourless, curved, about 0·0004 inch long.

342. S. (HENDERSONIA) SYRINGÆ, Fr. S. M. ii. 492. TAB. LIX. fig. 116, fruit, × 325. Fruit borne on stalks, not contained in asci, irregular in size and shape, dark brown. In the later arrangements it would be placed in the genus *Hendersonia*, or perhaps in *Diplodia.*

Div. 25. SUBTECTÆ.

343. S. (DIPLODIA) ILICIS, Fr. S. M. ii. 501. TAB. LIX. fig. 117, fruit, × 325. No asci. Fruit borne, I think, on short peduncles, elliptical, oblong, subglobose or turbinate, irregular in size and shape, almost colourless, but with a yellowish-green tinge.

344. S. (DIPLODIA) SARMENTORUM, Fr. S. M. ii. 498. TAB. LIX. fig. 118, fruit, × 325. No asci. Fruit borne on peduncles, dark brown, uniseptate when ripe, with sometimes a large globose nucleus in each division, irregular in size, about 0·0007 inch long on an average.

345. S. (SPHÆROPSIS ?) ATROVIRENS, β. BUXI, Fr. No asci. Stylospores exactly like those of *S. Juglandis*, but not septate or nucleate. Peduncles rather long.

346. S. EPIDERMIDIS, Fr. S. M. ii. 499. TAB. LIX. fig. 119, ascus with sporidia, × 325. Sporidia uniseriate or slightly overlapping, rather light brown, elliptical, uniseptate, or with the endochrome bipartite, hardly 0·0004 inch long. There is another plant in the herbarium, marked by Mr. Berkeley *S. epidermidis*, Fr., in which the perithecia have no asci, but contain a mass of fusiform, straight or slightly curved, yellow spores, faintly 1-, 2-, or 3-septate, or 1-, 2-, or 3-nucleate, measuring from 0·0002 to 0·0006 inch. These spores are drawn to the right of the ascus in fig. 119.

347. S. RUSCI, Wallr. TAB. LIX. fig. 120, sporidia, × 450. Sporidia straight or curved, normally 4-septate, occasionally 3- or 5-septate, constricted at the septa, each division usually with one or more nuclei; colour of the sporidia a clear yellowish brown; length 0·0006 to 0·0010 inch.

348. S. SERIATA, n. s. TAB. LIX. fig. 121, sporidia, × 325. Sporidia biseriate, colourless, slightly curved, with many nuclei, fusiform, 0·0008 inch long. Perithecia small, globose, bursting in somewhat parallel lines through the surface of the wood.

Div. 26. CAULICOLÆ.

349. S. DOLIOLUM, Pers.; Fr. S. M. ii. 509. TAB. LIX. fig. 122, sporidia, × 325. Sporidia biseriate, or uniseriate and overlapping, yellowish brown, curved, or almost straight, 3–5-septate, constricted at the septa, 0·001 inch long, or rather more.

350. S. Dematium, Pers.; Fr. S. M. ii. 505. Tab. LIX. fig. 123, sporidia, × 325. This plant was not, I think, quite ripe. Most of the sporidia were curved and colourless, as in the right-hand one of the three; but septa were just visible in one or two of the sporidia, and nuclei in others. I have little doubt that the sporidia, when ripe, are brown or yellowish, and three or four times (or even more) septate. There are three specimens of this species in the herbarium, marked α, β, and γ. The above description is from (α); I could find no fruit in (β) and (γ).

351. S. Arundinis, Fr. S. M. ii. 510. Tab. LIX. fig. 124, sporidia, × 425. Sporidia biseriate, at first yellowish, then brown, 3–5-septate, sometimes with six septa, slightly curved, somewhat pointed at each end, frequently with nuclei in the septa, 0·0010 to 0·0016 inch long.

352. S. (Sphæropsis?) Corni Suecicæ. Not a true *Sphæria*. Perithecia producing only minute, straight, cylindrical, colourless spermatia, 0·0002 inch long.

353. S. (Sphæropsis?) acuta, Hoffm. I believe *S. acuta*, Hoffm., to be only a sphæropsoid state of some common Caulicolous species; but whether of *S. complanata* or *S. herbarum*, or of any other species, it is impossible to say.

354. S. complanata, Tode. It is difficult, without authentic specimens, to be certain as to the true *S. complanata* of Tode. The sporidia shown in Tab. LIX. fig. 125, × 325 diameters, are those which I have always supposed to belong to the true species. These sporidia are biseriate, or uniseriate and overlapping, colourless, or yellow, 2–4-partite, sometimes apparently triseptate; they vary at different ages of the plant; (*a*) represents the young state, (*b*) the more advanced; (*c*) is a form equally common (in the same specimens) with (*b*); (*d*) is, I think, the perfect and typical form of fruit.

355. S. coniformis, Fr. S. M. ii. 508. Tab. LIX. fig. 126, sporidia, × 325. Sporidia biseriate, yellow, slightly curved, 5–11-partite, varying much in length, as is shown by the figure. See the remarks on the fruit of this species as compared with *S. acuminata*, Sow., in Ann. and Mag. Nat. Hist. ser. 2. vol. ix. p. 328.

356. S. imberbis, MS. This specimen contains three different plants—1st, *Sphæria herbarum*; 2ndly, perithecia containing curved colourless stylospores, like the spermatia of *S. verrucæformis*; 3rdly, perithecia containing minute, colourless, straight, or slightly curved cylindrical spermatia or stylospores.

357. S. phæosticta, Berk. Tab. LIX. fig. 127, ascus with sporidia and free sporidia, × 325. Sporidia uniseriate or biseriate, very dark brown, subcymbiform, 0·0004 inch long. Perithecia minute, punctiform. On *Hierochloe Brunonis*, from the Auckland Group and Campbell Islands.

358. S. (Hendersonia) Zeæ, Schwein.; Fr. S. M. ii. 527. Tab. LIX. fig. 128, fruit, × 325. No asci. Perithecia containing the narrowly cylindrical or irregularly-shaped bodies shown in fig. 128. These bodies have a bipartite endochrome, and are rather dark brown. On culms of *Zea Mays*. If there be no asci, this plant is a *Hendersonia*; but the asci may have dissolved, and then it would be a *Sphæria*. There is another specimen in the herbarium marked *S. Zeæ*, Sz., which is, I think, identical with *Hendersonia arcus*, B. & Br.

359. S. PELLITA, Fr. S. M. ii. 503. TAB. LIX. fig. 129, sporidia, × 325. Sporidia, × 325. Asci clavate; sporidia crowded, multiseptate, fusiform, yellow, with a swollen joint, which is sometimes the third, sometimes the fourth from the end, 0·0015 to 0·0016 inch long. There is another specimen in the herbarium, marked *S. pellita*, Fr., in which the fruit is not distinguishable from that of *S. coniformis, supra.*

360. S. NIGRELLA, Fr. S. M. ii. 512. TAB. LIX. fig. 130, sporidia, × 325. Sporidia biseriate, colourless or greenish, fusiform, 0·0008 inch long; endochrome bipartite.

361. S. PISI, Sow.; Fr. S. M. ii. 509. TAB. LX. fig. 131, ascus with sporidia, × 325. Sporidia biseriate, yellow or yellowish brown, multicellular, 0·001 inch long. On *Asparagus officinalis.* I think not distinct from *S. herbarum.*

362. S. ASTRAGALI, n. s. TAB. LIX. fig. 132, sporidia, × 325. Sporidia biseriate, subfusiform, varying at the extremities from acute to obtuse, colourless; endochrome unipartite, 0·0006 to 0·0008 inch long. Perithecia minute, globose, shining, half-hidden by the epidermis. On petioles of *Astragalus.* Dr. Richardson, Arctic expedition, 1827 (? =*S. nigrella*, Fr.).

363. S. ACUMINATA, Sow.; Fr. S. M. ii. 506. TAB. LIX. fig. 133, ascus with sporidia, and a broken ascus with sporidia protruding, × 325. Sporidia filiform, almost as long as the ascus, yellowish brown in a mass, but of a very pale colour when separate, arranged side by side. See the remarks of Mr. Berkeley on the fructification of this species in Ann. and Mag. Nat. Hist. ser. 2. vol. ix. p. 328. I could not clearly make out any septa in the specimens in the Hookerian herbarium, although some of the asci when full of sporidia seemed marked with very faint transverse lines. Mr. Berkeley says there are about twenty articulations.

364. S. CARICINA, Desm. The perithecia contain only minute, acuminate, colourless spermatia, without septa or nuclei, just like those of *S. Juglandis*, but slightly longer.

365. S. (DIPLODIA) CALVESCENS, Fr. S. S. 401. This specimen has perithecia containing the brown uniseptate fruit, not contained in asci, shown in TAB. LIX. fig. 134, × 325. It should be classed, I think, with *Diplodia.* In company with this plant are some other perithecia with asci and sporidia, the latter differing little, if at all, from the sporidia of *S. herbarum.*

366. S. CLIVENSIS, Berk. & Br. Ann. and Mag. Nat. Hist. ser. 2. vol. ix. p. 879. pl. 11. fig. 29. TAB. LIX. fig. 135, ascus with sporidia, × 220. Sporidia biseriate, dark brown, oblong or slightly curved, triseptate, constricted at the septa, 0·0006 to 0·0008 inch long.

367. S. RUBELLA, Pers.; Fr. S. M. ii. 506. TAB. LIX. fig. 136, ascus with sporidia, × 220. Sporidia filiform, quite filling the ascus, and of the same length, arranged side by side, colourless when detached, but yellowish brown in the mass. Length of the asci variable, about 0·007 to 0·008 inch long.

368. S. HELENÆ, n. s. TAB. LIX. fig. 137, sporidia, × 325. Sporidia uniseriate, overlapping, brownish yellow, curved, 3-septate, or rarely 4-septate, or with the endochrome 4-partite, or rarely 5-partite, 0·001 inch long. Perithecia conical, truncate. This species is very near *S. complanata*, Tode, but many of the perithecia are in the

form of truncated cones. It may, however, be merely a variety of the latter, and I propose it with doubt as a new species.

369. S. HERBARUM, Fr. S. M. ii. 511. TAB. LIX. fig. 138, asci with sporidia, × 220. Sporidia oblong-elliptic, at first yellow, eventually brown, multicellular, varying in size and in the mode of arrangement in the asci, as will be seen by referring to the figures.

Div. 27. FOLIICOLÆ.

370. S. RHIZOMORPHÆ, Kunze. TAB. LIX. fig. 139, ascus with sporidia and free sporidia, × 325. Sporidia crowded, brown, of rather a dark colour, but clear and transparent, 0·0012 to 0·0016 inch long. From Surinam.

371. S. TUBÆFORMIS, Tode; Fr. S. M. ii. 516. TAB. LIX. fig. 140, ascus with sporidia, × 325. Sporidia biseriate or crowded, colourless, or in age with a dirty-brown tinge, elliptical or subcymbiform, 0·0005 inch long.

372. S. (SPHÆROPSIS ?) MACULÆFORMIS, Pers.; Fr. S. M. ii. 524. This is not a true *Sphæria*. The perithecia produce only exceedingly minute, staff-like, colourless spermatia, not so much as 0·0002 inch long.

373. S. (SPHÆROPSIS ?) OLEÆ, D.C.; Fr. S. M. ii. 489. No asci. TAB. LIX. fig. 141, fruit, × 325. Fruit consisting of subcylindrical, colourless, highly refractive spores, 0·0007 to 0·0009 inch long. I could not make out the mode of attachment; a few of the spores had a sort of string, as in the right-hand figure; but I am doubtful whether it were a true peduncle, or a string of a kind of mucus in which the spores were imbedded. This appears to be the same plant as No. 298 in the *Obtectæ*.

374. S. (SPHÆROPSIS ?) LEPTIDEA, Fr. S. M. ii. 522. Not a true *Sphæria*. Fruit consisting of minute, colourless, straight or very slightly curved, subcylindrical spores, barely 0·0002 inch long.

375. S. (SPHÆROPSIS ?) DUPLEX, var. NARDI, Fr. S. M. ii. 520. Not a true *Sphæria*. Fruit the same as in *S. leptidea*, Fr.

376. S. ? PUNCTIFORMIS, Pers.; Fr. S. S. 86. The perithecia contain colourless saccate bodies, grouped together as in TAB. LIX. fig. 142; but whether they are spores or imperfect asci I cannot say, probably the latter.

377. S. (SPHÆROPSIS) HEDERÆ, Sow.; Fr. S. M. ii. 521. Fruit consisting of colourless cylindrical spores, 0·0008 to 0·001 inch long; not distinguishable from the fruit of *S. Oleæ*, D.C., excepting that the spores are rather narrower and not so refractive, and I observed no peduncles.

378. S. (SPHÆROPSIS) ÆGOPODII, Pers.; Fr. S. M. ii. 526. The fruit is the same as in *S. leptidea*, Fr., *supra*.

379. S. (DISCOSIA*) ARTOCREAS, Tode; Fr. S. S. 151; S. M. ii. 523. TAB. LIX. fig. 143, spores, × 325. The fruit consists of straw-coloured, curved, or almost straight spores, having an extremely delicate filiform appendage at each end. The average length of the spores without the appendage is 0·0007 inch. The spores are probably produced

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* DISCOSIA, Lib. Phlyctid. Notar. Perithecium innate, subcarbonaceous, at length collapsed and plicate; ostiolum pierced. Spores fusiform, prolonged at each end into a filiform appendage.

in asci, which deliquesce at an early period. I can see no sufficient grounds for separating this plant and the following one from *Sphæria.*

380. S. (DISCOSIA) ALNEA, Fr. S. M. ii. 520. This plant has asci; but the sporidia in the specimens in the Hookerian herbarium, which are from the Scl. Suec., are not formed.

381. S. GLAUCO-PUNCTATA, Grev. Fl. Edin. TAB. LIX. fig. 144, sporidia, × 325. Sporidia biseriate, rather dark brown, slightly curved, but sometimes straight; endochrome 3–6- or more partite, 0·0007 inch long. On *Ruscus aculeatus.* Not distinct, I think, from *S. Rusci,* Wallr.

382. S. (SPHÆROPSIS) PALUSTRIS, Fr. *in lit.* The fruit is the same as in *S. leptidea,* Fr.

383. S. (SPHÆROPSIS) VINCÆ, Fr. *in lit.* The fruit is precisely the same in form as in *S. Hederæ, supra.* Length=0·0006 to 0·0007 inch.

384. S. SETACEA, Pers.; Fr. S. M. ii. 518. TAB. LIX. fig. 145, sporidia, × 450. Sporidia biseriate, colourless or greenish, arcuate, usually tapering to a point at each extremity, but sometimes (though rarely) rounded at the ends, 0·0006 inch long, apparently septate; but the apparent septum is, I think, only the line of contact of the bipartite endochrome.

DIV. 28. DEPAZEA.

385. S. (HENDERSONIA) CORNICOLA, Dec.; Fr. S. M. ii. 530. TAB. LIX. fig. 146, fruit, × 325. No asci. Fruit consisting of elliptical, triseptate, pale-brown spores, 0·0004 to 0·0006 inch long, borne on long peduncles.

386. S. (DEPAZEA*) VAGANS, Fr. S. M. ii. 532. No asci. The perithecia contain long filiform or fusiform bodies, precisely like those figured under *S. Juglandis,* where, however, the bodies are not spores, but peduncles. Whether this is so in the present case, I am uncertain.

387. S. (DEPAZEA) UVARIÆ, Berk. TAB. LIX. fig. 147, fruit, × 325. Fruit not contained in asci, colourless, elliptical, subglobose or subturbinate, 0·0002 to 0·0004 inch long. On leaves of *Uvaria triloba.* Spots round or irregular, brown in the centre, becoming much darker towards the edge. Perithecia very small, black.

388. S. (DEPAZEA) FRAXINICOLA, MS.; marked also "*Sphæria lichenoides.*" TAB. LIX. fig. 148, fruit, × highly. Fruit not contained in asci, irregular in shape, being elliptical or subturbinate, or even subcymbiform, 0·0002 to 0·0003 inch long; spots round or irregular, brown, with a dark margin. Perithecia small and black.

389. S. DRYMIDIS, Berk. TAB. LIX. fig. 149, sporidia, × 325. Sporidia biseriate, colourless, uniseptate, the two portions of unequal width, 0·0005 inch long. Perithecia small, black, seated upon quite white, somewhat impressed, margined spots. This is a true *Sphæria* with the habit of a *Depazea.* On dead leaves of *Drymis,* Island of Juan Fernandez, May 1830.

390. S. (DEPAZEA) PALLOR, Berk. Ann. and Mag. Nat. Hist. series 1. vol. vi. p. 362. pl. 11. fig. 2. TAB. LIX. fig. 150, fruit, × 325. Fruit not contained in asci, colourless or with

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* DEPAZEA, Fr. Perithecium carbonaceous, subinnate, mouthless, opening in a circumscissile manner or dehiscing at the apex. Nucleus consisting of thread-like sporophores; spores acrogenous, simple.

a yellow tinge, sometimes straight, but usually more or less curved, 0·0006 to 0·0008 inch in the chord of the arc.

391. S. (Depazea) graminicola, Berk. Ann. Nat. Hist. series 1. vol. i. p. 207. Tab. LIX. fig. 151, fruit, × 325. Fruit not contained in asci, colourless, fusiform, straight or curved, 0·0008 to 0·0009 inch long; endochrome sometimes bipartite, sometimes not. I think it not improbable that this is an imperfect form of *S. graminis*, Pers.

392. S. (Depazea) Brassicæ, Pers. *in lit.* Fruit not contained in asci, similar to that of *S. leptidea*, Fr., but sometimes slightly thicker at each extremity than in the middle; spots rather large, roundish, with an irregular outline, brown in the centre, greenish towards the margin. Perithecia small, black, and numerous.

393. S. (Depazea) Dianthi, Fr. S. M. ii. 531. Fruit not contained in asci; similar to that of *S. vagans*, Fr., *supra*.

394. S. (Depazea) Pisicola, Berk. Tab. LIX. fig. 152, fruit, × 325. Fruit not contained in asci, colourless, of irregular shape, but mostly elliptical; endochrome bipartite or continuous; length from 0·0004 to 0·0005 inch. [I find a minute fungus hardly differing from this, on dead stems of *Smyrnium Olusatrum*. In my plant, however, the perithecia are not seated on an arid spot, and the fruit is rather larger and narrower, and generally more incurved at the sides, giving the spores a sort of dumb-bell shape.] Spots pale, round, margined, often confluent. Perithecia small, black.

395. S. (Depazea) Ribicola, Fr. S. M. ii. 530. Tab. LIX. fig. 153, fruit, × 325. Fruit not contained in asci, colourless, bluntly and irregularly crescent-shaped, 0·0006 to 0·0007 inch between the horns.

396. S. (Depazea) fuscella, Berk. Fruit not contained in asci; similar to that of *S. vagans*, *supra*. Spots brown, paler in the centre. Perithecia very small. On *Convolvulus arvensis*. King's Cliffe, Northamptonshire.

397. S. (Depazea) Alismatis, n. s. Tab. LIX. fig. 154, fruit, × 325. Fruit colourless, bordered, elliptical, subglobose or turbinate, with sometimes the apparent remains of a peduncle, 0·0004 to 0·0005 inch long. On *Alisma Plantago*. Suffolk, Mr. Stock. Perithecia subglobose, chestnut-coloured, at least in the dry plant.

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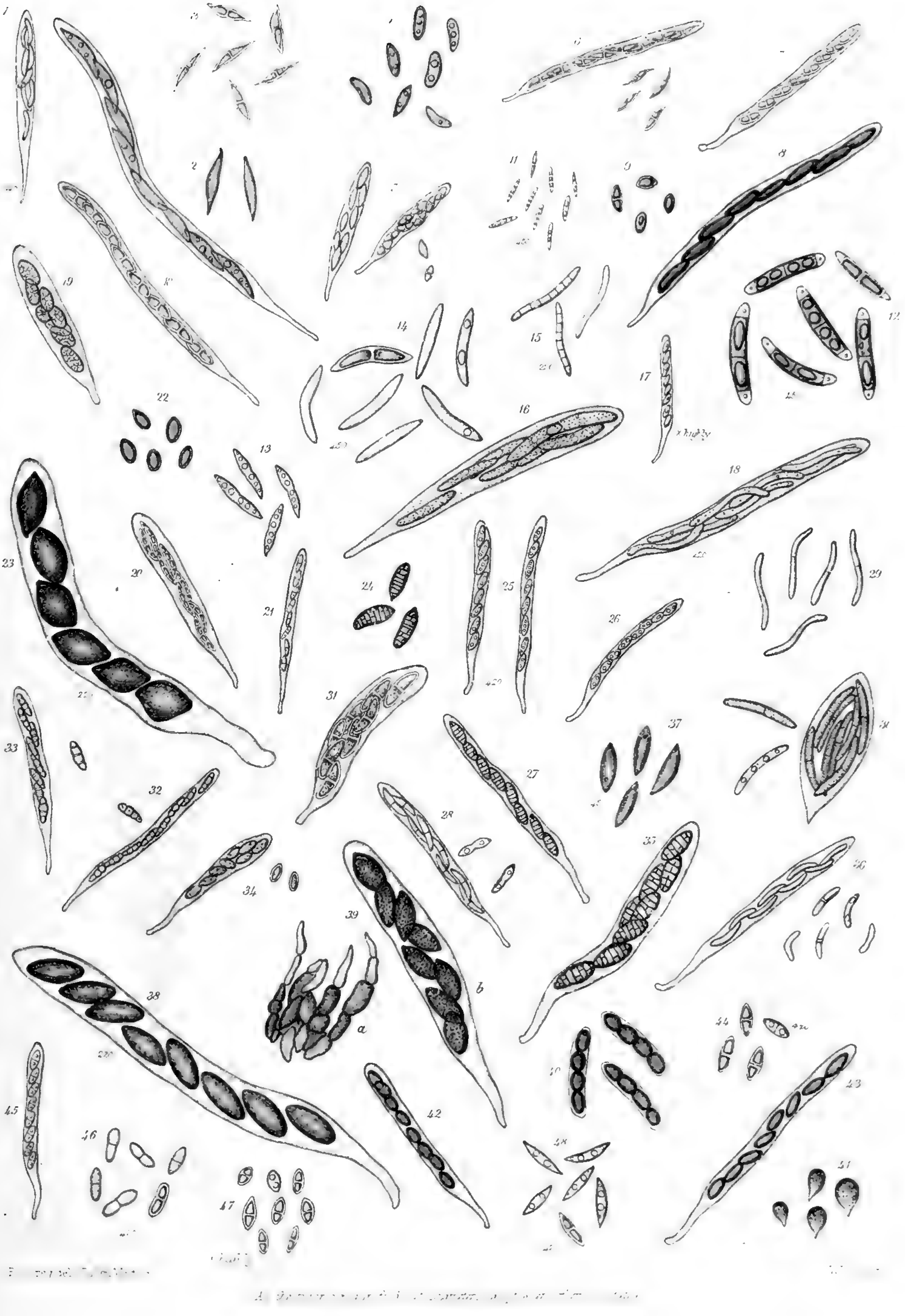
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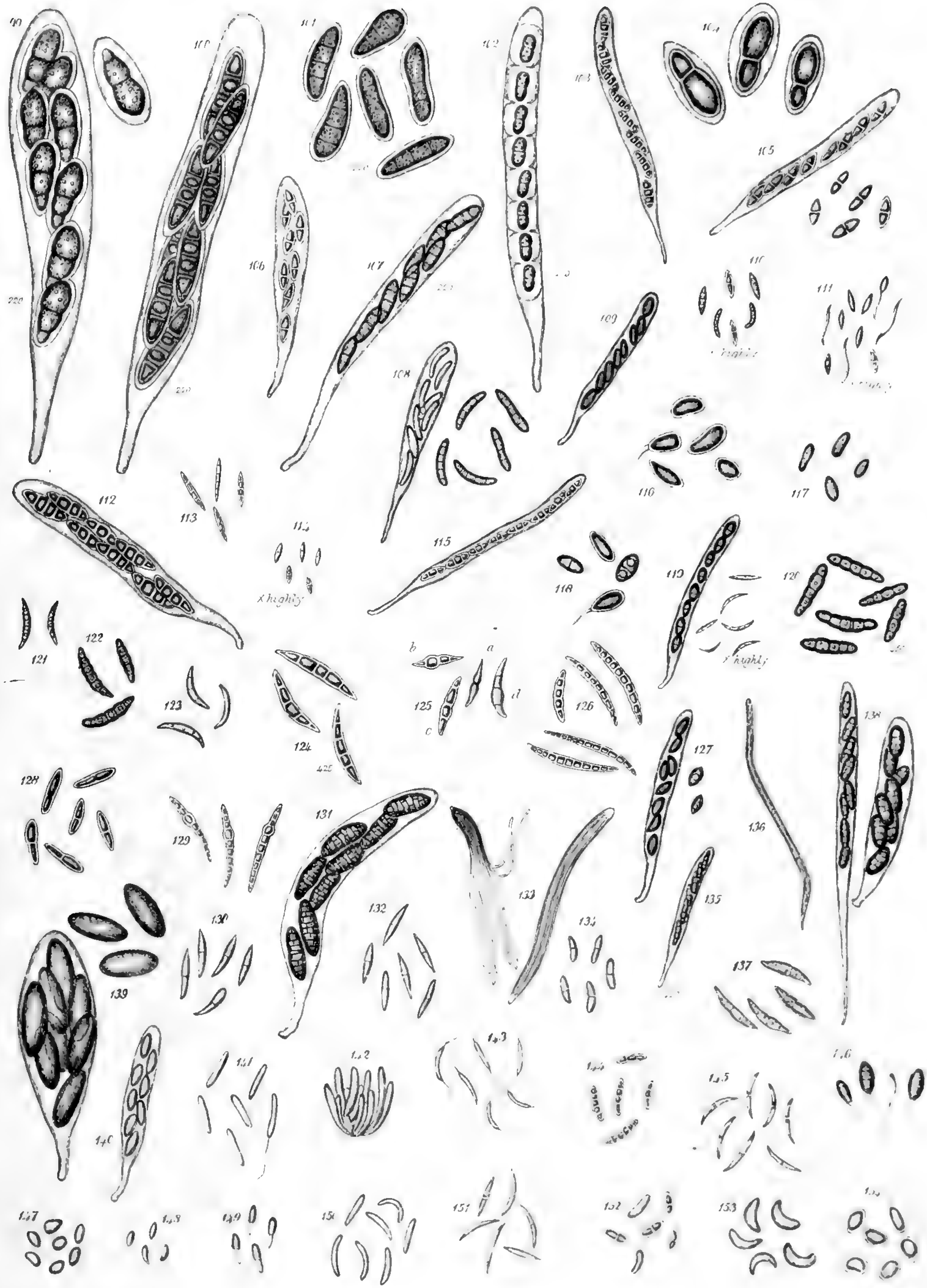

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XXV. *Synopsis of the Genera* Camellia *and* Thea. *By* BERTHOLD SEEMANN, *Ph.D., F.L.S.*

Read May 5th, 1859.

GREAT diversity of opinion exists as to whether the genera *Camellia* and *Thea* ought to be merged into one, or regarded as distinct. The advocates of the union argue that hitherto no difference of generic importance has been pointed out, which, on being put to the test, has not broken down, and that, notwithstanding great authorities have pronounced in favour of keeping them separate, the generic union of *Camellia* and *Thea* is dictated by the stern laws of systematic botany, whilst their opponents have as yet not been able to disprove, with any degree of satisfaction, those sweeping assertions. In order to arrive at an independent opinion, it will be necessary to examine the various generic characters that have from time to time been proposed by authorities on the subject, and to add such critical remarks as a careful study of these plants enables me to make.

Linnæus, who was acquainted with only two species of *Camellia* and one of *Thea*, thus defines them, in his sixth edition of the 'Genera Plantarum' of 1764:—

CAMELLIA, Linn.

Monadelphia Polyandria.

Cal. Perianthium polyphyllum, subrotundatum, imbricatum; squamis subrotundis, obtusissimis, internis sensim majoribus, concavis, deciduis. *Cor.* Petala 5, obovata, basi coalita. *Stam.* Filamenta numerosa, erecta, coalita in coronam stylo ampliorem, superne libera, corolla breviora. Antheræ simplices. *Pist.* Germen subrotundum. Stylus subulatus, longitudine staminum. Stigma acutum, reflexum. *Per.* Capsula turbinata, lignosa, sulcis aliquot exarata. *Sem.* Nuclei tot quot striæ capsulæ, subrotundi, seminibus minoribus sæpe repletis.

THEA, Kæmpf.

Polyandria Monogynia.

Cal. Perianthium 6-partitum, minimum, planum, foliolis rotundatis, obtusis, persistentibus. *Cor.* Petala 6, subrotunda, concava, æqualia, magna. *Stam.* Filamenta numerosa (ducenta circiter), filiformia, corolla breviora. Antheræ simplices. *Pist.* Germen globoso-trigonum. Stylus subulatus, longitudine staminum. Stigma triplex. *Per.* Capsula ex tribus globis coalita, 3-locularis, apice trifariam dehiscens. *Sem.* solitaria, globosa, introrsum angulata.

It is unnecessary to dwell much upon the imperfections of these characters. Linnæus, by placing *Camellia* in *Monadelphia Polyandria*, and *Thea* in *Polyandria Monogynia*, undoubtedly laboured under the belief that in *Thea* all the stamens were free. The greater number of them are, however, as firmly united at the base as those of the typical *Camellia Japonica* are, and the genus ought therefore to have been placed in *Monadelphia Polyandria*, as has been done by subsequent writers of the Linnean school. But Linnæus had very imperfect specimens of *Thea* at his disposal even when he published the sixth edition of his 'Genera Plantarum.' After the publication of that edition, however, he seems to have had access to better materials; for in one of his copies of that work preserved in our library we find several marginal notes in his own handwriting, emending the generic character of *Thea*: for instance, the words "Perianthium 6-partitum, ... planum . . . ." are altered into "Per. 5-partitum;" the number "6" assigned to the petals is struck out; to the description of the stamens is added "filamenta corollæ basi inserta," &c.; so that, if he had brought out a seventh edition, these corrections would have been introduced, and they would have tended to improve the limits of the two genera. But even giving Linnæus credit for all these intended improvements, his generic characters of the two contain little that either *Camellia* and *Thea* do not share with other *Ternstrœmiaceæ*, or that more ample materials have shown to be correct. There are, however, two characters upon which he relies to distinguish these genera which have never been shaken—the calyx of *Camellia* is termed polyphyllous and deciduous, whilst that of *Thea* is described with a definite number of persistent sepals. Morphologists may possibly object to attach much importance to them, as the calyx of *Thea* is clad with deciduous bracts, and what is termed a polyphyllous calyx in *Camellia* may also be explained as a simple calyx surrounded by bracts. This view of the subject would reduce the whole difference to one of time,—the sepals remaining longer attached to the plant in *Thea* than in *Camellia*. Systematic botanists, however, are compelled to take a practical as well as a theoretical view of such questions, and that is the course here pursued.

DeCandolle, who wrote in 1824, and who looked upon *Camellia* and *Thea* as forming a distinct natural order, chiefly differing from *Ternstrœmiaceæ* by the absence of albumen, thus defines (Prodr. i. pp. 529, 530) the genera in question:—

CAMELLIA, Linn.	THEA, Kæmpf.
Calyx imbricatus, nempe bracteis sepalisve nonnullis accessoriis cinctus. Stamina basi polyadelpha aut monadelpha. Antheræ ellipsoideæ. Capsula valvis medio septiferis, axim triquetrum liberum post dehiscentiam relinquentibus.	Calyx 5–6-sepalus. Petala 6–9 ima basi subcohærentia 2–3-serialia. Stamina basi sublibera. Antheræ subrotundæ. Capsula 3-cocca, septis valvaribus, nempe a valvularum marginibus introflexis formatis.

DeCandolle places under *Camellia* one species which has no right to be there, viz. *Camellia axillaris*, Roxb. (=*Polyspora axillaris*, Sweet), while under *Thea* he ranges Loureiro's *Thea oleosa*, which I hold to be the old oil-seeded *Camellia Sasanqua* of Thunberg; and it is possible that in drawing up his generic characters the presence of those plants may have influenced him in some degree, compelling us to make some allowance in criticising them. He terms the stamens of *Camellia* polyadelphous: that term must, I think, be suppressed, as it cannot be applied to those of any true species of that genus, unless we are prepared to apply it to the result of the mechanical rupture of the tube of the monadelphous stamens, witnessed in *Camellia Sasanqua* when the petals begin to fade, bend back, and become detached from the stamens. In *Thea* he describes the stamens as nearly free, but the outer series of them is always monadelphous, as in *Camellia*; and, following Gærtner, he assumes the cells of the capsule, unlike those of *Camellia*, to be formed by the edges of the valves being bent inwards. The latter are, however, exactly formed as those of *Camellia*, the septa being placed on the middle of the valve. DeCandolle has therefore not discovered any additional character by which *Camellia* and *Thea* could be distinguished from each other.

We now come to W. B. Booth, who in 1830 published an able history of the genera

Camellia and *Thea* in the 'Transactions of the Horticultural Society of London,' vol. vii. p. 519. The essential characters which he assigns to them respectively are as follows :—

Camellia, Linn.	Thea, Kæmpf.
Flowers axillary, sessile. Calyx inferior, of 7, 8, or more deciduous imbricated scales, the inner ones the largest. Corolla of 5 petals. Styles united nearly their whole length. Capsule furrowed, having as many cells as furrows, and one or two seeds in each.	Flowers axillary, stalked. Calyx inferior, of 5 deeply divided permanent roundish segments. Corolla of 5, 6, or 9 petals. Styles cohering at the base, dividing towards the point into three distinct bodies. Capsule 3-lobed, 3-celled. Seeds solitary.

Here another characteristic feature of the two genera is pointed out, viz. that in *Camellia* the flowers are always sessile, while in *Thea* they are stalked, though it can hardly be admitted in the essential characters of the two genera. The styles in *Camellia* are said to be united nearly their whole length : that is certainly the case in all those species with which Booth was acquainted in 1830; but in my *Camellia Hongkongensis* they are entirely free. Applying his generic character to the *Camelliaceæ* known at that time, Booth followed Lindley's suggestion, and transferred *Camellia euryoides*, Lindl., to *Thea*. According to that rule, he ought to have done the same with *Camellia maliflora*, Lindl. The fact that the latter was only accessible to him in a double state may partly be considered the reason why he failed to do so.

The last author who has attempted to frame a character for the two genera under consideration is Choisy, in one of the most elaborate papers that have as yet appeared on the whole order of *Ternstrœmiaceæ*. It was published in 1855 in the 'Transactions of the Natural History Society of Geneva.' He defines *Camellia* and *Thea* thus :—

Camellia, Linn.	Thea, Kæmpf.
Calyce à éstivation imbricative, sépales sur plusieurs rangs se recouvrant comme des tuiles. Capsule semi-déhiscente; cloisons séparées en haut du placenta central.	Calyce simple, à un seul rang. Capsule déhiscente dans tout sa hauteur. Cloisons non séparées du placenta central.

It does not appear to me that we are justified in saying the capsule of *Camellia* is semi-dehiscent, and its septa do not separate from the central placenta, and that the capsule of *Thea* is quite dehiscent, and the septa do not separate from the central placenta. The fact is, that in *Thea* the septa do at one time separate from the central placenta, and at another they do not. In normally developed capsules they generally do separate. Hence it follows that the dehiscence or semi-dehiscence cannot be regarded as a character of generic distinction between the two genera.

There is, however, one point which has been quite overlooked by all who have written on this subject, and which seems the more important as it is not one of degree. On examining the stamens, I was struck with the fact that there was in all *Camellias* and *Theas*, besides the outer series of monadelphous stamens of indefinite number, an inner series of free stamens, definite in number. With a little practice the outer series of these stamens is easily removed, and the inner one, closely surrounding the ovary, laid bare. In *Camellia* I found them to be double in number to that of the normal number of petals, and in *Thea* equal to it. I may add, that in the latter respect *Thea* agreed with what I discovered in *Pyrenaria*. On the other hand, the structure now discovered in *Camellia* (a definite number of free stamens surrounded by a series of monadelphous ones) was known to exist in *Calpandria* of Blume, placed by Endlicher (Genera Plantarum, n. 5546) among the "genera dubia" of *Meliaceæ*, and removed to *Ternstrœmiaceæ* by Choisy, who, however, did not suspect that it was so intimately related to *Camellia* as to render a generic separation impossible. True, in *Camellia* the filaments of the monadelphous series of stamens are more free towards their upper extremity than those of *Calpandria*; but it must be admitted this is a mere matter of degree; and no one would like to keep up *Calpandria* as a separate genus on that account only, especially as it agrees in habit and all other respects with *Camellia*.

The number of styles in *Thea* I have always found to be *three*, whilst in *Camellia* there are normally five, or by abortion four or three. I here use the term 'styles' for what some authors have called stigmas; and I justify this application by pointing to *Camellia Hongkongensis*, where the styles are quite free to their very base. There is, besides, another feature, which, though it cannot be admitted into the technical characters of the two genera, serves to distinguish them by their habit; I mean that in *Camellia* the flowers are always erect, whilst in *Thea* they are nodding. Thus, if we sum up the distinguishing peculiarities of the two, we have the following:—

CAMELLIA, Linn.	THEA, Kæmpf.
Calyx polyphyllus, sepalis deciduis. Stamina interiora duplo petalorum numero. Styli 5 (abortu 4 v. 3).—Flores sessiles, erecti.	Calyx bracteatus, 5-sepalus, sepalis persistentibus. Stamina interiora petalorum numero æqualia. Styli 3.—Flores pedunculati, declinati.

When we apply these characters to the aggregate body of *Camellias* and *Theas* as it now stands, we are enabled to retain all the older typical species under their respective genera. Thus *Camellia Japonica* of Linnæus, together with *C. reticulata*, Lindl., *C. Sasanqua*, Thunb., and *drupifera*, Lour., are kept under *Camellia*, whilst *Thea Chinensis*, Linn., remains undisturbed under *Thea*. Only four modern species of *Camellia* are placed with *Thea*; and that is all the change required. A few other species, which have nothing to do either with *Camellia* or *Thea*, are referred to their proper systematic position: *Camellia axillaris*, Roxb., is admitted to be the same as *Polysporă axillaris*, Sweet; *C. integrifolia*, Chois., proves itself to be a *Laurinea* (*Actinodaphne Chinensis*, Nees), according to specimens kindly transmitted by Prof. Choisy himself; *C.* ? *Scottiana*, Wall., is held to be *Andinandra dumosa*, Jack; whilst a plant which had been considered to be allied to the Wild Tea of Assam, and had been distributed by Wallich under the name of *Freziera* ? *attenuata*, I found to be a species of *Pyrenaria**.

I now proceed to give the generic characters of *Camellia* and *Thea*, and a synopsis of

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* ***Pyrenaria attenuata***, Seem. in 'Bonplandia,' vii. p. 49 [1859] (name only); foliis obovatis acuminatis serratis basi attenuatis glabris, floribus solitariis pedunculatis, pedunculis medio bracteis lunulatis obtusis alternis instructis, sepalis (5) suborbiculatis obtusis bracteisque ciliolatis, petalis (5) cohærentibus obovatis v. oblongis obtusis, 3 interioribus paulo majoribus, omnibus dorso sericeis, staminibus interioribus liberis 5, exterioribus monadelphis numerosis, omnibus glabris, stylis 5 liberis glabris, stigmatibus capitellatis, ovario ovato acuminato 10-sulcato hirsuto, fructu . . . . Affinis *P. masocarpæ*, Korth.—*Freziera* ? *attenuata*, Wall., an *Camellia* ?, Wall. Cat. n. 1451!—*Thea Assamica affinis sp.*, Chois. in Mém. Soc. Gen. xiv. i. p. 156 (1855).—*Thea viridis*, var. *Assamica* ?, Planch. in Herb. Hook. Chois. *l. c.* p. 179.—*Hab.* in Tavoy (*Gomez*! in Wall. Cat. n. 1451).

their species. I have considerably reduced the number of species, and only describe a single new one; but I trust the smallness of the number of species that remain will be regretted the less, as we may anticipate ere long a considerable increase from China and Japan, since both these countries are now open to a more unrestricted intercourse with Europe. I must also beg to apologize for the many imperfections to be found in my enumeration; but it must be borne in mind that, although the great herbaria of London, Paris, Berlin, and Vienna contain treasures which were carefully examined, yet these materials are in many cases not so complete as could have been wished; and, as all the species are not represented in our gardens, much is left for future investigation. Nor must it be forgotten that the plants under consideration have a tendency to form double or semi-double flowers, and that their normal type is traced out only after a great deal of close study and observation.

CAMELLIA, Linn.

CHAR. GEN. EMEND.—*Calyx* polyphyllus, foliolis imbricatis, interioribus sensim majoribus, deciduis. *Corollæ* petala 5 (vel in floribus semiplenis et plenis 6–plurima), hypogyna, imbricata, interiora majora. *Stamina* hypogyna biserialia, exteriora numerosa petalis adhærentia in tubo concreta, interiora petalorum numero dupla, libera; *filamenta* subulata, *antheræ* incumbentes, biloculares, oblongæ, connectivo crassiusculo, loculis longitudinaliter dehiscentibus. *Pollen* sphæricum vel ovato-oblongum. *Ovarium* liberum, 5- (vel abortu 4- vel 3-) loculare. *Ovula* in loculis 4–5, angulo centrali alternatim inserta, pendula. *Styli* 5, abortu 4 vel 3, liberi vel plus minusve connati; *stigmata* capitellata. *Capsula* 5- (abortu 4- vel 3-) locularis, dehiscens, loculicide 5-, vel in abnormis 3–4-valvis, valvis medio septiferis, axi centrali persistente, faciebus seminifero. *Semina* in loculis abortu solitaria, rarius gemina, inversa, *testa* nucamentacea, umbilico apicali impresso. *Embryonis* exalbuminosæ cotyledones crassæ, inæquales, radicula brevissima, supera.

Arbores vel *frutices* sempervirentes, Indiæ orientalis, Cochinchinæ, Chinæ et Japoniæ; *foliis* alternis, petiolatis, coriaceis, nitidis, serratis, gemmis magnis, perulis distiche imbricatis, floribus solitariis vel aggregatis, axillaribus, erectis, sæpe speciosissimis, albis, roseis vel purpureis.

Camellia, Linn. Gen. Plant. n. 848; Endl. Gen. n. 5425 (excl. sp.); DeCand. Prodr. i. p. 529 (excl. sp.).
Sasanqua, Nees in Sieb. Nipp. ii. p. 13 (excl. sp.).
Calpandria, Blum. Bijdr. bl. 178; Endl. Gen. n. 5546.

Obs. Nees von Esenbeck has proposed to divide *Camellia* into two genera (*Camellia* and *Sasanqua*), adopted as subgenera (*Kissi* and *Sasanqua*) by Endlicher; to the one is assigned a dehiscent, to the other an indehiscent fruit; but as *all Camellias* have a dehiscent fruit, though in *Camellia Sasanqua* the dehiscence takes place rather late, they fall to the ground.

1. C. JAPONICA; arborea; ramulis petiolisque glabris, foliis ovatis vel ovato-oblongis acutis vel acuminatis, subtus subaveniis, floribus inodoris, petalis (rubris, albis, flavidis variegatisve) rotundatis emarginatis (vel in var. hortens. fimbriatis), staminibus, ovariis, stylis connatis capsulisque glabris. (v. s. sp. et v. c.)

Camellia Japonica, Linn. Sp. Plant. p. 698 (1753), non Champ.; Thunb. Fl. Jap. p. 272 (1784); De Cand. Prodr. i. p. 529 (1824); Booth in Hort. Soc. Trans. vii. p. 529. t. 14 (1830); Sieb. et Zucc. Fl. Jap. p. 155. t. 82 (1835–44); Chois. in Mém. Soc. Gen. xiv. p. 147 (1855); Seem. in Bonplandia, vi. p. 278 (1858).

Thea Chinensis pimentæ Jamaicensis folio, flore roseo, Petiver, Gazophylacium, t. 33. f. 4 (1702).

San sa, vulgo Jamma Tsubakki, Kæmpf. Amœn. Exot. p. 850, cum ic. p. 851 (1712).
Thea Camellia, Hoffm. ex Steudl. Nom. Bot. i. p. 265 (1841).
Camellia Kæmpferiana, Reboul, Atti della Tercia Riunione, p. 494, ex Wlprs. Ann. ii. p. 178 (1851–52).
Nomina vernacul. In Japonia, "*Tsubaki, Jabu tsubaki*" (i. e. *Camellia sylvestris*), a Chinensibus "*San tsja*" (i. e. *Thea montana*) vocatur.
Geogr. Distr. Throughout Japan (*Kæmpfer*! *Thunberg*! *Siebold*!), forming dense woods, which, according to *Siebold,* look like those of our young Beeches; cultivated in China and in European gardens.

I have not seen wild specimens of this species from China, nor am I acquainted with any account of its having been found wild there. Champion thought he discovered it at Hongkong; but the species he took for *Japonica* turns out to be quite a distinct one (*C. Hongkongensis,* Seem.). The Chinese have from time immemorial cultivated *C. Japonica* in their gardens. In Europe it became known in the beginning of the eighteenth century, and the first figure of it was published in 1702 in Petiver's 'Gazophylacium.' Strange to add, though there are thousands of representations of the various varieties of this *Camellia,* yet we do not possess a single plate exhibiting the normal state of it. The form figured by Siebold and Zuccarini in their 'Flora Japonica' has semi-double flowers.

2. C. HONGKONGENSIS (Tab. LX.); arborea; ramulis petiolisque glabris, foliis ovato-lanceolatis vel lanceolatis acuminatis, subtus venis tenuibus distinctis, floribus inodoris, petalis (rubris) obovatis emarginatis, staminibus glabris, ovario stylisque liberis lanatis; capsula (glabra?). (v. v. sp.)

Camellia Hongkongensis, Seem. MSS.
C. Japonica, Champ. in Hooker's Journ. of Bot. and Kew Misc. iii. p. 309 (1851), non Linn.!; Champ. in Trans. Linn. Soc. xxi. p. 112 (1853); Seem. Bot. Herald, p. 367. n. 68 (1857).
Geogr. Distr. Cochinchina-Tourane (*Gaudichaud,* n. 271, in Herb. Par.!); Island of Hongkong (*Eyre*! *Bowring*! *Champion*! *Hance*! *Seemann*!).

This species was discovered in January 1837 by Gaudichaud in Cochinchina, and about 1849 by Lieut.-Colonel Eyre, of the Royal Artillery, in the island of Hongkong, where it grows in company with *Castanea concinna, Quercus bambusæfolia, Thea salicifolia,* &c.; it was afterwards collected by Bowring, Champion, Hance, and myself. Only three trees are known to exist in Hongkong. In a paper read November 5, 1850, before the Linnean Society, and published in 1853 in our Transactions, Capt. Champion took it for the true *Camellia Japonica* of Linnæus; and so did Mr. Bentham and myself in our respective enumerations of the plants of Hongkong. A more recent examination and comparison with a large set of specimens of the genuine *C. Japonica,* Linn., has, however, led me to consider the *Camellia* found by Gaudichaud and Eyre as indeed allied to, but very distinct from, *C. Japonica,* Linn. It differs from *C. Japonica* in the shape and dark-green colour of its leaves, in its free styles and woolly ovary; otherwise it has very much the habit of the common single pink variety of *C. Japonica,* and is easily mistaken for that species if the important differences pointed out be overlooked. Champion describes the capsule as "smooth," thereby meaning most probably "glabrous," as he has previously described that of *C. spectabilis* as "sericeous," and he adds that it is more than an inch in diameter.

3. C. RETICULATA; arborea; ramulis petiolisque sericeo-pubescentibus, foliis oblongis vel lanceolatis, subtus reticulatis, floribus inodoris, petalis (albis vel in var. fl. pl. variegatis) rotundato-obovatis emarginatis, staminibus glabris, ovario, stylis subliberis capsulaque sericeis (v. s. sp. et v. c.).

Camellia spectabilis, Champ. in Hook. Journ. of Bot. and Kew Misc. iii. p. 310 (1851); Champ. in Trans. Linn. Soc. xxi. p. 111 (1853); Chois. in Mém. Soc. Genève, xiv. i. p. 148 (1855); Seem. Bot. Herald, p. 367. t. 78. p. 432 (1857); Seem. in Bonplandia, vi. p. 276 (1858).

Var. *flore pleno*; *fl. pleno,* Hook. Bot. Mag. t. 4976 (1857); Van Hout. Fl. des Ser. t. 1282-3 (1857).

C. reticulata, Lindl. Bot. Reg. t. 1078 (1827); Booth in Hort. Soc. Trans. vii. p. 528 (1830); Chois. in Mém. Soc. Genève, xiv. i. p. 147 (1855).

Geogr. Distr. Island of Hongkong (*Eyre*! *Champion*!). Cultivated in European gardens.

The double state of this *Camellia* was first figured and described by Dr. Lindley in the 'Botanical Register,' t. 1078, from living specimens imported from Chinese gardens, while the normal state (with single flowers) was entirely unknown till discovered about twenty years afterwards in the woods of Hongkong by Capt. Champion. The discoverer did not, however, recognize it as such, but mistook it for a new species, to which he gave the name of *C. spectabilis* in a paper read November 1850 before the Linnean Society, and published in our Transactions. Bentham enumerated it under Champion's name in his 'Florula Hongkongensis.' When I went over the same ground (Bot. Herald, p. 367), I was struck with the great resemblance existing between *C. reticulata,* Lindl., and *C. spectabilis,* Champ.; but not having at that time good specimens for comparison, I contented myself with remarking, in the Supplement to my Hongkong Flora (Bot. Herald, p. 432), of *C. spectabilis*—"This species is closely allied to *C. reticulata,* Lindl." Afterwards I was fortunate enough to obtain complete specimens of *C. reticulata,* Lindl., through the kindness of my friend Mr. Edward Otto of Hamburg, and was thus enabled to establish (Bonplandia, vi. p. 276) the identity of *C. spectabilis* and *C. reticulata* as species: as varieties they are distinct: the form described by Champion, having single white flowers, is the normal state, while that described by Lindley, having double red flowers variegated with white, is the abnormal state. In a horticultural point of view, this identification is of some importance. Although our florists have as yet taken little notice of *C. reticulata,* we have already the two principal tints displayed by its ally the *C. Japonica,* viz. the white and the red. It therefore now behoves them to take this species in hand, and endeavour to raise it in horticultural eyes to a standard of perfection; for although the flowers of *C. reticulata* are destitute of that compactness peculiar to *C. Japonica,* and rather remind us of a Pæony, yet they have this in their favour, that they are of much arger size than those of *C. Japonica*—some specimens of the double variety observed by Sir W. J. Hooker actually measuring 20 inches in circumference, and being the largest floral development as yet recorded among the Camellias.

4. C. SASANQUA; fruticosa vel arborescens; ramulis petiolisque puberulis, foliis ellipticis vel ovato-lanceolatis acutis, subtus subaveniis, floribus inodoris, petalis (albis) obcordato-emarginatis vel bilobis, staminibus glabris, ovario lanato, stylis connatis, capsula pubescente. (v. s. sp. et v. c.)

Camellia Sasanqua, Thunb. Fl. Japon. p. 273. t. 30 (1784); Cav. Diss. vi. p. 306. t. 160 (1790); Staunt. Embas. to China, ii. p. 466 cum ic. (1797); Bot. Reg. t. 12 (1815), t. 1091 (1827); Lodd. Bot. Cab. t. 1275 (1827); Booth in Hort. Soc. Trans. vii. p. 521 (1830); Sieb. et Zucc. Fl. Jap. p. 158. t. 83 (1835–44); Chois. in Mém. Soc. Genève, xiv. i. p. 147 (1855); Seem. in Bonpl. vi. p. 278 (1858).

Sasanqua, Kæmpf. Delineat. plant. Japon. (MSS. in Mus. Brit.) fig. 25; Amœn. Exot. p. 853, ex parte (1712).

Camellia oleifera, Abel, Journ. in China, p. 174 cum ic., App. p. 363 (1818); Lindl. in Bot. Reg. t. 942 (1825); Lodd. Bot. Cab. t. 1065 (1825); Booth in Trans. Hort. Soc. vii. p. 524 (1830); Chois. in Mém. Soc. Genève, xiv. i. p. 147 (1855); Seem. in Bonpl. vi. p. 278 (1858).

Thea oleosa, Lour. Fl. Cochinch. p. 339 (1790); Chois. in Mém. Soc. Genève, xiv. i. p. 156 (1855).

Thea longifolia, Nois., et *Thea Sasanqua*, Nois., teste Steudl.

Nomina vernacul. Nomen Cochinchinense, teste Loureiro, "*Yeu-cha.*" Nomen Chinense, teste Abel, "*Tscha-Yeoa,*" teste Loureiro, "*Che-deau,*" et teste Staunton, "*Cha-whaw.*" Nomen Japonicum, teste Siebold, "*Sasankwa.*" Nomen Japon.-chinense, teste Siebold, "*Tsja-bai.*"

β. var. *flore semi-pleno*, Lindl. Bot. Reg. t. 12 (1815), t. 1091 (1827); Lodd. Bot. Cab. t. 1275 (1827).

Geogr. Distr. Japan (*Thunberg* in Mus. Brit.! *Siebold*). China, Prov. of Kiangsi (*Sir George Staunton* in Mus. Brit.!); Prov. of Kwangton (*Sir G. Staunton* in Mus. Brit.! *Abel, Loureiro*); Chusan (*Dr. Cantor* in Herb. Bth.!); Loo-choo (*C. Wright*, n. 28!). Cultivated in European gardens.

Camellia Sasanqua, Thunb., and *C. oleifera*, Abel, are in most works regarded as distinct species. They are here united, because I could not find a single character by which they could be distinguished from each other. I have also added as a synonym the doubtful *Thea oleosa* of Loureiro, which, from the description given by its author, agrees tolerably well with the old *C. Sasanqua.* I am the more convinced that this identification is correct, as there are only two Camelliaceous plants that yield seeds sufficiently oily to be used for economic purposes, viz. *Camellia Sasanqua* and *C. drupifera*; and Loureiro states emphatically that his *Thea oleosa* yields an oil and grows wild in the province of Canton, —a fact fully agreeing with what we know of *C. Sasanqua.* What is preserved in the Parisian Museum as the original specimen of *Thea oleosa*, Lour., is *Thea Chinensis*, var. *Bohea.* The latter plant (I mean *T. Chinensis*, var. *Bohea*) was well known to Loureiro, and named by him *Thea Cantoniensis*; and, as it neither yields an oil nor grows wild in Canton, I do not think that we are far wrong in assuming that the specimen preserved at Paris as *Thea oleosa* has obtained that name by a misplacing of the label, and that the genuine specimens of *Thea oleosa*, Lour., like those of *Camellia drupifera*, Lour., and *Thea Cochinchinensis*, Lour., have been lost. The genuine *C. Sasanqua* has always white flowers; and when Kæmpfer, who first brought it into notice, attributed pink ones to it, he undoubtedly confounded another species with it (viz. *Thea maliflora* = *Camellia maliflora*, Lindl.), which, until Lindley pointed it out as distinct, was always regarded as a variety of *C. Sasanqua.* Siebold and Zuccarini, in their 'Flora Japonica,' still kept up this old error. There are no specimens of *C. Sasanqua* in Kæmpfer's herbarium; but in a collection of manuscript drawings of that author, preserved in the British Museum, there is a figure of his '*Sasanqua,*' which represents the genuine *C. Sasanqua* of Thunberg. (Conf. *Thea maliflora*, Seem.)

5. C. DRUPIFERA; arborea; ramulis petiolisque puberulis, foliis lanceolatis vel ovato-lanceolatis longe acuminatis, subtus venis tenuibus distinctis, floribus odoratis, petalis

(albis) obovatis emarginatis, staminibus glabris, ovario lanato, stylis subliberis, capsula pubescente. (v. s. sp. et v. c.)

Camellia drupifera, Lour. Fl. Cochinchinen. p. 411 (1790); DeCand. Prodr. i. p. 529 (1824).

Camellia Kissi, Wall. in Asiat. Res. xiii. p. 429 (1820); DeCand. Prodr. i. p. 529 (1824); Wall. Cat. n. 977 (1828); Booth in Trans. Hort. Soc. vii. p. 525 (1830); Wall. Plant. Asiat. Rar. iii. p. 36. t. 256 (1832); Lodd. Bot. Cab. t. 1815 (1832); Chois. in Mém. Soc. Genève, xiv. i. p. 147 (1855); Seem. in Bonplandia, vi. p. 278 (1858).

Camellia Chamgota, Ham. MSS. (1814), teste Wall. in Asiat. Res. xiii. p. 429 (1820); Chois. in Mém. Soc. Genève, xiv. i. p. 147 (1855).

Camellia Keinia, Hamilt. MSS. in Don Fl. Nepal. p. 224 (1825).

Camellia? oleifera, Wall. Cat. n. 976 (1828).

Camellia symplocifolia, Griff. Itin. Notes, p. 40, n. 652 (1848), et Notulæ ad Plant. Asiat. iv. p. 560. t. 604. f. 2 (1854).

Camellia (*Thea*) *Mastersiana,* Griff. Notulæ ad Plant. Asiat. iv. p. 559 (1854).

Mesua bracteata, Sprengl. Syst. Veg. iii. p. 127 (1826).

Nomina vernacula. In Cochinchina, teste Loureiro, "*Cay Deau so*;" in Sylhetia, teste Hamilton, "*Chamgota*;" in Nepalia, teste Wallich, "*Kissi*" seu "*Kissi-Soah,*" et, teste Don, "*Keng-na*" vocatur.

Geogr. Distr. Nepal (*Wallich*! *E. Gardner*!); Khasia Mountains, 3–5000 feet (*Hooker* and *Thomson*!, *Griffith*!, *Th. Lobb*!); Bootan (E. Ind. Comp. Herb.!); Sikkim (*Hooker* and *Thomson*!); Assam (*Griffith*!, *Jenkins*!); Cochinchina (teste Loureiro). Cultivated at the Botanic Garden, Hamburgh.

This species was discovered by Loureiro in Cochinchina, and has since been found in different parts of the East Indies; as it has an extensive geographical range, and grows both in the high and low lands, it looks so different in different localities, that we can scarcely be surprised if one and the same author has not recognized it again when he met with it in a new place. Its nearest ally is *Camellia Sasanqua,* Thunb., and, like that species, it yields an oil. There are no original specimens of *Camellia drupifera,* Lour., either in London or Paris,—a misfortune the more to be regretted, as, owing to the very imperfect description given by Loureiro, this species has always been regarded as a doubtful one. I endeavoured to show (Bonplandia, vii. p. 48) that the characters furnished might be reconciled with those of *Pyrenaria serrata,* Blum.; but I am now convinced that the balance of evidence inclines more to *Camellia Kissi,* Wall.; *Pyrenaria serrata,* Blum., possessing no oleiferous properties, as I have since learned. That *Camellia drupifera,* Lour., has nothing whatever to do with *Mesua,* to which it has been referred by Sprengel, it is hardly necessary to demonstrate.

6. C. LANCEOLATA; arborescens; ramulis petiolisque puberulis, foliis lanceolatis vel ovato-lanceolatis acuminatis, subtus discoloribus, venis obscuris, floribus inodoris, petalis (albis) obovatis obtusis, staminibus glabris, ovario stylisque connatis lanato-pubescentibus, capsula . . . . . (v. s. sp.)

Camellia lanceolata, Seem. MSS.

Calpandria lanceolata, Blum. Bijdr. 178; Korth. Verhandel. p. 148. t. 31.

Geogr. Distr. Borneo (teste *Korth.*); Sumatra (*Marsden,* in Herb. Bth. et Hook.!).

7. C. QUINOSAURA; arborescens; ramulis petiolisque . . . . . , foliis oblongo-ovatis acutis,

subtus . . . . . , floribus inodoris, petalis (albis) . . . . . , staminibus . . . . , ovario stylisque connatis glabris, capsula . . . .

Camellia quinosaura, Seem. MSS.
Calpandria quinosaura, Korth. Verhandel. p. 149.
Geogr. Distr. Java (teste *Korth.*).

I have not seen any specimens of this plant.

Species exclusæ:

C. assimilis, Champ. = *Thea assimilis*, Seem.
C. axillaris, Roxb. = *Polyspora axillaris*, Sweet.
C. Banksiana, Lindl.[*].
C. Bohea, Griff. = *Thea Chinensis*, Linn.
C. caudata, Wall. = *Thea caudata*, Seem.
C. euryoides, Hort. = *Thea maliflora*, Seem.
C. euryoides, Lindl. = *Thea euryoides*, Booth.
C. integrifolia, Chois. = *Actinodaphne Chinensis*, Nees.
C. maliflora, Lindl. = *Thea maliflora*, Seem., *fl. pl.*
C. rosæflora, Hook. = *Thea maliflora*, Seem.
C. salicifolia, Champ. = *Thea salicifolia*, Seem.
C. Sasanqua fl. incarnato multiplici, Sims = *Thea maliflora*, Seem., *fl. pl.*
C. Sasanqua fl. rubro simplici, Sims = *Thea maliflora*, Seem.
C. Sasanqua rosea, Hort. = *Thea maliflora*, Seem., *fl. pl.*
C. Sasanqua stricta, Edw. = *Thea maliflora*, Seem., *fl. pl.*
C. ? *Scottiana*, Wall. = *Andinandra dumosa*, Jack.
C. Thea, Link = *Thea Chinensis*, Linn.
C. theifera, Griff. = *Thea Chinensis*, Linn.
C. viridis, Link = *Thea Chinensis*, Linn.

THEA, Kæmpf.

CHAR. GEN. EMEND.—*Calyx* bracteatus, 5-phyllus, foliolis imbricatis, interioribus majoribus, persistentibus. *Corollæ* petala 5, 7 vel 8, hypogyna, imbricata, cohærentia, interiora majora. *Stamina* hypogyna, biserialia, exteriora numerosa petalis adhærentia et in tubo concreta, interiora petalorum numero æqualia (5–7–8) libera; *filamenta* subulata, *antheræ* incumbentes, biloculares, oblongæ, connectivo crassiusculo, loculis longitudinaliter dehiscentibus. *Pollen* rotundato-oblongum lineatum vel globoso-subtrigonum. *Ovarium* liberum 3-loculare. *Ovula* in loculis 4–5, angulo centrali alternatim inserta. *Styli* 3, connati vel subliberi, *stigmata* capitellata. *Capsula* 3-locularis, dehiscens, loculicide 3-valvis, valvis medio septiferis, axi centrali persistente, faciebus seminifero. *Semina* in loculis abortu solitaria, rarius gemina, testa nucamentacea, umbilico apicali impresso. *Embryonis* exalbuminosæ *cotyledones* crassæ, carnosæ, inæquales, radicula brevissima, supera.

Frutices vel arbusculæ sempervirentes, Indiæ orientalis, Chinæ et Japoniæ; foliis alternis, petiolatis, coriaceis, nitidis, serratis, floribus pedunculatis, pedunculis bracteatis, axillaribus, solitariis vel aggregatis, nutantibus, albis vel roseis.

Thea, Kæmpf. Linn. Gen. (edit. vi. 1764) p. 269. n. 668; DeCand. Prodr. i. p. 530 (excl. sp.); Endl. Gen. Plant. n. 5426.
Camellia, sp. auct.

1. THEA MALIFLORA; ramulis petiolisque puberulis; foliis ovatis vel ovato-lanceolatis acuminatis, utrinque glabris, pedunculis imbricato-bracteatis, sepalis ovatis obtusis, dorso pubescentibus, petalis 7–8 obcordato-emarginatis erectis glabris (roseis), staminibus, stylis ovariis capsulisque glabris. (v. v. cult.)

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[*] "*Camellia Banksiana*, Lindl. (mentioned by Champion in Hook. Journ. and Kew Misc. iii. p. 310), is a nonentity, as neither Lindley nor any other botanist has ever published such a name."—Seem. Bot. Herald, p. 367; Bonpl. vi. p. 278.

Thea maliflora, Seem. MSS.
Camellia rosæflora, Hook. Bot. Mag. t. 5044 (1858).
Sasanqua, Kæmpf. Amœn. Exot. p. 853 ! ex parte (1712).
Camellia Sasanqua a, flore rubro simplici, Sims, Bot. Mag. sub t. 2080 ! (1819).
Camellia euryoides, Hort. Germ. et Angl. ! (non Lindl. !).
Var. *flore pleno*, Seem.
Camellia Sasanqua, β. stricta, fl. pl. carneo, Edwards, Bot. Reg. t. 547 ! (1821) ; Lodd. Bot. Cab. t. 1134 (1826).
Camellia Sasanqua, β. flore incarnato multiplici=Palmer's Double Sasanqua, Sims, Bot. Mag. t. 2080 ! (1819).
Camellia Sasanqua rosea, Hort. !
Camellia maliflora, Lindl. Bot. Reg. sub t. 1078 ! (1827) ; Booth in Hort. Soc. Trans. vii. p. 526 ! (1830) ; Chois. in Mém. Soc. Phys. de Genève, t. xiv. pt. i. p. 147 ! (1855).
Geogr. Distr. Japan. Cultivated in European gardens.

Kæmpfer (Amœn. Exot. p. 853) was the first who noticed the normal state of this species under the name of "*Sasanqua*," though he does not seem to have preserved any specimens of it, for the only species of *Camellia* to be found in his herbarium at the British Museum is *C. Japonica*, Linn. (Herb. Kæmpf. fol. 23. n. 2, et fol. 32. n. 2). He distinctly states that it has single *red* flowers. Thunberg (Flora Japon. p. 273), although he ascribed to his *Camellia Sasanqua white* flowers, quoted Kæmpfer's "*Sasanqua*" as an entire synonym of it (though it is only so in part), and thus, by confounding two very distinct species, laid the foundation of an endless series of mistakes committed by subsequent authors. DeCandolle, too (Prodr. i. p. 529), quoted Kæmpfer's "*Sasanqua*" as a synonym of *C. Sasanqua*, Thunb., further remarking that the latter species varied with white, flesh-coloured, pink and red flowers,—a remark not borne out by facts, as the true *C. Sasanqua*, Th., never bears any but white petals. Sims (Bot. Mag. t. 2080) figured, from garden specimens introduced by Capt. Rawes in 1816, the double state of the species under consideration, which he mistook for a variety of *C. Sasanqua*, Thunb.; but he felt the necessity of bringing the various synonyms, supposed to belong to *C. Sasanqua*, Thunb., into some kind of order, by arranging them as follows:—

Camellia Sasanqua.

Var. *a. flore rubro simplici="Sasanqua,"* Kæmpf. Amœn. Exot. p. 853.
Var. *β. flore incarnato multiplici=Palmer's Double Sasanqua*, Bot. Mag. t. 2080.
Var. *γ. flore albo simplici=C. Sasanqua*, Thunb. Fl. Jap. p. 273. t. 30 [excl. syn. Kæmpf. ex parte ! he ought to have added.—B. S.] ; Bot. Reg. t. 12 ; Staunton. Emb. to China, ii. p. 466, cum icon.

Of these three varieties only α. and β. belong to *Thea maliflora*, γ. appertaining to, or rather being, the veritable *C. Sasanqua*, Thunb. The double state of our plant was again figured from the same garden plant in the Bot. Reg. t. 547, under the name of *C. Sasanqua β. stricta, fl. pl. carneo.* At last (1827) Lindley (Bot. Reg. sub tab. 1078) pointed out that this so-called double pink variety of *C. Sasanqua* was in reality a distinct species, to which he gave the name of *C. maliflora.* Booth (Hort. Soc. Trans. vii. p. 526) adopted this view, and at the same time drew attention to the very different habits of *C. maliflora* and *C. Sasanqua.* Unfortunately, Siebold and Zuccarini (Fl. Jap. p. 158) overlooked the result of Lindley's investigation, and probably misled by the name which Kæmpfer had adopted for two plants, they quoted, like Thunberg, DeCandolle, Sims, and others, Kæmpfer's "Sasanqua" as quite synonymous with *C. Sasanqua*, Thunb., and in their detailed description ascribed to *C. Sasanqua* "petalis *puniceis* vel albis." Meanwhile the normal state of this species, *i. e.* the single-flowered variety, had found its way into our gardens, and was cultivated for many years, both in England and on the Continent, under the name of *C. euryoides*, Hort. (non Lindl. !), until (1858) Sir W. J. Hooker described it (Bot. Mag. t. 5044) as *C. rosæflora.*

There is undoubtedly a certain resemblance in the foliage of *Camellia Sasanqua*, Thunb., and *Thea maliflora*, Seem., that of both being coriaceous and almost glabrous, but on closer inspection the difference between the leaves becomes as evident as is that in their habit. The characters by which the two species may instantly be distinguished are, that *Camellia Sasanqua* has white petals and a woolly ovary, while *Thea maliflora* has pink petals and a glabrous ovary. When some authors ascribe flesh-coloured and red flowers to the latter species, they mean pink, the pink being more or less intense.

I have not seen any wild specimens of *Thea maliflora.* Whence and how the single state came into our gardens, is a matter of uncertainty; but as Kæmpfer met with it in Japan, it is probably indigenous to that empire. The double variety was introduced (1816) from Chinese gardens, and the Chinese may perhaps have obtained it from Japan.

2. THEA EURYOIDES; ramulis petiolisque pilosis; foliis ovato-lanceolatis acuminatis, subtus sericeis, pedunculis imbricato-bracteatis, sepalis ovatis obtusis, dorso pilosis, petalis 7–8 obovatis obtusis erectis glabris (albis), staminibus stylis ovariis capsulisque glabris. (v. s. sp.)

Thea euryoides, Booth in Hort. Soc. Trans. vii. p. 560 (1830); Chois. in Mém. Soc. Phys. de Genève, xiv. i. pp. 149, 156 (1855).

Camellia euryoides, Lindl. Bot. Reg. t. 983 (1826); Lodd. Bot. Cab. t. 1493 (1828); Seem. Bonpl. vi. p. 278 (1858).

Geogr. Distr. Chusan (*Dr. Cantor,* in Herb. Benth. !).

I have only seen a single specimen of this species, from China, preserved in Bentham's herbarium. It was first imported in a living state by the Horticultural Society of London in 1822, and again in 1824, and is used by the Chinese for grafting upon it their varieties of *Camellia Japonica.* It seems to have entirely disappeared from our gardens, what goes by the name of *Camellia euryoides* amongst horticulturists being the normal state of *Thea maliflora.*

3. THEA CAUDATA; ramulis petiolisque puberulis; foliis lanceolatis longe acuminatis, utrinque glabris, pedunculis imbricato-bracteatis, sepalis ovatis obtusis, petalis 5 obovatis obtusis, dorso villosis, patentibus (albis), staminibus stylis ovariisque villosis, capsula glabra. (v. s. sp.)

Thea caudata, Seem. MSS.

Camellia caudata, Wall. Cat. n 978 (1828); Wall. Plant. Asiat. Rar. iii. p. 36 (1832); Wlprs. Rep. Bot. Syst. i. p. 375 (1842); Chois. in Mém. Soc. Phys. Genève, xiv. i. p. 148 (1855); Griff. Itinerary Notes, p. 40. n. 651 (1848); Griff. Notulæ ad Plant. Asiat. iv. p. 559. t. 601. fig. 2 (1854).

Geogr. Distr. Khasia Mountains and Sylhet from the sea-level to 4000 feet (*Wallich*! *Griffith*! *Hooker* and *Thomson*!).

4. THEA SALICIFOLIA; ramulis petiolisque pubescenti-villosis; foliis ovato-lanceolatis longe acuminatis, supra (nervo medio except.) glabris, subtus pubescenti-villosis pallidioribus, pedunculis imbricato-bracteatis, sepalis ovato-lanceolatis longissime acuminatis, petalis 5 obovatis obtusis vel acuminatis, dorso villosis, patentibus (albis), staminibus stylis ovariisque villosis, capsula rostrata glabra. (v. v. sp. et cult.)

Thea salicifolia, Seem. MSS.

Camellia salicifolia, Champ. in Hook. Journ. of Bot. and Kew Misc. iii. p. 309 (1851); Champ. in Trans. Linn. Soc. xxi. p. 112 (1853); Chois. in Mém. Soc. Genève, xiv. i. p. 148 (1855); Seem. Bot. Herald, p. 367. t. 76 (1857); Seem. in Bonplandia, vi. p. 278 (1858).

Geogr. Distr. Island of Hongkong (*Champion*! *Hance*! *Seemann*! *Wilford*! *C. Wright,* n. 63!). Cultivated at Kew.

5. THEA ASSIMILIS; ramulis petiolisque adpresso-pilosis; foliis lanceolatis acuminatis, supra glabris, subtus ad nervos adpresso-pilosis, pedunculis imbricato-bracteatis, sepalis rotundatis obtusis, petalis 7 obovatis emarginatis patentibus (albis), dorso sericeis, staminibus stylis ovariisque villosis, capsula rostrata glabra. (v. s. sp.)

Thea assimilis, Seem. MSS.

Camellia assimilis, Champ. in Hook. Journ. and Kew Misc. iii. p. 309 (1851); Champ. in Trans. Linn. Soc. xxi. p. 112 (1853); Chois. in Mém. Soc. Genève, xiv. i. p. 148 (1855); Seem. Bot. Herald, p. 367. t. 77 (1857); Seem. in Bonpl. vi. p. 278 (1858).

Geogr. Distr. Island of Hongkong (*Champion*! *C. Wright,* n. 61!).

6. THEA CHINENSIS (TAB. LXI.); ramulis petiolisque glabris vel sericeo-puberulis; foliis lanceolatis, obovato-lanceolatis vel ovato-oblongis acuminatis, utrinque glabris vel ad nervos plus minusve puberulis, pedunculis 2–3 bracteatis, sepalis rotundatis obtusissimis, glabris vel sericeis, petalis 5 obovatis obtusis patentibus (albis) dorso glabris vel pubescentibus, staminibus stylisque glabris, ovario villoso, capsula glabra. (v. s. sp. et v. v.)

Thea Chinensis, Linn. Spec. Plant. edit. i. p. 515 (1753); Sims, Bot. Mag. t. 998; DeCand. Prodr. i. p. 530 (1824); Chois. in Mém. Soc. Genève, xiv. i. p. 155 (1855).

Thea Bohea, Linn. Sp. Plant. edit. ii. p. 735 (1762).

Thea viridis, Linn. Sp. Plant. edit. ii. p. 735 (1762).

Thea Cantoniensis, Lour. Coch. i. p. 339 (1790).

Thea Cochinchinensis, Lour. Coch. i. p. 338 (1790).

Thea Japonica, Kæmpf. Amœn. Exot. p. 605 (1712).

Thea Assamica, Masters. *Thea stricta,* Heyne.

Camellia Bohea, Griff. Notul. ad Plant. Asiat. iv. p. 553. t. DCII. fig. 1 (1854).

Camellia theifera, Griff. Not. ad Plant. Asiat. iv. p. 558 (1854).

Camellia Thea, Link., ex Steudl. nomen. bot.

Camellia viridis, Link., ex Steudl. nomen. bot.

Nomina vernacula. In Japonia, teste Kæmpfer, "*Tsja,*" in China, teste Wach, "*Ta,*" "*Sa*" vel "*Cha,*" et in Cochinchina, teste Loureiro, "*Chè ān nām*" vocatur.

Geogr. Distr. Upper Assam (*Griffith*! *Masters*!); cultivated in the East Indies, China, and Japan; also in European gardens.

I agree with Choisy, that there is only one species of the plant yielding the tea of commerce, for which I adopt the name of *Thea Chinensis* given to it by Linnæus in the first edition of his 'Species Plantarum,' and afterwards sanctioned by Sims and others as a collective one for *Thea Bohea, viridis* and *Assamica.* The propriety of taking the name "*Chinensis*" may be open to discussion, since we have no wild specimens of Tea from China, but only from Upper Assam, and a Chinese tradition of great antiquity states that the Tea-plant was introduced from India by the Buddist priests, so that it is possible that we may term a species "Chinese" that is in reality "East-Indian" in its origin, and thus furnish another instance of "lucus a non lucendo." Dr. Hooker, to whom I communicated these doubts, thinks that the plant may yet be found wild in North-western China, and his intimate knowledge of the Flora of India renders that opinion of the utmost value.

Respecting the varieties of *Thea Chinensis,* I think that they are supposed to be much more marked than they really are. There is indeed a vast difference between the narrow-leaved forms of what is called *Thea Bohea* in our gardens, and the broad-leaved specimens of the wild Tea of Assam (figured in our Plate LXI.); but the transition from *Thea Bohea* to *Thea viridis,* and thence to *Thea Assamica,* is so gradual, that it is almost impossible to draw up any precise definition of these three great varieties. Besides, it must not be supposed that when we have furnished characters for these three principal varieties, our labours have terminated. As in all cultivated plants, there are minor varieties, and forms of the highest agricultural and commercial value, that claim our attention, and for the working up of which but limited materials are at present at hand. The belief so long entertained that *Thea Bohea* yielded the black, *Thea viridis* the green tea of commerce, has long been exploded; but a slight doubt seems still to linger in some quarters whether the fact that *Thea Bohea* suffers less from frost, and begins to put forth its young leaves later than *Thea viridis,* does not prove a specific difference between them. The reply to this is, that *Thea viridis* of the gardens does certainly begin to grow earlier than *Thea Bohea,* and therefore is apt to suffer more from night frost than *Thea Bohea*; but it does not follow that it must on that account be specifically distinct, as, according to the same rule, we should have to make species of all the early and late sorts of our kitchen vegetables and of our fruit-trees *.

Species exclusæ :

Thea Assamica, affin. Chois. = *Pyrenaria attenuata,* Seem.
Thea Camellia, Hoffmsg. = *Camellia Japonica,* Linn.
Thea imperialis, Hort. = *Micromeria obovata,* Bth.
Thea longifolia, Nois. = *Camellia Sasanqua,* Thunb.
Thea oleosa, Lour. = *Camellia Sasanqua,* Thunb.
Thea Sasanqua, Nois. = *Camellia Sasanqua,* Thunb.

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* For an interesting paper on the tea of commerce, by Charles Wach, see Ed. Otto's 'Hamburger Gartenzeitung,' xiv. p. 451 (1858).

ADDENDA. (October 1859.)

After the foregoing paper had been printed off, a fine specimen of Fortune's "Yellow Camellia" flowered at Kew, affording me an opportunity for examination. It proves to be a variety of *Camellia Sasanqua*, Thunb., of the Warratah or Anemone Class, and may be termed

CAMELLIA SASANQUA, var. γ. ANEMONÆFLORA; foliis ovato-lanceolatis longe acuminatis, floribus plenis, petalis exterioribus (albis) obovato-oblongis bilobis, staminibus fere omnibus in petalos spathulatos (flavos) exterioribus multo breviores mutatis, stylis 5 (rarissime abortu 4) liberis vel connatis, fructu ..... (v. v. cult.).

Camellia Sasanqua, Thunb., *var. γ. anemonæflora*, Seem. MSS.; Bot. Mag. t. . (ined.).
Yellow Camellia, R. Fortune, Journ. to Tea Countr. p. 339 (1852); Gard. Chron. for 1852, p. 259; Seem. in Gard. Chron. for 1859, p. 807.
Fortune's Gelbe Camellia, Bonplandia, vii. n. 19 (1859).

"Those who have read my 'Wanderings in China,'" says Mr. Fortune (Journey to the Tea Countries, p. 339. London, 1852), "may remember a story I told of my endeavours to find a *Yellow Camellia*,—how I offered five dollars for one,—how a Chinaman soon found two instead of one,—and how he got the money and I got taken in! In one of those nurseries (about ten or twelve miles eastward of Shanghae), however, I found a Yellow Camellia, and it was in full bloom when I bought it. It is certainly a most curious plant, although not very handsome. The flowers belong to the Anemone or Warratah Class; the outer petals are of a French white, and the inner ones of a primrose-yellow. It appears to be a very distinct species in foliage, and may probably turn out more hardy than any of its race."

Fortune's supposition that his "Yellow Camellia" might be a distinct species has not been verified, nor is the plant in question to be regarded as a variety of *Camellia Japonica*. The latter flowers towards the spring, and has quite glabrous leaf-buds, petioles, leaves, and ovaries; whilst the Yellow Camellia flowers in the autumn, and has pubescent leaf-buds, petioles, and veins of the leaves, and a woolly ovary, characters agreeing with *C. Sasanqua*, and it may therefore be safely referred to that species as a Warratah or Anemone-flowered variety, the stamens of which are nearly all transformed into short spathulate petals of a primrose colour. Hitherto the Warratah state was only known to occur in *C. Japonica*; and the yellow colour is certainly quite a new feature in this genus, deserving the greatest attention of horticulturists. That *C. Sasanqua* has a tendency to assume a yellow tinge is evident even from the single flowering state, as will be seen from the figure in the 'Botanical Register,' t. 942, where the outer series of stamens displays the primrose colour peculiar to the Yellow Camellia. I may add that the plate quoted represents the form nearest approaching the plant under consideration,—the leaves of the Yellow Camellia always being more acuminate than those of the ordinary form usually found in the gardens, and the styles generally (not always) entirely free. This latter particular Fortune's novelty shares with *C. Hongkongensis*, Seem., and *C. drupifera*, Lour. (*C. Kissi*, Wall.). As a cause of the sickly appearance generally presented by the Yellow Camellia in our gardens, I have assigned (Gardeners' Chronicle for 1859, p. 807) its being grafted upon *C. Japonica*, and, as a cure, recommended its being grafted upon its nearest ally, *C. Sasanqua.*

EXPLANATION OF THE PLATES.

TAB. LX.

Camellia Hongkongensis, Seem.

Fig. 1. Petal. Fig. 2. Stamens of the monadelphous series. Fig. 3. Ovary and styles. Fig. 4. Ovary cut across. All, with the exception of Fig. 1, magnified.

TAB. LXI.

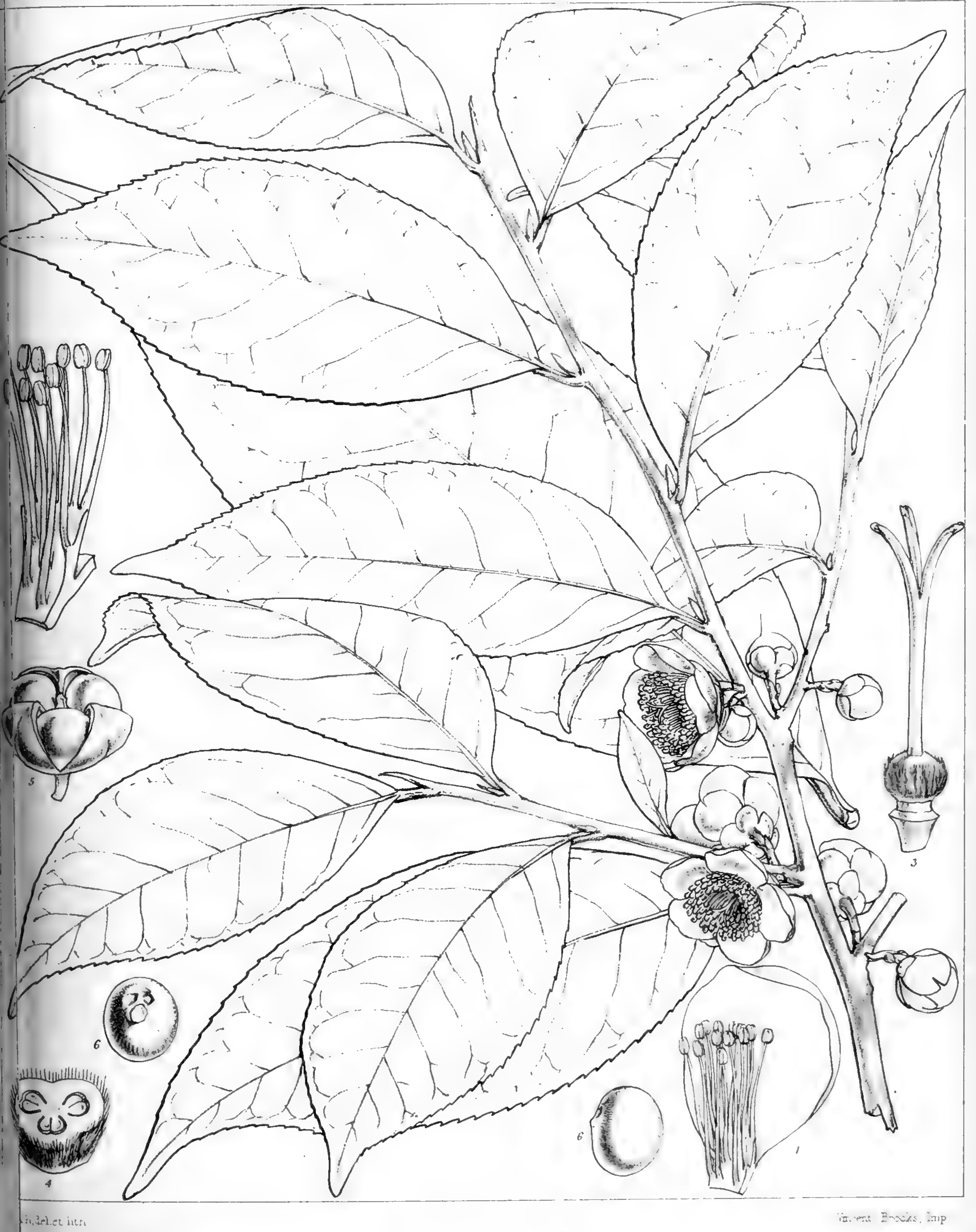
Thea Chinensis, Linn.

Fig. 1. Petal. Fig. 2. Stamens of the monadelphous series. Fig. 3. Ovary and styles. Fig. 4. Ovary cut across. Fig. 5. Ripe fruit. Fig. 6. A seed. Figs. 1, 2, 3, and 4 magnified.

del et lith

Camellia Hongkongensis. *Seem.*

Trans. Linn. Soc. Vol. XXII, tab. 61, p. 351.



h, del. et lith.
Vincent Brooks, Imp.

Thea Chinensis, *Linn.*

XXVI. *On* Tomopteris onisciformis, *Eschscholtz*. *By* WILLIAM B. CARPENTER, *Esq.*, *M.D.*, *F.R.S.*, *F.L.S.*, *F.G.S.*

Read Jan. 20th, 1859.

THE animal which forms the subject of the present communication is one which has not very frequently presented itself to the notice of zoological inquirers; and it is not a little singular that almost every one under whose observation it has fallen has given an account of its structure differing in some essential particulars from that of other observers. This circumstance may of course be readily accounted for on the hypothesis that the several specimens examined have belonged not to the same, but to different specific types. I cannot but believe, however, that a careful comparison of the published accounts will lead others, as it has led myself, to the conclusion that all the specimens described are referable to one and the same type, and that the differences are chiefly those of *phase* or *stage* of development. For it is remarkable that the accordance should be closest in those details of structure which might be expected, on the hypothesis of specific difference, to be most liable to vary; whilst the diversities are greatest in those features which seem most liable to undergo modification in the progress of development.

I shall first give a detailed account of my own observations, and shall then compare them with the descriptions which I have since found to have been given of this creature by those to whom it had already presented itself. My observations were made in the month of September last, on specimens captured in Lamlash Bay, Arran. I was fortunate in being able at the time to obtain the assistance of Mr. George West, whose intelligence and scrupulous accuracy as a microscopic draughtsman are well known to all who have employed him; and the drawings which accompany this communication having been all executed by him with the objects immediately before him, and under my own direction as to the points to which his attention should be specially given, I cannot but consider that they have a value much greater than can be attached to many of the representations heretofore published, most of which seem to me to be little better than ideal diagrams.

The study of this animal, I may say *in limine*, presents peculiar difficulties, from its incessant restlessness, and from the circumstance that its delicacy is such, that confinement is speedily fatal to it, its tissues and organs exhibiting a manifest tendency to disintegration some time before it ceases to move. We had, however, the great advantage of being able to make our observations on *several* specimens in the younger and simpler stage which I shall first describe; and I feel sure that we had accurately mastered all the most important features of *its* structure, before I met with the remarkable, and not a little perplexing form, which I think I cannot be wrong in regarding as a more advanced stage of the same.

The first phase under which the *Tomopteris* presented itself to me is delineated in Tab. LXII. fig. 1, under a power of 10 diameters. Its entire length was about ·20 of an inch. Its body was elongated, not quite cylindrical, but somewhat flattened, and extremely transparent; there was no other segmentation than that which was marked by the projection of the lateral appendages; but a delicate transverse wrinkling became apparent when a sufficient magnifying power was employed, as is indicated in figs. 2, 3, the former showing the *dorsal*, and the latter the *ventral* surface, under a power of 38 diameters. The part which may be designated as the *head*, from its containing the mouth, the nervous ganglia, and the eye-spots, and from its bearing what seem to be the principal organs of feeling, is not separated from the body by any constriction; and the perivisceral cavity is not only continued into it, but extends also into its appendages. These are of a very remarkable nature. In front of the head there projects (figs. 2, 3) what might be regarded as a short continuation of the body, narrowed into a kind of peduncle; and this terminates anteriorly in a pair of large horn-like appendages that project transversely on either side from their common base, somewhat after the fashion of the horns of certain Ruminants. Between the foregoing and the head, there arise from the under side of the peduncle a second pair of these horn-like appendages, which are smaller than the first; the inferior position of these is seen in fig. 4, which gives a *front* view of the head and its appendages. The perivisceral cavity is distinctly continued into the neck and the first pair of horns; but I could not satisfy myself that it penetrated into the second. From the sides of the head itself there projected a far more remarkable pair of appendages, nearly half the length of the body (fig. 1), which may for convenience be distinguished as the *styliform*. These were supported at the base by a lateral projection of the head on either side (figs. 2, 3), into which the perivisceral cavity extended, and which also contained the muscular apparatus that acted on the styliform appendage itself. This consisted of a long slender rod, which, though obviously very firm in texture, was not inflexible, and which, therefore, I should judge to be horny rather than calcareous. This rod was invested by a prolonged membranous sac, tolerably wide at the base, but gradually narrowing towards the apex, which appeared to close-in around the base of the rod, so that its cavity seemed completely isolated from the perivisceral cavity in which it lay; and it was to each side of this membranous envelope that the muscular bands were attached, which gave free motion to the styliform appendage.

The body bore *ten* pairs of lateral appendages, of which the *third* was the largest; the size of the 2nd being about the same as that of the 5th and 6th; that of the 1st about the same as that of the 7th; and that of the 8th somewhat smaller; whilst that of the 9th was not above half that of the rest; and the 10th (of whose character I was not at first by any means certain) was merely rudimentary. Each of these appendages consisted at its base of a nearly cylindrical prolongation of the body, transversely wrinkled like it, and containing an extension of the perivisceral cavity; this basal portion gradually narrowed itself, and then underwent bifurcation into two lobes, each of which supported a flattened fin-like expansion of somewhat oval form. In this expansion a sort of fibrous areolation could be seen with a sufficient magnifying power (figs. 2 *a*, 3 *a*). In their usual position these two fins seemed to be nearly at right angles to each other;

and by their incessant action the animal kept up a rapid swimming movement, varying continually in its direction, and very much resembling that of the Branchiopod Entomostraca, the strokes of the several appendages succeeding each other from before backwards.

Owing to the glass-like pellucidity of this interesting little creature, its interior structure can be made out as well as its continual restlessness allows; a further allowance having to be made for the circumstance, that owing to the difficulty occasioned by this very transparency in judging as to what is near and what remote, whilst its restlessness necessitates a continual shifting of the focal adjustment, the relative position of its internal parts cannot always be determined without some liability to error.

The mouth ordinarily opens by an elongated slit (fig. 3) on the underside of the head, into a thick-walled and apparently muscular pharyngeal cavity. This is shown in fig. 3 to be connected with the wall of the body by two bands on either side, one passing anteriorly and the other posteriorly; and it can scarcely be doubted that these are muscles for its protrusion and retraction, since I occasionally saw the pharynx protruded as a proboscis, after the fashion of many Annelids. About half-way between the styliform appendages and the first pair of fin-bearing appendages, the pharynx terminated by a well-marked constriction in the intestinal tube, which was a straight and simple canal whose diameter was usually no more than about a quarter of that of the body itself, and passed direct to the posterior extremity of the body, where it terminated with a pouch-like dilatation in the anal orifice (fig. 5). I never saw any solid matter in this canal; but it was frequently distended in parts by water, a wave of which would occasionally pass peristaltically from one extremity to the other. When thus distended, its wall could plainly be seen to be chiefly composed of ovoidal cells very compactly arranged, as shown in figs. 3, 5. No indications whatever of a dorsal vessel could be distinguished; but the fluid which occupied the large perivisceral space of the body, head, and appendages, could be seen to contain within it minute semipellucid granules of irregular form and size, by whose movements it was made obvious that this fluid was continually shifting its place,—rather in consequence, however (as it appeared to me), of the general movements of the body, than of any more special provision for its circulation.

I could not detect any organs of respiration, and I did not observe ciliary motion on any part of the surface. For the reasons already mentioned, however, I would not take upon myself to affirm its non-existence.

In the head there could be plainly distinguished a bilobed mass having all the appearance of a nervous ganglion; and upon this lay two little masses of pigmentary matter, each of which bore a small pellucid lens-like body (fig. 2). There can scarcely, I think, be a reasonable doubt of these being ocelli. From the central portion of the ganglionic mass, I thought that I could distinguish something very like the axis-band of a nerve-fibre without its tubular sheath, passing backwards along the *dorsal* surface of the body, keeping near to the median line, but not exactly upon it, and passing at intervals not very regular through red spots, which seemed like aggregations of granules, or very minute cells, and of which there were commonly six or seven in each of the divisions of the body. From each side of the bilobed ganglion I thought that I could trace a similar fibre passing to the styliform appendage; and the membranous sheath of its stylet was studded at intervals with isolated red granules or minute cells, which appeared to me to be connected by delicate fibres having the same general resemblance to the axis-band of ordinary nerve-fibres. I do not speak with any confidence on this point; more especially on account of the *à priori* improbability of the longitudinal nerve-cord being on the *dorsal* aspect of the body. But I think it right to record the fact of the constant presence of these red spots (of which very little notice has been previously taken), and of the apparent existence of fibres passing between them.

The impression at first left on my mind by the study of this interesting creature, of which I had never before seen or heard any account, was that it was a *larval* form, perhaps of an Annelid, but not impossibly of some Isopod Crustacean; the latter notion being suggested by its strong resemblance in habit to the Branchiopod forms of that class. I tried every expedient I could think of, for preserving specimens for subsequent examination and exhibition; but I could not succeed. Any medium in the slightest degree different in density from sea-water caused either an immediate *endosmose,* by which the body was made to burst, generally at the ends of the members; or an *exosmose,* by which it was at once shrivelled-up; and the tendency to disintegration which I have already noticed as showing itself even during life, operated still more strongly so soon as life became extinct.

Not many days after I had made the observations already detailed, I captured a specimen of larger size, having *twelve* pairs of fin-like appendages, and a caudal prolongation destitute of appendages,—its structure being in every other respect the same. And after a few days more I was fortunate enough to obtain (along with several specimens of the younger form) the specimen represented in fig. 6, which can scarcely be considered as anything else than another phase of the same type. Its entire length was about 2½ times as great; but of this only about the anterior three-fifths corresponded in structure to the original, the posterior two-fifths being obviously an addition formed upon a very different plan. Looking first to the anterior portion, we observe that it differs from fig. 1 in the following particulars. The head appears to carry on its front only one pair of horn-like appendages; a careful examination, however, shows that the second or smaller pair is really present, though, from its arising from the under side of the peduncle (which is here relatively shorter), it is concealed by the anterior part of the head when viewed from the dorsal aspect. The styliform appendages are greatly increased in relative length, so as even to pass considerably beyond the anterior three-fifths of the body.

The number of fin-bearing appendages is now *sixteen*; of these the first eight are nearly of equal size; and there is then a gradual diminution down to the 16th, which, though comparatively small, presents the structure characteristic of the rest. The alimentary canal, instead of being limited to a portion of the cavity of the body, now fills it entirely, except in the pharyngeal region; and it seems to be in a state of constant distension, except where narrowed at any part by a wave of peristaltic contraction which occasionally passes from the mouth to the anus. Such a narrowing is seen between the 12th and 13th pairs of fin-like appendages, and is shown on a larger scale at the top of fig. 7. The structure of the canal remains quite simple as far as the 16th pair of appendages, and closely resembles that which is seen in the narrow canal of the earlier phase when partially distended with fluid.

The posterior portion of the body, however, constituting about two-fifths of its entire length, presents a number of very marked differences in conformation. Its aspect is more cylindrical and worm-like; its parietes are relatively thicker and stronger, and their transverse wrinklings far more decided. It bears eight pairs of slightly-developed appendages, which might at first sight be supposed (especially in regard to their terminal bifurcation) to be rudimentary forms of the fin-feet of the anterior part of the body, but which a more careful examination will show to be formed upon a different plan; for whilst the appendages that bear the fin-feet, as already described, contain extensions of the general cavity of the body, the parietes of which correspond with those of the body itself both in their tenuity and in their delicate transverse wrinkling, those of this vermiform continuation are solid tubercles of ovoidal shape, put forth from the comparatively thick integument, and which do not receive any prolongation of the perivisceral cavity. On reverting to figs. 1 and 5, it will be seen that in that period of the animal's life at which it is most rapidly undergoing increase upon the ordinary type, the last and consequently least developed pair of appendages is still formed upon the same plan with those anterior to it; and the same is the case with the 16th pair in the more advanced form we are now considering. If the 17th and seven succeeding pairs appertaining to this vermiform continuation had any relation to the preceding, we should expect that there would be some gradation from one type to the other; so far is this, however, from being the case, that the 17th pair (the *first* of the vermiform continuation) shows the most decided unlikeness to the 16th (the *last* of the anterior series); the 18th, 19th, 20th, and 21st are of nearly the same size and aspect; whilst the 22nd, 23rd, and 24th become progressively smaller, the last pair being scarcely distinguishable. But further, at the very same point at which this change manifests itself in the condition of the body and of the appendages, there is a very marked change in the condition of the intestinal canal; for this, instead of being continued upon the straight and simple plan which so remarkably characterizes it in the anterior portion of the body, abruptly begins to present the appearance represented in figs. 6, 7. Whether this appearance is due to convolution or to sacculation, I am unable to state with certainty. I was unwilling to submit my only specimen to the compression which would have been requisite to ascertain this point, until I had secured a good delineation of it; and as it died and began rapidly to disintegrate before I could subject it to further investigation, I was deprived of the opportunity of subsequently doing so.

The extreme delicacy of structure and the low grade of development of the earlier phase of this interesting creature having strongly suggested to me that it was a *larval* form, the resemblance presented by the vermiform continuation, in the more advanced specimen, to the ordinary Annelidan type, together with its higher development and its appearance of greater permanence, led me to conjecture that this posterior portion would become the true type of the species, the anterior probably separating itself from it so soon as it should have acquired the power of sustaining itself independently, after the fashion of the Bipinnaria-zooid of the Star-fish. And notwithstanding that the information I have subsequently received as to the phenomena witnessed by other observers has thrown much doubt on this notion, yet I think it right to record it, for the sake of the suggestion it may afford to those who may have the opportunity of following up the inquiry. Certain it is, that if all the accounts of it be correct records of actual phenomena, and if they all refer (which, for the reasons I have already stated, I can scarcely doubt) to the same specific type, the creature's life-history must vary considerably in different circumstances.

Before referring to the published observations, I shall take advantage of the kindness of Prof. Huxley, who has given me permission to append to my own account of *Tomopteris* his descriptive notes and figures of two specimens captured by him in Torres Strait, during the voyage of the 'Rattlesnake,' Aug. 1, 1849:—

"Body elongated, perfectly colourless and transparent, with thirty-one pairs of lateral appendages, exclusive of what may be termed the head (fig. 8). The body is transversely wrinkled, but not, properly speaking, annulated, there being a great many rings between every two pairs of appendages, especially anteriorly. Posteriorly the wrinklings become coarser and wider, but they are still numerous in proportion to the appendages, and are not true annulations.

"What may be considered to be the head, on account of its containing the mouth and the organs of sense, is provided with two pairs of appendages. The first pair terminate the anterior extremity of the body, the two appendages being united by their base, and disposed transversely. They give the animal the appearance of a hammer-headed shark. Their anterior edge is thin and delicate, the posterior rounded; and this part contains a cavity continuous with that of the body.

"Behind the first pair of appendages the body suddenly narrows into a sort of neck, which expands again into two other transverse processes stouter than the former. Each of these is prolonged at its extremity into a long, slender, curved process nearly equal to half the length of the body, and this process contains a still more slender cylindrical spine, apparently of a horny nature. The end of the spine, covered by a membrane, projects into the cavity of the wide base of the appendage, and its extremity there gives attachment to several bundles of muscular fibres, which go to be attached to the sides of the cavity, and move the spine on occasion.

"In the cavity of the body, situated just where the narrow neck expands into the space which lies between the second pair of appendages, is a transversely elongated mass, which appears to be divided into two parts by a central line. Towards the outer side of each of these parts, there is, upon the dorsal surface, a rounded mass of black pigment, and, imbedded in the outer edge of this, a spherical (?), transparent, crystalline body; these are doubtless eye-spots, and the mass a double ganglion. Two delicate cords connect this double ganglion with the parietes, and I think I could trace a bundle of fibres running down on each side of the mouth; but I am not certain about this, and I am quite sure there was no chain of ganglia along the ventral surface of the body.

"In the cavity of the body likewise, and extending between the second pair of appendages of the head and the first pair of the body, is a narrow, thick-coated, pyriform pharynx. It commences in a rounded oval aperture on the ventral surface, and terminates by opening into the wide stomach. This has much thinner walls, and continues as a plain tube as far as the first fourteen or fifteen pairs of appendages. It then becomes transversely folded and wrinkled, and thus passes, preserving a very even diameter, to the end of the body.

"The cavity of the body contains, floating about between the intestine and the parietes, certain rounded free masses. These are made up of other more or less rounded masses, flattened when their sides are applied to one another (fig. 9), which have perfectly the structure of ova. These ova had a diameter of $\frac{1}{250}$th of an inch, and less. In those of the former size the germinal vesicle measured $\frac{1}{625}$th of an inch, and was clear and delicate. The germinal spot, vesicular and thick-walled, measured $\frac{1}{1600}$th of an inch.

"The appendages are hollow processes of the body, and their cavities are continuous with that of the body, as was evident from the passage of the ova from the one into the other. They increased in size to the fourth or fifth pair, and diminished again from the seventh or eighth. The first sixteen or seventeen pairs consisted of a stout basal portion terminated by two divisions, each of which was provided with a flat, vertical oar-like expansion. The remaining appendages became smaller and smaller and more rudimentary. The anterior ones were provided with two conical processes merely, while the posterior ones were themselves nothing but short simple processes. There was a short space between the last pair of processes, which were mere buds, and the truncated anal extremity.

"At the re-entering angle between the second pair of cephalic appendages and the narrow neck, there is, on each side, a rounded elevation, from which a sort of band or ridge runs back upon the dorsal surface.

"On the ventral surface, close to the two rounded elevations, a long, curved, spine-like process arises upon each side. In their natural position these two processes lie parallel with one another, one on each side of the mouth.

"Aug. 28th.—A small specimen obtained to-day appears to be a male, for it contained masses of round cells, each rather more than $\frac{1}{5000}$th of an inch in diameter, in the place of the masses of ova of the previous specimen; these were perhaps young spermatozoa. In other particulars its structure agreed with the foregoing."

It is obvious that Professor Huxley's specimen must have been in a more advanced stage of development than mine, since it had no fewer than thirty-three pairs of appendages, and was also maturing its sexual organs. His figure and description indicate that the conformation both of the body and extremities underwent a change at about the sixteenth or seventeenth pair; but the transition seems to have been far less abrupt than it was in my specimen; so that he does not appear to have been struck with any very decided difference in the conformation of the anterior and posterior parts of the body. And his figure of one of the appendages of the latter would seem to indicate that in their more advanced condition these approach more nearly to the type of those of the anterior, than they seemed to me likely to do.

Tomopteris onisciformis was first described by Eschscholtz, who briefly characterized and rudely delineated it in the 'Isis' for 1825 (p. 735, pl. 5. fig. 5), assigning to it a place among Heteropodous Mollusks. He would appear to have met with it only in its earlier phase; for his figure shows no more than twelve pairs of lateral appendages, without any caudal prolongation.

It seems, however, to have been previously (?) observed by Quoy and Gaimard, who met with it in the Bay of Gibraltar during the voyage of the 'Astrolabe;' but as their account of it was first published in 1827 (Annales des Sciences Naturelles, tom. x. p. 235), the name *Briarea scolopendra*, by which they designated it, must yield in priority to that of Eschscholtz. The specimen which they describe as having been taken in the Bay of Gibraltar, is stated to have attained a length of 4 inches. If there be no error in this description, it must have been far larger than any that has been elsewhere met with. They speak of it as possessing 24 or 25 pairs of lateral appendages or fin-feet; of these, however, their figure shows only 21 pairs, of which 17 belong to the body, and 4 to the caudal prolongation. If this figure (which strikes me as in many respects rather an ideal diagram than a true representation) approaches in any degree to the real proportions of their specimen, its lateral appendages must have been very much longer than those figured by any of the other naturalists who have described it, their maximum length being in the anterior portion of the body, and a progressive diminution taking place as far as the commencement of the caudal prolongation, behind which they are merely rudimentary. Thus the outside contour of the entire animal is not very dissimilar to that of a boy's kite, the caudal prolongation representing the tail. It is somewhat singular, that, notwithstanding the extreme transparency of this animal, MM. Quoy and Gaimard were unable to make out its alimentary canal, although they described and figured what they believed to be ova. They considered *Briarea* to be a Mollusk, nearly allied to *Glaucus*.

In Müller's Archiv for 1847, there are a description and a figure of *Tomopteris onisciformis* by Busch, who met with it in the North Sea. This figure nearly corresponds, except in the proportional shortness of the lateral appendages, with that of MM. Quoy and Gaimard. The number of these appendages which Busch represents is 18 pairs, the form of all being the same, and their size diminishing gradually from the 1st pair to the 18th, which is close to the posterior extremity of the body, there being no distinct caudal prolongation. Busch described and figured the ova in the perivisceral cavity, as Professor Huxley has done subsequently; and he also noticed other bodies which seem to correspond with what Professor Huxley regarded as bundles of spermatozoa.

In the succeeding volume of the same Journal (1848) is a very elaborate memoir by Grube on *Tomopteris*, based on specimens collected by Krohn (probably in the Mediterranean), and preserved in the Museum of St. Petersburg. This memoir is specially devoted to the description of some of the minutest details of the structure of the animal, and to the inquiry into its place in the zoological scale. Grube's figure of the entire animal is not only small in scale, but is somewhat rudely sketched; it represents twenty pairs of lateral appendages, and a caudal prolongation of cylindrical form, apparently without any appendages at all. In his description, however, the author speaks of this caudal prolongation as bearing rudimentary fins, in the form of whitish protuberances; these, he remarks, are as yet undivided; whilst the fully-developed appendages of the anterior part of the body are bifid, and in large specimens the lobes of the posterior not-fully-developed appendages are relatively larger than the former. One of the most important parts of Grube's memoir relates to the nervous system. He asserts that he has distinctly seen, in many specimens, a double nervous cord passing backwards along the ventral surface of the body from an œsophageal ring, of which the upper part is formed by the cephalic ganglia. This double cord, he says, does not anywhere present ganglionic enlargements; but, when examined under a high magnifying power, it presents a series of transverse striæ at short intervals. I cannot but express some doubt as to the existence of this ventral cord; for Grube's description of it is entirely based upon preserved specimens *; and although I looked for it carefully and repeatedly in living specimens, I was not able to detect it. Grube's description of the muscular structure also, especially in the fins, is very minute; but I can state confidently that this presents itself under a very different aspect during life; indeed, as to the general histology of the creature, I was struck with the remarkable change which it seemed to undergo when the animal appeared to be suffering from confinement, but while as yet far from having lost its vital activity.

The most recent notice of *Tomopteris* is that given of it by Mr. Gosse in his 'Naturalist's Rambles on the Devonshire Coast' (p. 356), under the name of *Johnstonella Catharina*; it adds nothing, however, to what had been previously recorded, excepting as to the occasional eversion of the pharynx so as to form a protruded proboscis, which Mr. Gosse seems to have been the first to observe. His specimens appear to have been in the same stage of development as my most advanced specimen, having 16 pairs of fin-like appendages, and a caudal prolongation without any obvious appendage. He seems to have overlooked the posterior pair of frontal "horns," which, for the reason I have stated, are not to be seen in the larger specimens unless carefully looked for. In his 'Marine Zoology' (vol. i. p. 106), Mr. Gosse has introduced *Tomopteris* (by its proper designation) amongst the "animals of doubtful position, probably belonging to the Annelida;" and he has given a figure of it, which, like the figure in his 'Devonshire Coast,' wants the second pair of frontal "horns," and which is further erroneous as giving not the least indication of the bifid character of the fin-like appendages.

There cannot, I think, be any longer a reasonable doubt as to the Annelidan character of *Tomopteris*; and the principal point which now requires investigation seems to me to be the question of the real nature of the caudal prolongation,—that is, whether it is simply an extension of the body, or is a zooid destined to be cast off and to maintain an independent existence. The former view seems to be that of all previous observers; no such marked peculiarity having been observed by them, either in the conformation of its appendages, or in the structure of its integument and of the portion of the alimentary canal included in it, as that which seemed to me to differentiate it completely from the anterior part of the body, and to bring it nearer to the ordinary Annelidan type. I speak with diffidence, however, on these points, since I find myself at issue in regard to them

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* It would be interesting to know in what fluid these specimens were mounted; as I tried all the ordinary media without succeeding in preserving in any specimens an approach to their life-like appearance.

with observers of unquestionable competency. And if, as would seem scarcely to admit of doubt, the process of sexual generation is carried on in the portion which I imagined to be larval, such a notion of its character becomes obviously untenable. I have deemed it right, however, to record my first impression, that any observers to whom the animal may present itself may have their attention more strongly directed to the peculiarities of structure by which it was suggested. And as the animal does not seem to be very uncommon on our coasts (having been taken by the late Dr. Robert Ball in the Bay of Dublin, and by Dr. S. J. Salter in Poole Harbour, as well as by Mr. Gosse and myself), it may be hoped that further light may ere long be thrown upon this question, as well as upon the nature and distribution of the nervous system of this beautiful and interesting creature.

[SUPPLEMENTAL NOTE.—Subsequently to the reading of the foregoing paper, another memoir on *Tomopteris* has been published in Müller's Archiv, 1858, p. 588, by Drs. Leuckart and Pagenstecher. These observers describe, under the name of *Tomopteris onisciformis*, a specimen with twelve pairs of fin feet and a caudal prolongation destitute of appendages, corresponding closely in its grade of development with a specimen I have mentioned in p. 354. In the perivisceral cavity of the anterior part of its body, they distinguished sexual products, as Busch and Huxley had done. They also describe, under the name of *Tomopteris quadricornis*, a smaller specimen, having only ten pairs of fin feet, and obviously identical with those first seen by me; this they consider to be specifically distinguished from the preceding by the presence of two pairs of horn-like appendages, the *T. onisciformis* seeming to have but one. I have already mentioned, however, that the second pair really exists in the larger specimens as in the smaller (p. 354); so that there is no reason for regarding the two as otherwise than specifically identical, the difference in the number of fin feet being obviously a character of age merely.]

EXPLANATION OF THE PLATE.

TAB. LXII.

Fig. 1. Young specimen of *Tomopteris* with ten pairs of fin feet; enlarged 10 diameters.

Fig. 2. Head and anterior part of the body, as seen upon the dorsal aspect, enlarged 38 diameters; *a*, bifid extremity of one of the fin feet.

Fig. 3. The same, as seen upon the ventral surface.

Fig. 4. Front view of the head, showing the position of the two anterior pairs of cephalic appendages, and the opening of the mouth upon the ventral surface.

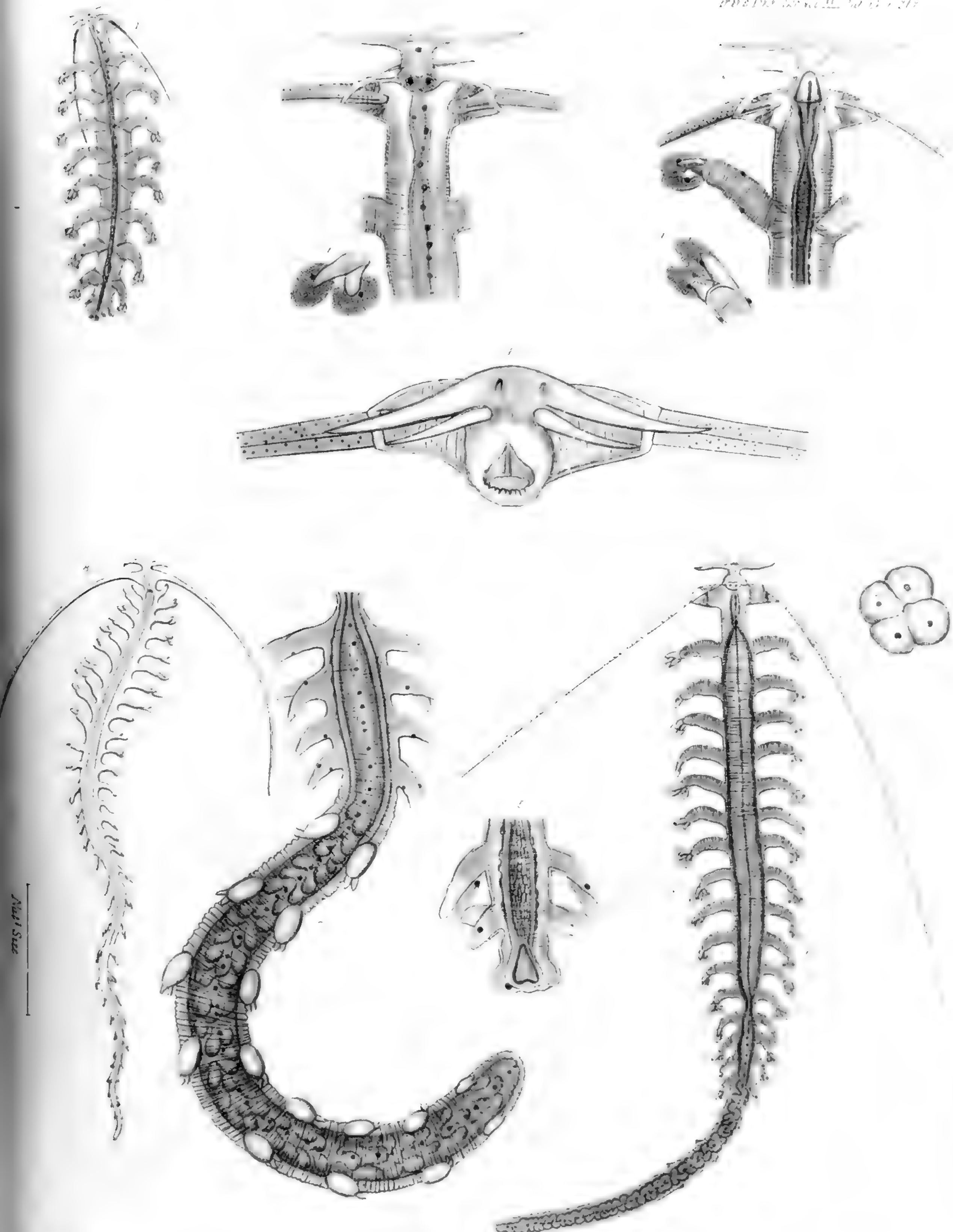
Fig. 5. Caudal extremity, showing the last two pairs of least-developed fin feet, and the termination of the intestine in an anal orifice.

Fig. 6. Advanced specimen of *Tomopteris* with sixteen pairs of fin feet; enlarged 10 diameters.

Fig. 7. Posterior extremity of the body of the specimen represented in fig. 6, with its last four pairs of ordinary fin feet, giving origin to a caudal prolongation of very different conformation, furnished with eight pairs of rudimentary appendages.

Fig. 8. Specimen of *Tomopteris* with thirty-three pairs of appendages (*Huxley*).

Fig. 9. Masses of ova in the perivisceral cavity of the preceding (*Huxley*).



Tuffen West del.

XXVII. *On some new forms of* Entozoa. *By* T. SPENCER COBBOLD, *Esq., M.D., F.L.S.*

Read January 20th, 1859.

BY permission of the authorities of the Zoological Society, I have enjoyed the opportunity of examining a large proportion of such animals as have died at the Society's Gardens, Regent's Park, during the spring and winter months of last season.

The materials thus afforded for a search after *Entozoa* consisted of six species of Reptiles, thirty-one of Birds, and the same number of Mammals. With three duplicate exceptions in the case of birds, and one in mammals, only a single example of each species came under notice, thus giving a total of seventy-two animals subjected to dissection. Of these, but three reptiles, nine birds, and ten mammals were found infested,—a result of considerable interest to the Zoological Society, as it proves these animals to enjoy greater freedom from internal parasites in their condition of domesticity than in the wild state. This indeed is precisely what we should expect, as it is well known that the larvæ of *Entozoa* occur only in a limited number of *hosts*; and it is equally evident, in the case of *Trematoda* for example, that the uninfested foreign animals can have had no opportunity of devouring the various forms of molluscan hosts which under ordinary circumstances supply the *cercariæ* destined to become adult flukes in their viscera.

1. DISTOMA COMPACTUM (mihi). Body smooth, ovate, oblong, not compressed; oral sucker terminal, orbicular; ventral sucker subcentral, aperture triangular; reproductive pore immediately below, a little to the left. Length $\frac{1}{6}$–$\frac{1}{3}$ in.; breadth $\frac{1}{8}$–$\frac{1}{5}$ in. (Pl. LXIII. figs. 1, 2, 3.)

Remarks.—On the 19th of February I removed five specimens of this trematode from pustular cavities in the left lung of an Indian Ichneumon (*Viverra mungos*, L.). All conjecture as to the source of its larvæ must be useless; but the adult form is well marked, and easily recognized by the compact condition and arrangement of the internal organs. It is provided with a short œsophageal bulb, giving off two simple, tortuous and unusually broad digestive canals. The twisting is so marked and regular as to approach the peculiar zigzag condition of *Campula*—a genus which I have recently established (Linn. Trans. vol. xxii. part 3. p. 168). The vitelline cæca almost entirely cover the lateral and dorsal surfaces, and are connected in the middle line by two primary transverse branches; these again unite to form a trunk which opens into the base of the short and folded uterine tube. The testes lie directly below.

The nearest resemblance to this species is a fluke discovered by Natterer at Matogrosso, in cavities of the lungs of the American Otter. Under the title of *Distomum rude*, Diesing has described and figured it in his 'Neunzehn Arten von Trematoden: Wien, 1856.'

2. DISTOMA MINUTUM (mihi). Body flat, smooth, oblong, narrowed in front; oral sucker oval, subterminal; ventral sucker orbicular, central. Length $\frac{1}{120}$–$\frac{1}{100}$ in.; breadth $\frac{1}{180}$–$\frac{1}{120}$ in. (Figs. 4, 5.)

Remarks.—This exceedingly small trematode was found in great abundance in the duodenum of an Oyster-catcher (*Hæmatopus ostrealegus*, L.), and could scarcely be discerned with the naked eye. Its form is entirely different from *D. brevicolle* described by Creplin as infesting this bird; moreover the latter is a much larger species. The presence of a long uterine canal crowded with ova showed its mature character, while few traces of other organs were to be seen. I did not succeed in detecting with certainty the position of the genital pore, but appearances seemed to indicate its presence directly above and to the right of the ventral sucker.

3. DISTOMA BOSCI (mihi). Body subclavate, covered with minute spines, slightly compressed, thickened below; oral sucker orbicular, subterminal; genital pore above the ventral acetabulum. Length $\frac{1}{4}$–$\frac{1}{2}$ in.; breadth $\frac{1}{12}$–$\frac{1}{10}$ in. (Figs. 6, 7.)

Fasciola colubri, Bosc, Hist. Nat. des Vers, i. p. 271, with figs.

Distoma colubri Americani, Rudolphi, Entoz. Hist. vol. ii. p. 434; and Synops. p. 121; Diesing, Syst. Helminth. vol. i. p. 398.

Remarks.—This species has hitherto been only very briefly noticed, and is placed by Diesing among doubtful and imperfectly-described forms. Like Bosc, I found several specimens in the buccal cavity of an American serpent of the genus *Coluber*, the specific name of which I am unable to give. The worm is provided with a muscular œsophageal bulb, two simple digestive cæca, and largely-developed reproductive organs.

4. BILHARZIA MAGNA (mihi). Body smooth, linear, gradually narrowed anteriorly; oral sucker oval, subterminal; ventral acetabulum round, very prominent. Length upwards of 1 in. (Figs. 8, 9.)

Remarks.—Up to the time of Bilharz's discovery of *Distoma hæmatobium*, all the flukes were considered hermaphrodite, and I am not aware that any other species excepting the above has been since found to present a deviation from the general type. Trematodes possessing so marked a structural peculiarity as *D. hæmatobium*, associated as it is with the presence of a gynœcophoric canal in the male, deserve, I think, to be generically separated from *Distomata* properly so called, and I have therefore employed the indefatigable discoverer's name for this purpose. Only a single male example of the species here recorded was observed by me, while engaged in the dissection of a Sooty Monkey (*Cercopithecus fuliginosus*), in some blood which had escaped from the divided portal veins. It is a much larger species than *Bilharzia* (*Distoma*) *hæmatobia*; but its precise length I am unable to record, as a portion of the caudal extremity had been accidentally removed. Unfortunately it was at the time regarded as a common nematode; but had its true nature been earlier detected, a more careful examination of the blood-vessels would probably have brought other individuals to light.

5. ASCARIS TRIBOTHRIOIDES (mihi). Head truncate, with three sucker-like processes; neck constricted; body uniformly linear; tail conical, with a short blunt extremity. Length about 1 in. (Figs. 10, 11.)

Remarks.—I am not certain that this eccentric-looking nematode should be considered a true *Ascaris*. Two examples only were detected in the small intestine of a Dusky Duck (*Anas obscurus*), and neither of these was sufficiently fresh to exhibit its internal structure to advantage.

6. CŒNURUS. From a specimen of the Ring-tailed Lemur of Madagascar (*Lemur maco*), which died at the Zoological Gardens on the 30th December 1857, and which had been in this country only four months, I procured a remarkable series of hydatid-like *cœnuri* (fig. 12). They existed in such abundance in the liver, and on both sides of the thorax, as to become the immediate cause of the animal's death. Those in the chest were connected to the pleura, and occurred in semitransparent pedunculated masses, split up, as it were, into numerous lobules, the entire parts of each separate bunch being connected together and to the surface of the extremely atrophied lungs by short pedicles. Here and there small colonies, consisting of only one or two lobules, were in process of development. Each lobe presented a variable number of small, round, papillary elevations, which in some places assumed a more or less regular linear arrangement. Under a low magnifying power, the surfaces of the imperfectly-formed papillæ exhibited a central oval depression (fig. 13), while each of the more completely developed eminences was found, on dissection, to contain a single well-formed tape-worm head. Enlarged forty diameters, every head displayed four suckers and a short proboscis armed with thirty-two hooks disposed in two rows (figs. 14, 15). No loose *scolices* occupied the interior of the lobules, which were filled, however, with a pale-yellow serous fluid.

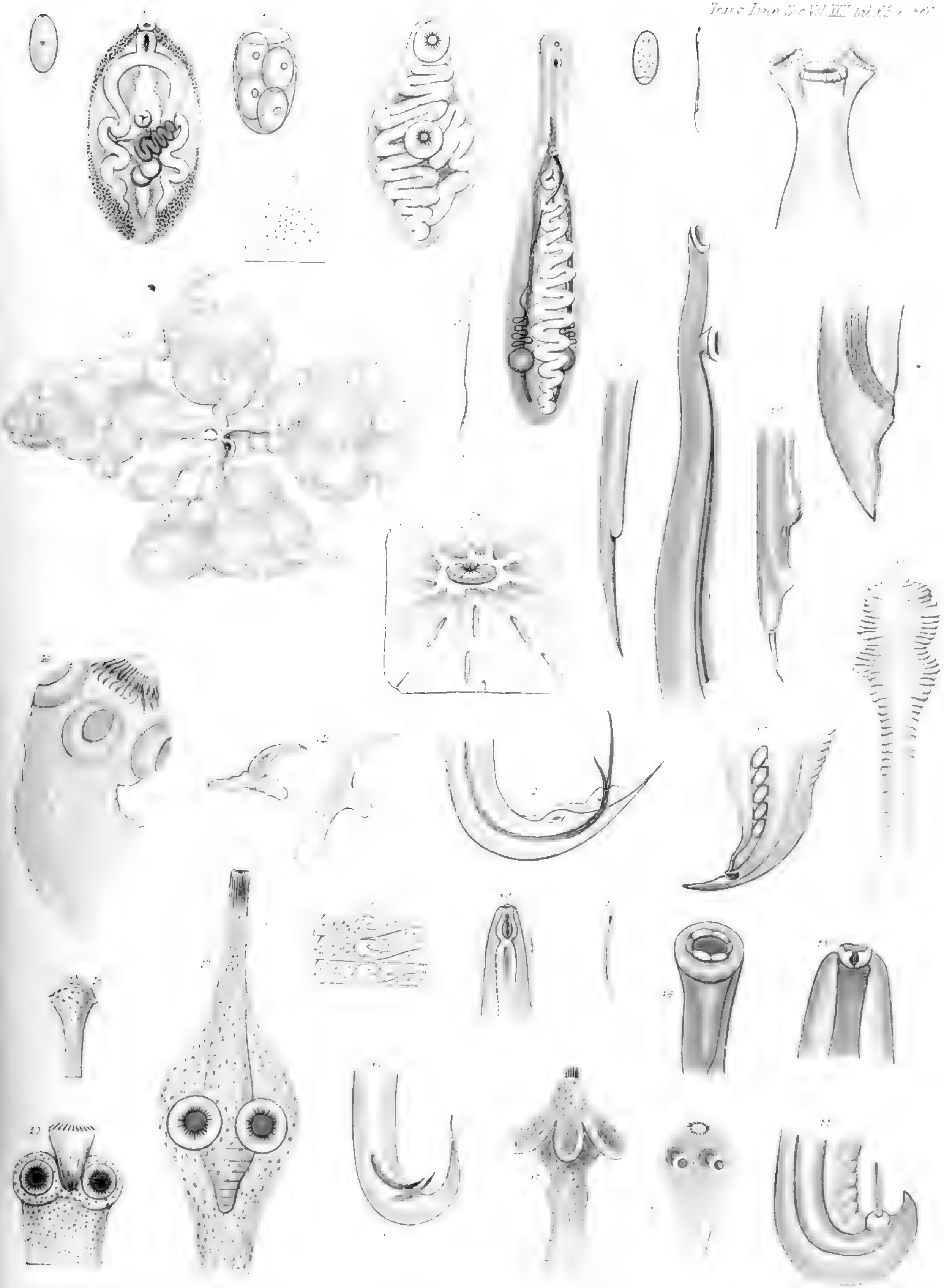
Appendix.—Among known forms of *Entozoa*, I may mention the occurrence of *Tænia paradoxa* in the Oyster-catcher (figs. 16–19 inclusive); and in the Dusky Duck (*Anas obscurus*) of numerous partially decomposed *Tæniæ*, referable, I think, to *T. lanceolata* (fig. 20). From the duodenum of a Night Heron (*Ardea nyctocorax*) I obtained ten or twelve examples of *Tænia multiformis* (fig. 23); also three fine specimens of *Eustrongylus papillosus* (fig. 24) from the mouth of a Crane (*Grus antigone*). From the small intestine of an American Barn Owl (*Strix perlata*) were procured nine individuals of *Distoma æquale*, and from a Horned Pheasant several examples of *Tænia infundibuliformis* (fig. 25). The cæca of a Ring-necked Pheasant (*Phasianus torquatus*) were crowded with *Ascaris vesicularis* (fig. 21); and the intestines of a Sandwich Island Goose contained several worms very like *Heterakis dispar* (figs. 26 and 27), besides other nematodes requiring further investigation. The liver of an Axis Deer (*Cervus axis*) contained a few degenerated *Cercariæ*, while a large aborted *Cœnurus* or acephalocyst occupied the left lung of a Goat (*Aries tragelaphus*). Several nematodes (fig. 28) were obtained from the lungs of a Peccary (*Dycoteles torquatus*), while the rectum of a Weasel-headed Armadillo (*Dasypus sexcinctus*) yielded several specimens of *Ascaris retusa* (fig. 22). From the lungs of the Four-horned Antelope (*Antilope quadricornis*) I procured several very large cysts of

Echinococcus veterinorum (*altricipariens* of Küchenmeister), precisely like those described by Professor Huxley from the Zebra. I also procured some nematodes (figs. 29 and 30) and cestodes (fig. 31) from an Indian Rat Snake (*Coluber Blumenbachii*) measuring six feet long, as well as a single round worm from an Indian Lizard (*Calotes versicolor*), which, together with another large *Ascaris* (figs. 32 and 33) from the intestine of the American Snake formerly alluded to, I have not at present been able to identify.

DESCRIPTION OF THE PLATE.

Tab. LXIII.

Fig. 1. *Distoma compactum.* Enlarged $\frac{1}{5}$th.
Fig. 2. Another example. × 5 diameters.
Fig. 3. Egg of the same. × 360 diameters.
Fig. 4. A few drops of mucus, &c., taken from the duodenum of the Oyster-catcher, and spread on a thin square of glass. It shows several small flukes. Nat. size.
Fig. 5. *Distoma minutum,* from the same. × 180 diameters.
Fig. 6. *Distoma Bosci.* × 8 diameters.
Fig. 7. Egg of the same. × 200 diameters.
Fig. 8. *Bilharzia magna.* Nat. size. Assumed proportion of the lost end of the tail in outline.
Fig. 9. Upper two-thirds of the same. × 10 diameters.
Fig. 10. Head of *Ascaris tribothrioides.* × 160 diameters.
Fig. 11. Tail of the same. × 160 diameters.
Fig. 12. Colony of *Cœnuri* from *Lemur maco.* Nat. size.
Fig. 13. Part of an immature lobule. × 20 diameters.
Fig. 14. Tape-worm head from one of the mature papillæ. × 40 diameters.
Fig. 15. Hooks from the same. × 260 diameters.
Fig. 16. *Tænia paradoxa.* Nat. size.
Fig. 17. Head of the same. × 260 diameters.
Fig. 18. Everted extremity of the rostrum. × 260 diameters.
Fig. 19. Upper joints of the same. × 150 diameters.
Fig. 20. Tape-worm head. *T. lanceolata*? × 250 diameters.
Fig. 21. Tail of *Ascaris vesicularis.* Male. × 30 diameters.
Fig. 22. Tail of *Ascaris retusa.* Male. × 25 diameters.
Fig. 23. Head of *Tænia multiformis.* × 200 diameters.
Fig. 24. Head of *Eustrongylus papillosus.* Enlarged.
Fig. 25. Head of *Tænia infundibulum.* × 80 diameters.
Fig. 26. Tail of *Heterakis dispar*? Male. About 60 diameters.
Fig. 27. Tail of *Heterakis dispar*? Female. About 60 diameters.
Fig. 28. Tail of a female *Ascaris* from the Peccary. × 100 diameters.
Fig. 29. Head of an *Ascaris* from *Coluber Blumenbachii.* × 60 diameters.
Fig. 30. Larval nematode from a cyst in the heart of the same Serpent. × 60 diameters.
Fig. 31. Head of a cestode from the muscles of the same. Enlarged.
Fig. 32. Head of an *Ascaris* from the intestines of an American Snake.
Fig. 33. Tail of the same. × about 20 diameters.



T. S. Cobbold, M.D. del.

XXVIII. *On the Anatomical Characters of three Australian species of* Tunicata *referable to Savigny's subgenus* Cæsira. *By* John Denis Macdonald, *F.R.S., Assistant Surgeon of H.M.S. 'Herald,' commanded by Captain* H. M. Denham, *R.N., F.R.S. Communicated by* George Busk, *Esq., F.R.S., F.L.S.*

Read January 20th, 1859.

I. In another paper, on the anatomical characters of *Perophora Hutchisoni*, I had occasion to notice the frequent occurrence of a small sessile and solitary Ascidian, attached to the same branches of *Amphibolis*, covered with a similar granular coating, and so far exhibiting a corresponding habit. As this little tunicary forms the type of a well-marked genus, of which we have discovered several species, a short description of it may not be uninteresting.

The body is of a depressed pyriform shape, and from one-half to three-fourths of an inch in length. It generally rests a little on one side, as well as on its base, being thus in part sessile and in part recumbent.

The two external openings lie nearly on the same plane, and in general appearance, more especially in the contracted state, resemble those of *Boltenia*, a resemblance which is heightened by an infolding of the test extending between them. The branchial aperture, however, is obscurely divisible into six rays instead of four.

The test is exceedingly thin, and so densely studded with fine grit, that it is rather difficult to investigate its structure satisfactorily; an internal glistening coat of a fibrous texture is nevertheless distinctly traceable.

The *pallio-vascular* system, which is so highly developed in other cases, is scarcely at all visible in the present species, a circumstance most probably to be accounted for by the thinness of the test, the greater part of whose apparent thickness is due to extraneous matters.

On removing the test, an elaborate system of reticulated vascular canals, invested with a greenish-yellow pigment, presents itself beneath the epithelium of the mantle and the more superficial fibres of the muscular coat.

The outer part of the branchial opening is armed with a circlet of simple, pointed or bifid tentacula, the equivalents of which are also present in *Boltenia*; and, as in the latter genus, the inner rim of the same opening is surrounded by compound tentacula, divided into pretty equal branchlets and pinnæ.

The branchial network is composed of rather stout transverse bars and very delicate longitudinal nervures, strengthened at intervals by stronger ones assuming the character of folds.

The mouth is situated at that part of the respiratory chamber which is nearest to the cloacal cavity, and leads by a very short œsophagus almost directly into an elongated stomach which curves gently downwards and backwards, and gradually diminishes in size to the point where it becomes continuous with the intestine. The latter courses backwards and then upwards on the right side of the body, until, having arrived opposite the branchial opening, it bends suddenly forwards, forming a simple loop, and again passes towards the stomach, above but parallel with its former course, to terminate in the cloacal chamber close to the position of the mouth.

The liver is of a rudimentary character in this species, consisting of minute sacculations, which emboss the surface of the stomach, and impart to it a rich amber or brown hue.

The ovaria are two in number, one lying on either side of the body, between the branchial membrane and the muscular coat. The right ovarium does not occupy the loop of intestine, as it does in *Boltenia* and most other Tunicata, but is placed in a recess in front of it. These organs are pyriform in shape and laterally compressed, with the smaller end and the short duct issuing from it directed towards the cloaca. The testes are also two in number, consisting of numerous elongated and finely-divided lobules radiating round the base of the ovaria.

II. In Hamelin's Harbour, Shark Bay, a second species of this genus, but of much larger size, is rather plentiful. Unlike that just described, it appears to lie loosely, or with a very slight attachment, on the sandy bottom, being too massive to be supported on the delicate stem of a *Zostera* or an *Amphibolis*.

The body of the animal is somewhat rounded, compressed on the sides, and averages one inch and six-tenths in antero-posterior measurement, and one inch and three-tenths in the vertical direction.

The test itself is very thin; but numerous branched and interlacing fibres, often tubular, and containing prolongations from the mantle, arise from every part of its outer surface, and form a matrix for the lodgement of shell and coral grit, foraminifera, and other extraneous matters. In this way the coat assumes a thickness of about one-fifth of an inch.

The external openings lie nearly on the same plane upon the upper or neural surface; but they are usually so surrounded with small and irregular processes of the test, that it is difficult to determine their actual configuration; they are, however, connected by a straight fold of the test, as in the former species.

The mantle presents an almost uniformly greenish-yellow tint, produced by minutely-divided and reticulated vessels.

The fibres of the muscular coat are delicate, and rather loosely disposed over the general surface of the body, though very strongly developed round the branchial and cloacal openings, in circular and radiating bundles. The lining membrane of the latter opening presents a rosy hue; and just within the margin of that which leads to the respiratory chamber spring several tentaculiform bodies, which appear to correspond with the duplicatures of the contracted aperture. The true tentacula, however, always lie internal to these or their modifications in the Tunicata generally.

The tentacula in the present, as in the former species, are compound, consisting of a tapering central portion, with six or seven pairs of subramose lateral processes, openly set with minute papillæ. Both the axis and rami are crested or angulated in the middle, gently curved, and ornamented with yellow vascular lines. The curvature of these beautiful organs is due to the presence of longitudinal muscular fibres on the concave border, having no others to antagonize them on the opposite side.

The branchial network is minute and regular, and the membrane is thrown into about fourteen longitudinal folds; seven on either side of the body extending between the branchial and oral apertures, and increasing in length from before backwards, in which direction also they gradually become more curved.

The mouth is small and surrounded by the converging ends of the longitudinal folds of the branchial membrane, leading into a short œsophagus, which curves downwards and backwards to join an elongated stomach, from whose tapering pyloric end the intestine takes a very similar course to that described in the former case, and terminates in the cloacal chamber near the position of the mouth.

The liver consists of numerous short and compressed glandular sacculi of a rich brownish-red colour, lying on the left side and along the inferior border of the stomach, into which their contents are poured.

The products of digestion are usually to be seen in the intestine, connected together by a plastic substance, and rolled into a filiform, continuous, and highly convoluted mass, extending from the stomach to the vent.

The testes and ovaria are identical in character, position and relations with those of the foregoing Ascidian.

The heart lies on the left side of the body, just below and in front of the corresponding ovarium. It rests on a small brown cylindroid body with rounded extremities, and exhibiting a slight curvature, with its concavity looking upwards and forwards. This body appears to lie loosely in a blood-sinus adapted to receive it, and is chiefly composed of minute cells, cell-nuclei, and an amorphous matter enclosed in a membranous sac, but exhibiting no very definite arrangement. What its real nature is I have not been able to determine, though I am disposed to believe that it may be the representative of the "*elæoblast*" of the Salpian.

III. In Shark Bay also, and in about three fathoms water, we obtained another small Ascidian, so nearly allied to those just described as to merit brief notice here. It is nearly of the same size as the King George's Sound species, but rather more narrowed and produced above, and more rounded at the base.

The branchial and cloacal openings lie on nearly the same level, at the extremes of the upper border, and are tubular and prominent, though capable of considerable retraction.

The test is thin, smooth, colourless, and beautifully transparent, so far calling to mind the pelagic Tunicata generally. It is, however, loosely covered over with the fine sandy particles of the sea-bottom on which it rests, being apparently quite unattached, though perhaps unable to change its place at will.

The muscular coat and its epithelial covering are also quite transparent and free from pigment.

The external openings, particularly at their base, are surrounded with radiating and circular muscular fibres, while others are scantily distributed in various directions over the body.

The branchial network is very delicate and rests upon a stout transparent membrane, which is sacculated or embossed towards the respiratory cavity.

The internal tentacula are compound, as in the former species; and the mouth, stomach, intestine, testes, and ovaria exhibit the same general disposition, so that the description of those organs above given will equally apply to the present case, with the following exceptions, namely, that the stomach in the latter is covered with a very dark pigmentary matter, probably including biliary follicles, and the intestinal loop is more open, so that the right testis and ovarium lie within it.

Finally, the heart holds a slightly oblique position below the left ovarium, and rests on a curved cylindroid body tinted with a rich madder-brown pigment, unquestionably the equivalent of the organ which I have assumed to be an "*elæoblast*" in the last-described species.

June 1858.

EXPLANATION OF THE PLATE.

Tab. LXIV.

[The same general references apply to all.]

I. *Cæsira parasitica.* King George's Sound species.

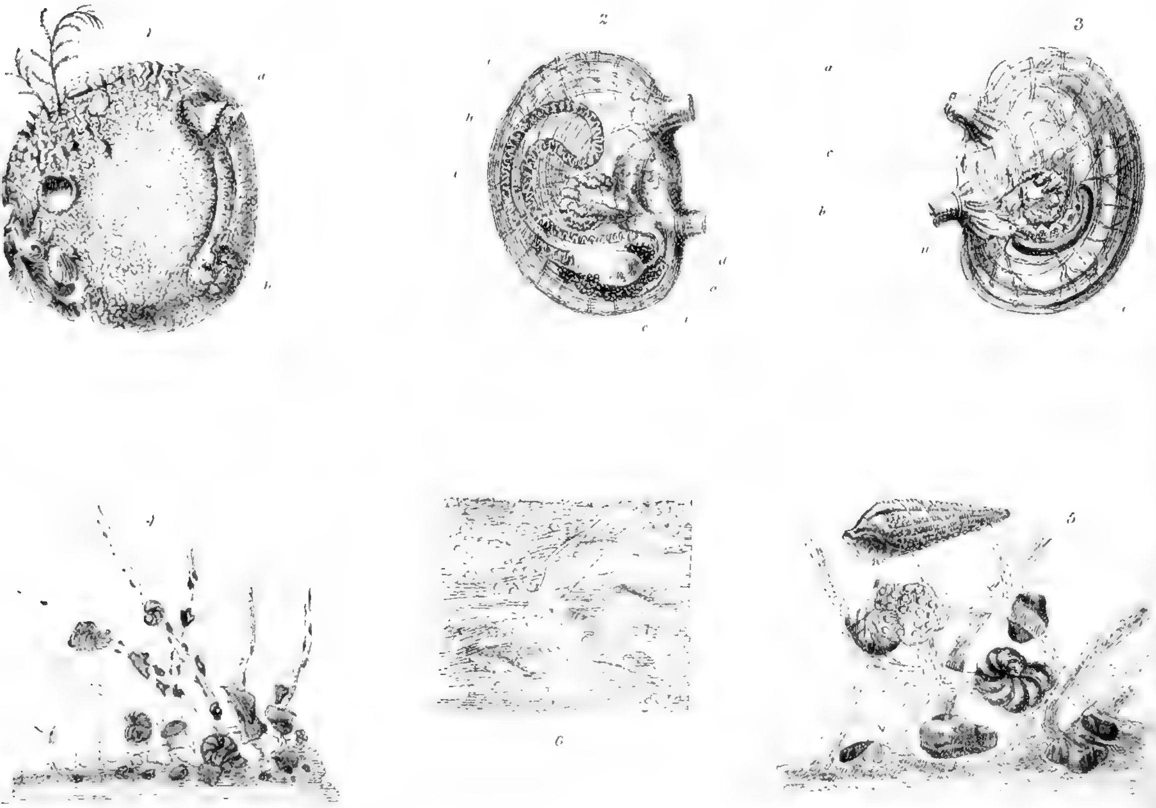
Fig. 1. Animal *in situ,* with a cluster of zooids of *Perophora Hutchisoni.*
    a. Branchial, and
    b. Cloacal opening (both being contracted and radiately puckered).
Fig. 2. The animal removed from the test, to show its internal parts.
    c. Nervous ganglion.
    d. Position of the mouth.
    e. Stomach, and *e'*. Liver.
    f. Intestinal canal and loop.
    g. Rectum.
    h. Right testis.
    i. Right ovarium.
Fig. 3. Simple external tentacula, magnified.
Fig. 4. One of the compound internal tentacula.
Fig. 5. Immature ova.
Fig. 6. Perfect ovum with additional yelk-granules and outer covering.

II. *C. ficus.* Shark Bay species (No. 1).

Fig. 1. The animal as it appears in its natural state, with one or two Sertularians growing on its granular coat.

I

II



III

[illegible] Tuffen West [illegible]

W. West Imp.

Fig. 2. Right view of the animal removed from its test.
Fig. 3. Left view of ditto.
Fig. 4. Portion of the test, under a low power.
Fig. 5. Portion of the test, highly magnified.
Fig. 6. Part of the internal fibrous and granular layer of the test, seen in face, and showing the apertures of nutritive canals.

III. *C. pellucida.* Shark Bay species (No. 2).

Fig. 1. The animal in its natural state.
Fig. 2. Right view of the animal removed from its test.
Fig. 3. Dorsal view of the same.
  k. Sacculations beneath the branchial membrane.
  l. Endostyle.
Fig. 4. Left lateral view.
  m. Left testis and ovarium.
  n. The heart.
  o. Elongated body on which the heart rests, as alluded to in the text.

XXIX. *On the Anatomical Characters of a remarkable form of* Compound Tunicata. *By* John Denis Macdonald, *F.R.S., Assistant-Surgeon of H.M.S. 'Herald,' commanded by Captain* H. M. Denham, *R.N., F.R.S. Communicated by* George Busk, *Esq., F.R.S., F.L.S.*

Read February 17th, 1859.

On examining an encrusting form of Compound Tunicata, taken from the ship's copper while refitting in Sydney Harbour, I was surprised to find that each little cluster of viscera was surmounted by two similarly-constructed branchial chambers or thoraces, as though two zooids had been combined together.

Each branchial chamber was supported on a narrow pedicle, and both pedicles arose from one short trunk, which suddenly expanded into the abdomen, while little gemmations were frequently seen clustering near its base.

About four delicate and unbranched tubules, with a dilated and glandular extremity (derived from that part of the mantle which invests the viscera), extended themselves into the connecting substance.

A stout endostyle occupied the dorsal region, and the branchial network exhibited three or four principal transverse bars, intersected at right angles by the more numerous longitudinal nervures. The orifice of entry was guarded by a circlet of six broad and short tentaculiform processes—organs which are so often mistaken, in other cases, for the true tentacula; and there being no proper atrium, the anus opened directly upon the surface near the middle of the ventral aspect. The existence of a superficial common cloacal system was clearly indicated by the low position of the rectum, and the absence of pigment-cells within a circumscribed space on the fore-part of the body. The actual disposition of this system, however, I have not succeeded in determining, on account of the peculiar delicacy of the connecting substance.

A small spur-like appendage or caudex was sometimes distinctly observed, projecting from the dorsal surface of the pedicles, just below the branchial chamber.

The viscera formed a large subglobular mass, in which a voluminous stomach, testis, and ovarium were plainly discernible. In the specimens examined, the diameter of the ova, visible in the ovarium, far exceeded that of the pedicles, through which, according to the present view of the subject, they were destined to pass; moreover, numerous ova, scarcely further advanced than those within the ovarium, were scattered through the connecting substance, in which they were perfectly enclosed. The ova of this genus, like those of the larger solitary Ascidians, were invested with a stout chorion, supporting a beautiful epithelial pavement, and containing a dull amber-coloured or reddish yelk.

The process of yelk-cleavage was easily traceable in a selected series of ova; and where that of differentiation had commenced, the vitelline mass appeared to be encircled almost completely by a long and gradually tapering tail, while three short sucker-tubes diverged from an opposite point. In more advanced examples, the transparent polygonal cells, including the true embryonic structures, formed an oval tadpole-like body, from the delicate investing membrane of which the tail received a covering. These cells no doubt form the proper test of the embryo, and as such must also be the basis of the connecting substance or common test of the mass.

The part destined to become the future abdomen was divided into several rounded lobes, from the confluence of which the tail emerged posteriorly, and two distinct branchial chambers arose in front.

A nervous ganglion with an otolithic sac, and what may probably be a rudimentary visual organ, were connected with one of the thoraces; while the three sucker-tubes and four glandular stolons, above referred to, originated near the pedicle of the other.

The incipient branchial network was marked by several transverse rows of short slits, which appeared to have thickened or everted edges, on account of the highly-refracting property of the epithelium at this stage of development.

There are many interesting questions connected with this double form of existence, to be answered perhaps by further observation of its structure, evolution, and history.

The unusually large ova, which undergo the ordinary round of changes subsequently to their liberation from the body of the parent, and are perfectly enclosed in the connecting substance, seem to negative the idea of their being discharged in the usual way, and rather suggest their escape by rupture of the abdominal walls, or by pedicellation and ultimate separation from the abdomen. With this consideration before us, the query naturally arises, Does the embryo at any stage become free and locomotive, as in other cases? and if not, which I am much disposed to believe is the fact, what purposes can the transitory suckers, organs of sense, and tail subserve?

There being two respiratory chambers, with their proper openings, two mouths and two vents, with a visceral mass common to both, forming perhaps the most perfect diplozoon in creation,—now that the originally simple nature of Nordmann's celebrated example has been satisfactorily explained,—are we to recognize here two distinct entities? If so, are the sexes and generative function common to both, divided between them, or restricted to either? Some species of *Polyzoa* clearly exhibit the union of two zooids *ab origine* in the formation of the so-called "ovicell" and its contents, which are very probably developed at the close of a definite cycle of gemmations. These ideas may be considered transcendental and visionary; but surely the scope of our philosophy is legitimate so long as our judgment in relation to immaterial and abstract things is circumscribed by that evidence alone which material things afford. Be it as it may, however, each little animal in the present genus, just as in the case of simple Ascidians, propagates its kind both by gemmation and true oviparous development; and the offspring appears to differ in nowise, either in its structure or history, from the parent. No vascular bond of union pervades the mass; and but for the continuity of the cell-structure of the connecting substance, it would be difficult to regard it as any more than a simple aggregation of individuals. Indeed it is common enough to find the members of aggregate species of simple Tunicata blended by the coalescence of their test or outer covering; yet this circumstance alone cannot be considered a valid reason for classifying such with the compound forms.

What then are the most important distinguishing features of the latter? I think it may be affirmed that, when the zooids of a compound genus are pedunculated on a central axis, vascular continuity is the most striking characteristic; but, where they are immersed in the connecting substance, the importance of vascular communication as a character yields to the existence of a common cloacal system. The curiously modified forms of the latter system, taken as one of the grounds of classification, I shall have to notice in a summary of Australian genera, now in progress.

It is now full time to give a name to the little subject of this paper; an appropriate one would be *Diplosoma*, as at once sufficiently expressing the peculiar nature of the animal. I therefore propose to call the species *Diplosoma Rayneri*, after Mr. F. M. Rayner, Surgeon of H.M.S. 'Herald,' who investigated its anatomy with me, and satisfied himself of the truth of the descriptive particulars above given.

June 1858.

EXPLANATION OF THE PLATE.

See p. 379 for pl. [illegible]

Tab. LXV. Div. I.

Fig. 1. A diplozooid, separated from the mass, and highly magnified, exhibiting the more important points of its structure.
  a, a. The two distinct thoraces.
  b. The pedicles, bearing gemmations near their confluence, and a caudal appendage at the upper part of their dorsal surface.
  c. Branchial opening.
  d. Anal aperture.
  e. Visceral mass.
  f, f. Pallio-vascular tubules, with their dilated glandular extremities.
  g. Stomach, showing a sort of valvular cardiac orifice.
  h. Ovarium, containing one principal ovum, and several others in an earlier stage of development.
  i. The large sacculated testis.
Fig. 2. Ovum in which the process of cleavage is going forward.
Fig. 3. Ovum further advanced.
Fig. 4. Primary state of the embryo, showing the central vitelline mass, the three sucker-tubes, and caudal process.
Fig. 5. Embryo in the ovum more fully developed, presenting, besides the frontal suckers and tail-process, nearly all the parts discernible in the adult state.
  a, a. The two distinct thoraces.
  b. Otolithic sac, occurring only on one of the thoraces.
  c. The frontal suckers arising in common with
  d. The pallio-vascular processes from the pedicle of the thorax to the left.
  e. Vitelline mass, in which the viscera are faintly marked off.
  f. The caudex.
  g. Polygonal cells of the primordial test.
Fig. 6. Cells and intercellular corpuscles of the connecting substance.
Fig. 7. Marginal coronet of the branchial opening.
Fig. 8. Caudal process of the adult, springing just below the root of the endostyle.
Fig. 9. Cæcal extremity of one of the stolons.
Fig. 10. Nervous ganglion with otolithic sac and eye-speck (?).

XXX. *On the Anatomical Characters of an Australian species of* Perophora. *By* John Denis Macdonald, *F.R.S., Assistant-Surgeon of H.M.S. 'Herald,' commanded by Captain* H. M. Denham, *R.N., F.R.S. Communicated by* George Busk, *Esq., F.R.S., F.L.S.*

Read February 17th, 1859.

DURING our stay at King George's Sound, the dredge obtained several specimens of a very interesting compound Tunicary, belonging to the "social" division so called, and which I believe to be a new species of the genus *Perophora.* The points in which it differs from the known species appear to me to be too trifling to warrant the fabrication of a new genus for its reception. I shall therefore name it *Perophora Hutchisoni,* after its first discoverer, Lieut. John Hutchison, R.N.

The zooids are about one-fifth of an inch in length, pyriform in shape, and supported on alternate tubular foot-stalks of a corneous texture, with one or more transverse articulations. These pedicels are continuous at their base with a tubular axis, from which they appear to be derived by simple extension of its walls without articulation.

The principal trunk in the specimen before me is firmly fixed upon a sprig of *Amphibolis antarctica,* over which its rather irregularly-divided branches extend themselves, occasionally drooping freely, like the tender sprays of a climbing plant.

No articulations are anywhere to be found except in the pedicels of the zooids, whose test commences at a definite line, where the corneous tissue of the pedicels terminates.

The test is finely coated over with a minute siliceous grit interspersed with Foraminifera and calcareous atoms.

When all these adhering particles are removed by cautious immersion in dilute nitric acid, which destroys all the carbonate of lime and loosens the attachment of the siliceous elements, their impressions are left on the surface of the test, and here and there on that of the axis, which thence presents a deeply pitted appearance.

The internal surface of the tubular axis is lined throughout with a very distinct epithelial membrane, obviously connected with its nutrition; and in the little buds, which spring, botanically speaking, in the indefinite mode, from the growing branches, the cæcal dilatation of the rudimentary test is lined with an extension of the same membrane. This lining, however, is not to be confounded with the true pallio-vascular system which is contained within it, and consists of a simple branched tube exactly corresponding with the trunks and ramifications of the corneous axis, while the coats of the tubules which enter the pedicels of the zooids are continuous with the mantle. Thence results a sort of "*cænosarc,*" exhibiting a remarkable analogy to that of the *Sertularians,* an analogy which is still further sustained by the nature of the sclerous axis just described. This, however, may be regarded as perfectly homologous with the repent tubes and free pedicels of *Laguncula, Pedicellina,* and other Polyzoa.

The branchial and cloacal openings present little or no external prominence, and are still further concealed by the gritty coating. The former is situated on the upper surface near the free extremity, holding a subterminal position, so that in the mutual relationship of these openings, *Perophora*, and indeed also other pedunculate forms, may be said to exhibit an approach to *Boltenia*.

The surface of the mantle is beautifully marked with yellow branched and reticulated lines, similar, no doubt, to those which have been noticed in *Clavelina*, indicating the distribution of vessels.

The endostyle occupies a portion of the dorsal surface extending from near the branchial opening to the inner extremity of the sac, where it presents a slight curvature towards the oral orifice.

The transverse bars of the respiratory network are about five in number, and join the endostyle in a direction nearly parallel with a line drawn through the branchial and cloacal openings, while the much smaller and more numerous longitudinal nervures lie parallel with the endostyle. The beautiful network so formed is invested with a stout epithelium, and its meshes are fringed with vibratile cilia.

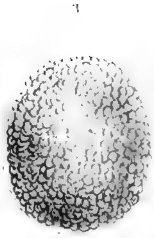
The mouth is situated at the anterior and inferior part of the respiratory cavity, and opens into a short cylindrical œsophagus which passes downwards and backwards to join a comparatively small and subglobular stomach. The intestine arises from the dorsal surface of the latter organ, and after having performed a graceful flexure by turning forwards and outwards, terminates in a very ample atrium or open space between the exterior of the branchial network and the muscular coat. The lining of this space is very obviously continuous through the branchial slits with that of the respiratory chamber.

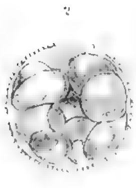
The generative organs, as in most compound Tunicata, are included within the intestinal loop, and, on account of the close proximity of the cloaca, the ducts are necessarily very short.

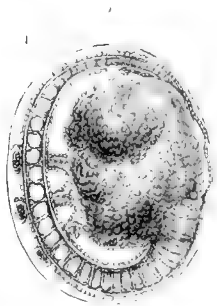
Two distinct canals, alternately interchanging the office of artery and vein, are circumstantially described as occupying the pedicels of the British species of *Perophora*, but I cannot say that I have found such to be the case in the Australian one. There is, however, much difficulty in determining the question, on account of the obstacles which the superficial gritty particles and the pigmentary matter of the mantle and tubules oppose to the observation of the vital phenomena of the animals. I think I may safely affirm that no such arrangement is traceable in *Didemnium*, *Botryllus*, and numerous other Tunicata, both simple and compound, that might be adduced; and if it be actually present in the British *Perophora*, I cannot help regarding the fact as something quite exceptional in the group.

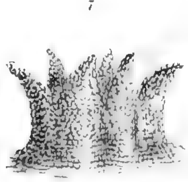
May 1858.

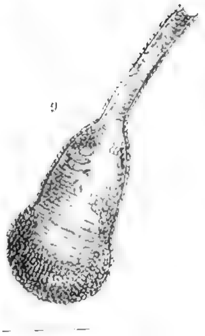
I











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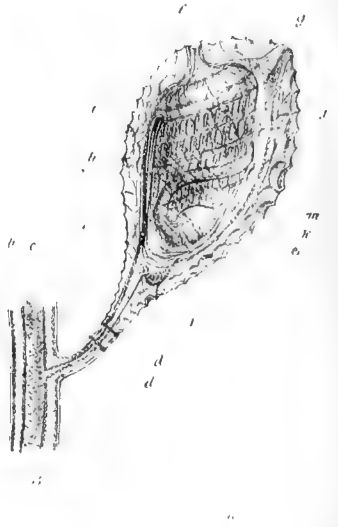

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EXPLANATION OF THE PLATE.

Tab. LXV. Div. II.

Fig. 1. A sprig of *Amphibolis,* with *Perophora Hutchisoni* climbing over the stem and leaves.
- *a, a.* Drooping branches.
- *b.* Solitary Ascidian, usually occurring with *Perophora,* and, like it, having a thin test closely covered with sandy particles. [I have reserved the more particular description of this species for a separate communication.]
- *c.* Encrusting Polyzoon.

Fig. 2. A growing branch, magnified to show the disposition and mode of gemmation of the zooids.
- *a.* Growing point, always slightly in advance of
- *b, b.* The gemmations.
- *c, d, e.* Zooids further advanced, with the gritty coating removed.
- *f.* Corneous tubular axis.
- *g.* Epithelial lining of *f.*
- *h.* Pallio-vascular membrane.

Fig. 3. One of the zooids, more highly magnified.
- *a.* Corneous axis.
- *b.* Lining membrane of *a.*
- *c.* Pallio-vascular canal.
- *d, d.* Articulations of the pedicel.
- *e.* The test, showing the pitted surface remaining after the removal of the gritty matter.
- *f.* Branchial orifice, and
- *g.* The cloacal orifice (both somewhat contracted).
- *h.* Endostyle.
- *i.* Branchial sac.
- *j.* Cloacal chamber.
- *k.* Œsophagus.
- *l.* Stomach.
- *m.* Intestine, embracing the generative organs in its flexure.

XXXI. *Observations on the* "Bitentaculate Slug" *of New Zealand* (Limax bitentaculatus, *Quoy and Gaimard*; Janella antipodarum, *Gray*; "Aneiteum Slug"?, *Macdonald*). *By* CHARLES KNIGHT, *Esq.*, *F.L.S.*

Read June 2nd, 1859.

Auckland, New Zealand,
27th December, 1858.

DEAR SIR,

I HAVE lately compared Mr. J. D. Macdonald's observations on the Bitentaculate Slug found at Aneiteum (Annals and Mag. Nat. Hist. 2 ser. xviii. p. 38, 1856) and Dr. Gray's description of *Janella antipodarum* (Annals and Mag. Nat. Hist. 2 ser. xii. p. 414, 1853) with the living Gasteropod found in New Zealand, and trust that the following notes and the accompanying drawing will interest the members of the Society.

The New Zealand mollusk is little more than an inch in length. The mantle (?) covers the whole of the upper surface. The space which Dr. Gray describes as existing between the edge of the mantle and the foot, is on the under surface of the animal; so that the edge of the mantle forms the outline of the body as seen from above. The mantle (?) is mottled with light-coloured spots, the larger of which are at regular intervals, and are at times elevated above the surface in sharp conical points (fig. 14). The "raised margin" of Dr. Gray's description is due to the effects of alcohol.

In alcohol the animal becomes subcylindrical, and answers to the description of Dr. Gray and to that of Lamarck (Anim. sans Vert. 2nd ed. vol. vii. p. 723, *Limax bitentaculatus*, Quoy).

The aperture of respiration (*d*, fig. 3) is on the right side of the slightly depressed roof of the pulmonary sac. There are four small, semitransparent, calcareous (?) granules in the anterior wall of the pulmonary sac (fig. 13); and immediately anterior to the sac is a small foramen (*a*, fig. 3), affording passage to a fluid which flows in pulsatory waves over its roof. Generally this pulsatory movement occurs at regular and frequent intervals; and the wave extends around the pulmonary aperture, as if a limpid fluid were propelled under the glutinous secretion which covers and protects the body of the mollusk.

The buccal mass is armed above with a single horny plate or tooth (figs. 7, 8). In feeding, the animal forces forward the buccal mass, and scrapes or hoes up with the horny plate the surface of the substance it is feeding on.

The lingual sac, instead of being furnished with the single, symmetrical, tubular appendage of the common Slug of these Islands, has posteriorly two delicate, plicated, convolute appendages armed with transverse rows of dental processes (figs. 11, 12). The sac itself is furnished with a complete armature of rasps (figs. 9, 10) placed in numerous transverse parallel rows, which meet in the median line at a very obtuse angle. Each rasp has several minute teeth, and is set diagonally in the row, as are also the spine-like plates from which the minute rasps project (fig. 10).

There is no such mantle as that described by Mr. Macdonald in the Aneiteum Slug as covering the roof of the pulmonary sac; but there is a depression instead of it, and the roof of the sac is extremely thin.

In deference to the views of Dr. Gray, I have termed the covering of *the whole of the upper surface* of the animal "the mantle;" but, taking into consideration that it would be extraordinary that the eyes of the animal should be protruded through the secretory organ of the shell, this interesting Gasteropod may more probably be regarded as quite *naked*.

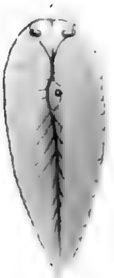
Believe, dear Sir, yours very truly,
CHARLES KNIGHT.

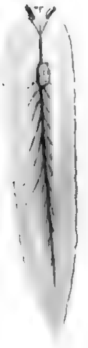
J. J. Bennett, Esq., F.R.S.,
Secretary of the Linnean Society.

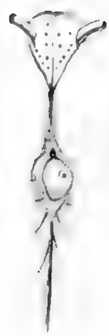
EXPLANATION OF THE PLATE.

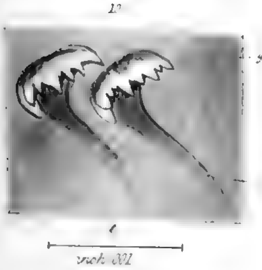
TAB. LXVI.

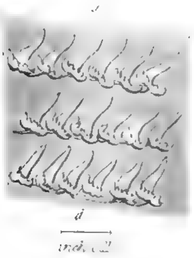
Figs. 1, 2. Dorsal aspect of *Janella antipodarum*.
Fig. 3. Lateral view.
Fig. 4. Portion of dorsum, enlarged, and showing—
  a. Small foramen anterior to pulmonary sac.
  d. Respiratory orifice.
Fig. 5. Lingual sac laid open.
  a. Plicated folds.
  b. Transverse rasp-like processes.
Figs. 6, 7. Horny plate of buccal mass.
Fig. 8. Lingual sac and its tubular appendage.
  a. Tubular appendage.
  b. Sac.
Fig. 9. Armature of lingual sac magnified.
Fig. 10. Magnified view of rasps.
  g. Rasp.
  f. Plate.
Figs. 11, 12. Dental processes and plates on plicated appendages.
Fig. 13. Calcareous particles in wall of respiratory cavity.
Fig. 14. Conical cutaneous papilla.

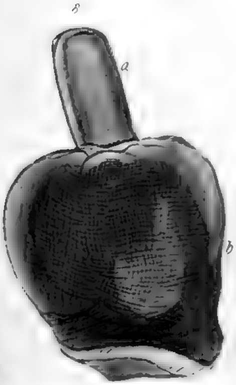


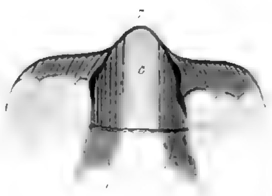


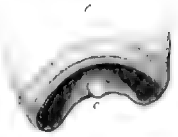


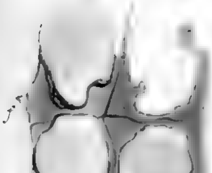


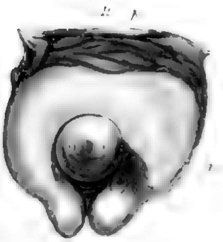












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XXXII. *Further Remarks on the Organs of the Antennæ of Insects, described in a Paper published in the 'Transactions of the Linnean Society,' vol.* xxii. *p.* 155. *By* J. Braxton Hicks, *Esq., M.D. Lond., F.L.S., &c.*

Read May 5th, 1859.

On the 2nd of June, 1857, I read a paper before this Society, describing some "peculiar structures in the Antennæ of Insects," which was published in the 'Transactions,' vol. xxii. p. 155; since which time I have extended my inquiries among the different tribes, the results of which I have now the pleasure of laying before you. But before doing so, it seems to me that it would be well to give an outline of what had been previously accomplished towards the determination of the structure and uses of the antennæ, and of the various opinions founded upon those researches.

I shall first of all quote Burmeister, who, in his 'Manual of Entomology,' translated by Shuckard, 1836, p. 295, § 195, says, "But as insects doubtlessly hear—as some, for example the Cicada, Grasshopper and May Beetle, &c., produce a peculiar sound, which serves to attract the attention of the female—they must evidently be provided with an organ of hearing, which is either very recondite, or referred to organs whose form does not evince their function. The antennæ are doubtlessly of this class; and, indeed, Sulzer, Scarpa, Schneider, Bockhausen, Reaumur, and Bonsdorff considered them organs of hearing. That they are not organs of touch is proved, anatomically, by their hard, horny upper surface, and physiologically by the observation that they never use them as such, this function being exercised by other organs, viz. the palpi. Besides, the analogy of the Crabs, in which it is well known that the organ of hearing lies at the base of the larger antennæ, speaks in favour of the opinion of their being in general organs of hearing. If after this hint we look to the insertion of the antennæ, we likewise detect here a soft articulating membrane, which lies exposed, and which is rendered tense by the motion of the antennæ. This membrane, beneath which the nerve of the antenna runs, might, without much inconsistency, be explained as the drum of the ear, and thus would the antennæ be transformed helices, which, as very moveable parts, would receive the vibrations of the air caused by sound, and act as conductors to it. Whoever has observed a tranquilly-proceeding Capricorn Beetle which is suddenly surprised by a loud sound, will have seen how immoveably outward it spreads its antennæ, and holds them porrect, as it were with great attention, as long as it listens, and how carelessly the insect proceeds in its course when it conceives that no danger threatens it from the unusual noise. Carus, Straus-Dürckheim, and Oken are of the same opinion, which I have entertained for years, and endeavoured to confirm myself in by numerous experiments."

§ 196. "Much more doubt and uncertainty attend the observations and opinions upon the organ of smell of insects. Reaumur, Lyonet, and several modern French anatomists consider the antennæ as such; but I would ask, with what right? The hard, horny organ, displaying no nerve upon its surface, cannot possibly be the instrument of smell, for we always find in the olfactory organs a soft, moist mucous membrane furnished with numerous nerves. No such tunic is to be found in insects, at least in their head, or upon the surface of their bodies."

Robineau Desvoidy (see Ray Society vol. for 1845) considers there is still doubt on the the point. "He has already shown, in year 1827, that in the Crabs, as the outer antennæ are evidently the seat of hearing, so the inner ones are the seat of smelling; and afterwards proved, in his 'Recherches sur l'organisation vertébrale des Crustacés, des Arachnides, et des Insectes,' 1828, that in the Isopodes the sense of hearing is no longer doubtful; in the Arachnides it is wanting, while, on the other hand, the parts pointed out as the mandibles are here organs of smelling, and the poison-canal in them corresponds to the lacrymal passage of the higher animals. In the Insects the antennæ are organs of smelling, and usually also of touch. They have no organs of hearing at all."

Küster (see Ray Society vol. for 1847, p. 306) assigns to the feelers (antennæ) of insects the function of smelling. In some experiments with turpentine in glass tubes the reporter says, "If these experiments show that the feelers betray a sensibility to the effect of powerful odours, it is not yet proved that these act on them directly; and so the evidence that the sense of smell has its seat in the feelers is defective."

Newport has given us a valuable paper on the use of the antennæ of insects, in the 'Transactions of the Entomological Society,' vol. ii. p. 229 (read in 1838, but prepared in 1831). He examined the antennæ of *Ichneumon Atropos*; he found all the joints, except the second, perforated all around by very minute holes. This, he says, is the structure of nearly all the setaceous antennæ. He observed two tracheæ passing up its whole length, which gave off branches at every joint, and which seemed to him—but of that he was not quite certain—to communicate with the holes in the antenna-wall. He also noticed a nerve passing throughout its length.

From this, and from analogy with other animals, he judged it probable that the antennæ were not organs of smell. He instituted a series of interesting experiments which led to the same conclusion, and mentions that "*Copris Molossus*," when in motion, extends the plates on the end of its antenna, as if to direct the insect in its course; but that on the occurrence of any loud and sudden sound, it instantly closes the plates and retracts the antennæ, as if injured by the percussion, while the insect stops and assumes the appearance of death. The Geotrupides also behave in like manner. He says, "In conclusion, from all that has been observed of the antennæ, it seems probable that in all insects these are the auditory organs, and that the means by which they are fitted for the function of hearing are varied in different insects, to adapt them to the perception of sounds, according to the habits of the species; that in some species they are endowed also with the sense of touch; that they are of great, although not of vital importance to the insect; and that the loss of both of them, more particularly when endowed also with the sense of touch, will clearly explain in every instance the agitation, delirium, or stupor of the insect, it being in fact tantamount to a total deprivation of the faculty of hearing, feeling, and, I might almost add, of speaking."

The most advanced investigations into the anatomy of the antennæ I had met with, on the occasion of reading my former paper, were those by E. F. Erichson, published at Berlin in 1847, and contained in his 'Dissertatio de fabricâ et usu antennarum in Insectis,' in which he states that he has arrived at the following laws :—

"1. Antennarum testam in insectis nequaquam solidam, sed numerosis poris perforatam esse.

"2. Poros hosce ab interiore parte membranâ tenui clausos esse.

"3. Poros in variorum insectorum antennis variis modis dispositos esse."

He then proceeds to show the position of these closed pores in the various forms of antennæ, and that they are never found on the basal joints. He describes the dilated third joint in *Musca* as alone possessing these pores, and considers the seta to be the true continuation of the antenna, which view had already been promulgated by Mr. Curtis. He also notices the numerous hairs on the antenna, between the pores, which he considers to form a protection to them from extraneous bodies. Now these pores he regards as organs of smell; because, he remarks, the olfactory organs of the higher animals are moist membranes in order that the odorous particles may be dissolved by the humour secreted, therefore he doubts not that these membranes perform the same office, protected by the downy hairs, and retained moist by them. Another reason for which he considers them organs of smell, is that they are more numerous in those tribes whose scent is acute.

Of this work I was not aware at the time of reading my former paper, it being very scarce. The plates accompanying it simply show holes or pores, closed in by a delicate membrane.

Vogt (Zoologische Briefe, vol. i. p. 516–17, Frankfurt a. M., 1851) says, " If these uniform feelers are examined with a sufficiently high magnifying power, the outer surface of all the divisions, except the articulating joint, is found to be covered with minute punctures, which are closed in at the bottom by a thin membrane that appears to be clothed with numerous hairs. In the antennæ that are not of a uniform shape throughout, there is a shaft or style, and these pores or indentations are then found only upon the toothed processes, branches, and feathers of the feelers, whilst the integument of the shaft is constituted like that of the remaining portions of the body. The peculiar structure of the antennæ is, no doubt, closely connected with their functions; but it would be going far to say, with some recent observers, that it affords undeniable proofs of the correctness of the oft-contested theory that they are organs of smell only." He then says, "We are of opinion that these minute pores, filled with fine hairs, perform a function combining those of smell and touch; for it is an undoubted fact that many insects, such as Ants, Crickets, and others, constantly employ their antennæ to touch and recognize objects, and that nocturnal creatures of this class, especially, possess a remarkably acute sense of touch in the organs; whilst others, again, as the Longicornia, in which these organs are considerably developed in size and form, make no such use of their feelers. On the other hand, we know of no other organs of smell in insects; and all attempts to find the seat of this sense have been hitherto ineffectual."

Thus we see how many different opinions have been entertained regarding the functions of the antennæ. Sulzer, Scarpa, Schneider, Bockhausen, Reaumur, Bonsdorff, Carus, Straus-Dürckheim, Oken, Burmeister, Kirby and Spence, and Newport are all in favour of their being auditory organs; whilst, on the other hand, we have Lyonet, Robineau-Desvoidy, Küster, Erichson, and Vogt in favour of their being olfactory organs. In point of number, the majority are evidently in favour of their being organs of hearing, though it appears to me that some on either side base their opinions on but slender foundations, and that the most important advocate on the olfactory side, Erichson, has formed his opinion upon an imperfect knowledge of the true nature of the organs: he has thought them to be closed perforations opening internally; whilst I have, in the paper mentioned, shown them to be closed sacs, sometimes considerably convoluted, to the inner aspect of which the nerve passes. I shall, in the course of the present paper, show that by no means in all cases is the closing-in membrane thin and delicate, but that in some insects it is thickened and even raised into a conical and hair-like eminence; his arguments, therefore, regarding its analogy to the pituary membrane clearly cannot hold. None of these writers, and, so far as I am aware, no one else, had at the time when my former paper appeared pointed out these closed, chambered sacs; and it is evident that the opinions concerning the functions of the antennæ, hitherto entertained upon an imperfect knowledge of their structure, will undergo considerable modification when the structures I have already, and those which I am now about to describe, are duly considered and re-investigated.

I shall now proceed to the detailed description of the other antennæ which I have examined since my last paper. At that time I had not investigated the antennæ of the Coleoptera to any extent; but I find they form no exception to the rest of the Insecta.

1st. In *Necrophora Vespillo* the organs are only found on the last three joints, two of which are foliaceous, while the terminal one is rounder and pointed at the apex, forming the club or clava; and a fourth, foliaceous joint does not possess these organs.

The sacs are found on both sides of the leafy joints, and all round the terminal one, though they are larger on the back. At A. fig. 1 (Pl. LXVII.), I have shown the surface enlarged, with the covering-in membranes and position of the hairs between them. At A. fig. 2. is the section of the same. The average diameter of the sacs is about $\frac{1}{3500}$ inch.

The distribution of the nerve, spreading by many branches throughout the breadth of the joint, can be seen by focusing for the centre of the lamella. This antenna is mentioned by Erichson, who, after describing its form, says of the last three joints, "Testa ei est poris subtilissimis creberrimisque perforata, relictis nonnullis areis minutis impressisque, e quibus setula nascitur" (*op. cit.* § 10). It is these pores I have drawn at A. fig. 2, showing a sac which can be clearly made out in the bleached antenna.

In the genus *Silpha* there are eleven joints: the last three are dilated and covered with fine hairs; and scattered equally over the surface is to be found a number of sacs, one-fifth less in quantity than the hairs, B. fig. 1 *b b*. Besides these, there are larger sacs, B. fig. 1 *a a*, principally found on the terminal joint, about twenty-four in number. These show clearly the form of the organs from above, and at B. fig. 2 their nature can be further understood in section. The covering-in membrane is delicate, and rises as a low cone from the general surface-level; between the organs the hairs arise and overhang them. The diameter of the larger ones at the surface is $\frac{1}{1760}$ inch. This is the character of the antenna throughout all the genus, so far as I have ascertained.

In *Creophilus*, and probably in kindred genera, the organs are found only on the terminal joint, which is more elongated than the rest: they consist of the smaller and larger sort, as in *Silpha*, but arranged in a manner very peculiar, and confined to the lower half of the terminal joint. The smaller forms are disposed in groups of from six to sixteen in each. The groups are diamond-shaped, with a row of hairs between them: at the angle are occasionally found the larger organs, as in *Silpha*, as also a few scattered on the upper half of the joint. Their covering-in membrane, however, is not so conical. The diameter of each of the small organs is $\frac{1}{5400}$ inch. (See C. fig. 1.)

In *Goerius olens* the organs are distributed thickly over the surface, rather more frequently than the hairs, and show their sacculated nature very well (D. *a a*).

In *Carabus* there are eleven joints in the antenna; only the last five possess the organs. They are not so numerous as those I have described before, and are principally placed on one side of the antenna, as shown in E.

In all the species examined of this genus, I have found the closing-in membrane raised considerably above the surface-level, more so than in *Silpha*, and having six or eight ridges running from apex to base, as is shown in E. figs. 2, 3. The greatest diameter of the sac is $\frac{1}{1660}$ inch, while that of the closing-in membrane at the surface is $\frac{1}{3000}$ inch. The Section, fig. 1, shows the form of the sacs and closing-in membrane.

In six species of *Elater* which I have examined, I find the same conditions, namely: chiefly on the serræ of the joints, generally in front of the base of the hairs, are small sacs about $\frac{1}{3000}$ inch in diameter, as is shown in F. figs. 1, 2 *a* & *b*. The closing-in membrane is slightly raised above the surface; and on the apex are from three to six, generally four, small papillæ or tubercles, as is shown in F. fig. 2 *b*, & fig. 3.

In *Strangelia elongata* these sacs are very numerous, disposed over eight of the twelve joints, and becoming larger and more frequent towards the apex. They are generally situated in front, or near the roots of the hairs; and their closing-in membrane is much smaller than the diameter of the sacs beneath. These sacs vary much in size, being from $\frac{1}{3750}$ to $\frac{1}{6000}$ inch in diameter. The larger sort seem convoluted, or two- or three-chambered.

The antennæ of the Musk Beetle (*Aromia moschata*) are very similar; and the same description will apply, except that the sacs are larger than the above.

In *Cetonia aurata* the three lamellæ are furnished with sacs, which are placed close together, and are found on both sides of the middle one only, and on that side of the first and third which is in contact with the middle one.

In the antenna of *Dynastes Hercules* the sacs are very numerous, and the covering-in membrane well marked, their diameter being about $\frac{1}{3700}$ inch. They are found on the same parts of the lamellæ as in *Cetonia aurata*. In consequence of the sacs not extending through the whole thickness of the antenna-wall, a tube passes from the inner aspect of each to connect it with the interior of the lamella: towards the margin of the lamella the form is modified, the sac being placed halfway within the thickness of the integument; and there is not only a tube connecting it with the interior, but also a smaller one extending to the outer surface (H. figs. 1, 2). Numerous depressions, in some cases forming cavities, are to be found in the antenna; and in all the Lamellicorns I have hitherto examined, the sacs are situated on all portions of these depressions, which are thus common to them.

In some of the Lamellicorns the closing-in membrane is prolonged to a point, sometimes rigid, so as to be easily mistaken for a hair; but closer inspection and comparison, I am sure, will satisfy any one as to its true nature. I can best explain what I mean, by the antenna of *Geotrupes stercorarius*. The surface of the lamellæ is patterned all over in the same parts as in the former Lamellicorns, and in a very similar manner to those of *Andrena fulva*, shown in fig. 8 of my former paper. The surface is occupied with about an equal number of true hairs, and articulated projections very like hairs (I. fig. 2 *b*), beneath each of which is a sac, as in the former kind of antennæ; and as the sac does not extend through the whole thickness of the antenna-wall, there is, as in *Dynastes*, a tubular communication with the interior of the lamella. (See I. figs. 1, 2.)

This structure will help to explain other forms in the Lamellicorn groups, as for instance in the Stag Beetle (*Lucanus Cervus*). Over the same parts as in the others are a number of apparent hairs, slightly curved, projecting from the antenna-wall. On looking more closely, it will be observed that they are not all true hairs; on the contrary, only a few of the larger ones are hairs, while beneath the rest an elongated sac is placed, as is shown at K. figs. 1, 2. In this insect the terminal lamella has a large cavity—sometimes there are two—extending deeply into its interior (fig. 3). The diameter of the sac is $\frac{1}{2100}$ inch.

A similar condition exists in *Hydrophilus piceus*; but the nature of the sacs is well shown by the fact that some have the closing-in membrane level, and others slightly raised, whilst some have it prolonged into a spine (G. fig. 2). The diameters range from $\frac{1}{1660}$ to $\frac{1}{3700}$ inch. This peculiar-shaped antenna has nine joints; the last three are liberally furnished with these sacs, and of a larger size than any I have hitherto found: possibly the size of the insect will account for it, though it may generally be said that the size of the insect has but slight relation to the size of the sacs, as will be seen by comparing the various measurements I have given.

That these sacs with hair-like apices are the same as those which are found in *Melolontha*, *Dynastes*, &c. is evident from the facts—1st, that they are situated in the same position; 2nd, that some have level, others spinous apices on the same antenna; 3rd, so far as I have found on examination of a large number of insects, I think it may be laid down as a rule, that no cuticular projection or spine has a cavity or sac beneath it in any other part of the insect, except in the antennæ. In some *Hemiptera* I have found beneath the true hairs a cavity, but not like these sacs, inasmuch as the whole antenna-wall was protruded, with a true hair at the apex.

The spinous condition of the covering-in membrane is an important point, because it seems to be clearly at variance with what is generally understood to be the structure of an olfactory organ. Again, when we consider the habit of *Hydrophilus* and compare it with another aquatic Beetle, *Dyticus marginalis* (to be presently alluded to), I think we may obtain a clue as to the nature of these organs in the antennæ. If watched attentively, it will be seen that the *Hydrophilus* is very careful not to wet his antennæ. The moment he is placed in water he suddenly brings them beneath the joint of the head and thorax, where they remain in a hollow, surrounded by the silvery film of air which covers the under surface of the thorax, and which is collected by the numerous downy hairs on that part of the body. If this insect employed its antennæ to scent its food, which is aquatic, does it not seem very improbable that the olfactory organs should be carefully shut off by a peculiar provision, from the medium in which both the insect and the food are, and which medium is known to be well fitted for the diffusion of odorous particles? Now in *Dyticus marginalis* we shall see the reason that its antennæ are bathed with the water,—not because it uses its antennal organs for scent, but because it uses them as instruments of touch, and has them provided with special organs for that purpose.

The antenna of *Dyticus marginalis* (L.), very similar in general appearance to the palpi of *Hydrophilus piceus*, consists of nine joints, all nearly alike, except the terminal one, which is pointed. The antenna is almost universally smooth: the only representatives of the hairs are on the prominent parts of the joints and apex, which I will describe shortly. But on one side of the upper part of each of the joints are a number of circular depressions (L. fig. 1 *b b b*, fig. 3.), of the diameter of $\frac{1}{3000}$ inch, more numerous towards the apex of the antenna; in the centre of each circular depression is a short canal, which enters a sac having its interior aspect in communication with the interior of the antenna; whether closed or not it is difficult to determine, but it appears to be so by a firm substance frequently found on the inner surface of the antenna where these organs are present. The nerve is to be seen very plainly giving off branches as it passes up the antenna to each of these groups, and finally expends itself in those of the apex, sending off a branch to the roots of the hairs.

To these hairs, of which I have given a drawing (L. figs. 2, 4), I would also request attention, because of their peculiar form, and because such a form is not uncommon in insects, both on the antennæ and palpi, when those parts are used as organs of touch. That all the hairs, long as well as short, possess to some extent the faculty called in the higher animals "general feeling," I think cannot be doubted for a moment; but hairs of the form I am about to describe seem, from their position and shape, to be specially adapted as instruments of that more refined tactile sense called "touch." Perhaps the most marked example is to be found in the antenna of *Dyticus marginalis*. The organ in question consists of a widened follicle (L. fig. 1 *a a a a*, figs. 2, 4), becoming gradually narrowed to the centre, from which a delicate membrane, in the form of a depressed cone, stretches across; from the centre of this membrane springs the modified hair, something like a ninepin, its apex reaching a little above the general surface of the antenna. There are three on the apex of the antenna, three on each side of the widest part, and two or three on each side of the upper end of each joint at its widest part. Their situation on the prominent parts will show their use for touch; and the habits of the insect also show how valuable as a tactile organ is its antenna.

The whole of the antenna of this insect is wetted by the water, in which it passes the greater part of its life, and where it finds its sustenance. In form the organs on them are not essentially different from those before described in other insects; but it is difficult to suppose that odorous particles could pass through a membrane, then through a very small tube into a sac, itself probably closed, before they could affect the nerve placed at the inner surface; while it is easy to understand how such a structure is well adapted for hearing in water. In the larval antennæ no such organs are found: the hairs on them are few and long; whilst the apex, which has three spinous processes which are supplied with a nerve, doubtless possesses the sensation of touch (see M. figs. 1, 2, 3).

In *Meloe* the antennæ consist of eleven joints, of which the 1st, 2nd, 3rd, and 9th are not furnished with the organs, as all the rest are, especially the 6th, 7th, 10th and 11th: those in the last, or 11th, are the largest. They have the same form as those of the *Necrophora Vespillo,* but rather smaller.

In *Clytus arcuatus* the sacs are found interspersed between the hairs, of the diameter of $\frac{1}{3000}$ inch, in considerable number on the last five joints, and of the same form as in *Necrophora Vespillo.*

I shall next describe the antennæ of the *Hymenoptera.*

In the genus *Vespa,* whose antenna I have described in my former paper, I have since had an opportunity of examining the antenna of the male, female, and neuter, both of *V. vulgaris* and also *V. Crabro.* In all these, as there described, the last ten joints are covered on all sides from base to apex by organs having the canoe-shaped closing-in membrane. The number of these on each antenna of *V. vulgaris* is prodigious; on each segment there are rather more than 2000. The 3rd segment possesses rather fewer, and the 12th rather more, making altogether on the ten segments 20,000 for each antenna. There are also on this antenna many dwarfed hairs, as on that of *Dyticus marginalis.* There is no particular difference between the different sexes and neuters; and I may add that a distinct sac is visible behind the oval opening, which is seen behind the canoe-shaped closing-in membrane.

In *Apis mellifica,* however, the antenna of the worker or neuter (described in my former paper) possesses the organs only on one side; whilst in the drone or male the antenna is entirely covered with them, similar to those of the male *Eucerus longicornis* (see former paper, Pl. 30. fig. 7). I have, unfortunately, not succeeded in obtaining a female or queen, to enable me to institute a comparison: still one would argue that if these organs were olfactory, we ought to find them in a peculiar degree developed in the worker, and scanty in the male, who seldom leaves the hive, and then only for a short distance; but the contrary is the case.

Odynerus murarius possesses organs very like those of the neuter *Apis mellifica,* situated on one side; and as the other side is free from any markings, the nerve and its distribution and the accompanying tracheæ can be beautifully seen. The nerve, accompanied by two tracheæ, passes from base to apex, through the centre, giving off a branch from either side, about the centre of each segment, which branch passes through the next joint, to be distributed to the organs in the succeeding segment, and again giving off numerous fibres to supply the organs with sensation.

A remarkable antenna among the Hymenoptera is that of the Red Ant, *Myrmica rubra.* It consists of twelve segments: the first is very elongated, the rest being joined to it at a right angle; the segments after the second gradually increase in width to the last, which is longer than any, except the first, and tapers gradually to a point, towards which the antenna-wall gradually becomes thinner, so that at the extreme apex it is very delicate, and the hairs also abbreviated. The surface is furnished tolerably thick with hairs, as in most antennæ. It also possesses the sacs very well marked, as may be seen at N. fig. 1 *a*, 3 *a*, 4.

They exist on the last nine segments more towards the distal end of each. The different forms are shown at N. fig. 3 *a a*, fig. 4. : the diameter of the closing-in membrane is about $\frac{1}{2700}$ inch; the length of the sac is from $\frac{1}{1900}$ to $\frac{1}{1700}$ inch.

But, besides, there is another form of what seems to be the same structure, and which has a rather less-marked parallel in the antenna of *Pronœus inetabilis* (to be described next). There will be observed at N. fig. 1 *b b b*, a number of small closing-in membranes, of a diameter of $\frac{1}{4000}$ inch; behind each is a very small sac, leading to a long delicate tube, which, bending towards the base, dilates into an elongated sac having its end inverted, as may be also seen in the larger sacs (see N. figs. 2 & 3 *b*). What their specific use may be, it is at present impossible to say; but, supposing these organs to be auditory, we may easily conjecture that they would be able to appreciate notes in a higher key. The nerve in this antenna is well seen, throwing off branches to the organs in its course upwards.

The antenna of *Pronœus inetabilis* consists of thirteen segments, and possesses three, if not four forms of these organs, disposed in groups on one side of each segment:—

First. In the middle of the segment are a number of small closing-in membranes, of the diameter of $\frac{1}{4300}$ inch; they are raised above the level of the surface, and have a small elongated cavity behind them, which is shown at O. fig. 1 *d d*, fig. 3 *d*.

Secondly. On the side are level, circular or slightly oval closing-in membranes, with an oval opening just beneath, leading into sacs; in the centre of each inner surface is a papilla pointing inwards. These are shown at O. fig. 1 *b b*, fig. 3 *b*. The diameter is $\frac{1}{2300}$ inch.

Thirdly. There is a scanty group of organs towards the middle of the segment, whose closing-in membrane is also level and quite circular; and beneath it is a shallow cavity, having a small opening in the centre leading into a tube, which soon dilates, and is connected with a curved tube, which expands in the form of a trumpet. The exact method by which these trumpet-shaped expansions end internally is difficult to decide, owing to the delicacy of the parts and the thickness of the antenna-wall. It is impossible to make out the exact nature of the junction at the curve. This form I have shown at O. fig. 1 *c c*, fig. 3 *c c*. There is a strong resemblance between these and the long expanding tubules in *Myrmica*; and they probably have the same function.

Fourthly. On the remaining portion of the half-antennal surface occupied by these structures, are a number of low projections, at first sight like dwarf hairs; but on closer inspection they will be found to be conical projections of a delicate membrane protruded from the centre of a depression of the cuticle, and having a sac behind: to these the nerve can be plainly seen passing, as in the other forms; and a quantity of firm granular matter may be observed at the junction of the nerve with the sacs. There is no real analogy between these organs and true hairs. Their diameter is $\frac{1}{1900}$ inch, and they are shown at O. fig. 1 *a a*, fig. 2.

That these different forms are capable of imparting to the insect the power of appreciating notes of different pitch, will scarcely be denied, if we admit that they are auditory organs; while, if considered as olfactory, it would be difficult to explain the reason of such a variety of forms.

Sirex gigas possesses two forms of these organs, as is shown at P. They are found freely scattered over the segments on one side, the other being free from them. They consist of—

1st. A number of depressions, diameter $\frac{1}{900}$ inch, in the centre of which is a closing-in membrane; beneath is a tube passing through the antenna-wall, and leading to a membrane-sac, as is shown at fig. 1 *b*, fig. 2, fig. 3 *b*.

2nd. A number of closing-in membranes, having a distinct cavity behind them, in the antenna-wall. They are shown in section at fig. 4, and from above at fig. 3 *a*. Diameter at surface $\frac{1}{3000}$ inch. These appear to be nearly the same as at O. fig. 2, and similar to those in *Carabus*.

We come now to the Lepidoptera. In the Diurna I have examined

Gonepteryx rhamni,
Pieris, or *Pontia brassicæ*,
Pontia rapæ,
Vanessa urticæ,
Hipparchia Janeira,
Lycæna Phleas;

and I find the same description will apply to them as to the antenna of *Argynnis Paphia* (of which I have given a description and figure in the paper before referred to), with the exception of a variation in the comparative number of organs, and of the number of cavities.

In the Moths I have as yet only found the smaller organs described in *Argynnis Paphia*: their position on the pectinated forms in the *Bombicidæ* and *Geometridæ* seems to be universally towards the apex of the division; and in the forms less deeply pectinated they are found on those sides where the deepest indentation exists. They are more numerous towards the apex of the antennæ.

I have figured those of *Arctia Caja* (Great Tiger Moth) at Q., showing their position in the male at fig. 1, and in the female at fig. 2. At fig. 3 the same is magnified, showing in the dotted lines the existence of a cavity in the interior.

Q. shows them on the dilated end of the combs in *Odonestes potatoria* (Drinker Moth): fig. 5 shows one enlarged.

This condition I have found to exist in

Drinker Moth (*Odonestes potatoria*),
Yellow-tailed Moth (*Porthesia chrysorrhœa*),
Vapourer (*Orgyria antiqua*),
Lackey (*Clissocampa neustra*),
Ermine (*Pilosoma lubricipeda*),
Willow Beauty (*Alcis rhomboidaria*).

In those antennæ which are simple and filiform, I find that they exist on one side only, and situated towards the distal end of each segment, as in the Buff Tip (*Pygæra bucephala*), and Yellow Underwing Moth (*Tryphæna Bomba*). The latter I have figured at R.: fig. 1 shows their position; fig. 3 shows a magnified view of them, with the peculiar markings on the cuticle, while at fig. 2 the nerve (*a*) is shown distributing branches to them. In the interior of the antennæ, underlying the organs, is found a lobulated membranaceous mass (fig. 2 *b*), in which the extremities of the nerve lose themselves. It is difficult to make out the precise structure of the mass; but it seems composed of a number of membranous sacculi. It occurs in a great number of insects, and principally, if not always, in those whose organs are not dilated into a distinct sac in the antenna-wall.

In *Pygæra bucephala* I have noticed a depression on each segment of the antenna, similar to those observed in some Coleoptera.

In the Ghost Moth (*Hepialus humuli*) the organs are in appearance more like those of the simple sort in the Diptera, and are dispersed over the whole antenna. The male and female antennæ and antennal organs are precisely alike; and it may be stated, as a rule, that those Moths which possess such an exquisite sense of smell as *Orgyria antiqua* have the organs more developed in the male than in the female, but they do not seem to be more numerous than in those Moths which are reputed to possess a more obtuse olfactory power.

In *Anthocera loti* (Burnet Moth) the organs may be easily detected, being very distinctly placed in a slight depression between the cuticular projections covering that part of the antenna in which they are situated. The closing-in membrane is irregularly circular, of a diameter of $\frac{1}{2300}$ inch, and has a small papilla in its centre (S. fig. 1 *b*, fig. 2 *b*). Behind this is a bowl-shaped sac, which has projecting into it a small papilla in the centre of its inner wall, probably where the nerve impinges. This is shown in the section at S. fig. 2 *a*, while at *c* the hair-like cuticular projections are seen partly overhanging it.

The antenna of *Macroglossa stellatorum* is peculiar in having one side of each segment furnished with numerous rows of hairs. In the centre of each facet may be seen sacs (fig. 19 *a*). These hairs give a peculiar appearance to the antenna. They gradually enlarge towards the exterior of each facet, and possess large roots or follicles.

In *Sphinx ligustri* (Privet Hawkmoth), the organs are to be found from base to apex on every segment, on one side only, and in considerable profusion; and, so far as I can make out, are on the same plan as in the Burnet Moth.

I have examined many specimens of foreign species of *Tetrix* of all sizes, and find the organs are on precisely the same plan, and as numerous, as in the *Tetrix* described in my former paper.

At U, I have drawn the antenna of *Forficula auricularis* (common Earwig). Fourteen segments are found to possess the sacs; from one to three on each, at the distal or outer end, as in fig. 1 *a a a*. Their shape may be seen in section at fig. 2 *a*; their diameter at the surface is about $\frac{1}{2300}$ inch.

I have also examined the antennæ of an *Agrion*: they possess a few (about three or four) of the simple cells I mentioned as occurring in such a clear manner in *Libellula*, while in the common May-fly (*Ephemera diurna*) they exist in but a very rudimentary condition.

In the parasites also, the antennæ are furnished with similar organs, as shown at V., where the antennæ of the *Pediculus* of the Crow are represented. Two organs are found on each joint, except the last two. In the *Pediculus* of the Dog the organs are very large; they are shown in profile at V. fig. 1 *b*.

Pulex also has them on each joint, as seen at V. fig. 2. An enlarged view of those of the *Pulex* of the Mouse is shown in fig. 3.

Having now detailed all the principal facts I have been able to secure since my last paper, I shall again endeavour to point out the great advantage to be derived from the process of bleaching which I described at that time, without which it would have been impossible, by reason of the depth of colour of the insect-integument, to have made such advances upon our previous knowledge. It is for this reason that I have no doubt the opinions of the naturalists I mentioned at the beginning of this communication would have been different, had they known the precise nature of the organs behind the closed pores; for it does seem to me impossible that the essential nature of an olfactory organ should be included in the structures just mentioned, and that odorous particles could pass, first through a membrane, sometimes even spinous, then through a cavity filled with fluid, and thirdly through another membrane to reach the extremity of a nerve. On the other hand, it is not difficult to conceive that such a structure would be well suited to the transmission of sound, upon the principles pointed out by Müller; and the numerous modifications of these antennal organs especially to be found in the Hymenoptera, seem to form an additional reason for supposing them to be auditory—namely, that they may give the insects a power of appreciating sounds of various pitch.

Amongst entomologists, some misconception as to the nature of the antennæ has arisen from their not duly considering, in their observations on the habits of insects, that the antenna has (whatever other function it possesses), in a great number of insects, a faculty of feeling superadded, at least in those insects whose antennæ are tolerably mobile. There can be no doubt that most of the Hymenoptera use them as tactile organs; and I am sure that the Honey-bee, *Andrena*, and the *Ichneumonidæ* do so continually, though most writers have considered that the numerous movements of the antennæ of the Ichneumons are for the purpose of smelling; but I am confident that strict observation would confirm my opinion that these motions are for feeling—and thus to enable the Insects to detect the opening of the holes in which the larvæ they are seeking reside; and that the antenna could be used as well for hearing any noise the larvæ made, as for smelling out their position. The Ant has been quoted as an instance strongly showing that the antennæ are used for smelling, as is manifested in the power of mutual recognition possessed by these Insects. Last summer I had opportunities of observing the Wood-ant; and found that it invariably acted in the following manner when two individuals met one another from opposite directions:—First, they approached and brought their antennæ into contact for a moment; then, approaching nearer, they brought their palpi together, and retained them in contact during the whole time, whilst the antennæ never touched each other again. By what means they communicated their thoughts it is impossible to say; but I suspect the palpi played the most important part.

From the various remarks made in this paper, as well as from the observations of

Newport on the habits of insects, I think it may be concluded that the antennal organs are formed upon a plan in accordance with our present ideas of an auditory apparatus, and are therefore capable of hearing, and that:—1st, they consist of a cell, sac, or cavity filled with fluid, closed in from the air by a membrane analogous to that which closes the foramen ovale in the higher animals; 2nd, that this membrane is for the most part thin and delicate, but often projects above the surface, in either a hemispherical, conical, or canoe-shaped, or even hair-like form, or variously marked; 3rdly, that the antennal nerve gives off branches which come in contact with the inner wall of the sacs; but whether the nerve enters, or, as is most probable, ends in the small internally projecting papilla which I have shown to exist in many of these sacs, it is very difficult to say. The principal part of the nerve proceeds to these organs, the remaining portion passing to the muscles, and to the roots of the hairs, at least to those of the larger sort. The distribution of the nerve can be very beautifully seen in the antennæ of the *Pronœus* before mentioned, as also in *Odynerus*.

Another point, which might be mentioned as rather tending by inference to the confirmation of this opinion respecting the antennal organs, is that in the Shrimp and Crawfish among the Crustaceans (which have a sac at the base of the antenna, commonly regarded as the auditory organ) there is no trace of any organs similar to those of the Insecta; the nerve simply supplies the hairs and muscles.

More than a year after the reading of my former paper on this subject, one was read on August 30, 1858, by M. Lespés, before the Academy of Sciences, Paris, reported upon satisfactorily by a Committee, and subsequently published in the 'Annales des Sciences Naturelles:' Paris, 1858. The title of this paper was "The Auditory Apparatus of Insects." Both the author and the reporters seem ignorant of what I had already done on this subject, as, by not being aware of the value of bleaching the integument, M. Lespés had very great difficulties to contend with, which would have been avoided had he used that process, and moreover he would have escaped a great error. He had in consequence to employ the most colourless species; and the most minute of his researches were upon the antenna of the Lamellicorns, *Melolontha, Polyphyllus*, &c., and he was obliged to view the organs perpendicularly only. He certainly asserts the existence of sacs behind the membranes, which he calls "*tympanules*," and gives a drawing and description of the ultimate branches of the antennal nerve proceeding to them. But he states that the sac or cell (which he terms "*cellule*," or "*poche*") contains a rounded, transparent, solid body attached to the inside of the membrane; this body he calls an "*otolithe*." Now, in all the numerous antennæ which I have observed with good and high powers, I have never seen this otolithe, the nearest approach to that body being the small chain of solid granules passing, in *Tetrix*, from the centre of the closing-in membrane to the back of the sac. But by following his directions for the observation of these structures in *Melolontha*, by splitting open one lamella of the antenna and viewing the wall from within, I have seen the very same appearance he describes, when viewing it with low powers. However, the apparent otolithe is very soon resolved into its true nature: for by using an $\frac{1}{8}$-inch objective and high eye-piece, the appearance supposed to be the otolithe is seen long before the rest of the sac; and by adjusting the focus, the otolithe melts away; so that by the time the sac is in the proper focus, the appearance of the otolithe has vanished; and on further examination it will be plainly seen, especially where the sac is viewed obliquely, that the appearance of a solid body was an optical deception, produced by the looking perpendicularly at the tube which passes from the sac behind the tympanum to communicate with the interior of the antenna: as the tube is seldom in the centre, the appearance of the "otolithe" is usually more or less on one side. Another great proof against the existence of an otolithe is the fact, that when looked at sideways the sac is, so far as I can see, perfectly empty.

M. Lespés, with myself, considers these organs to be none other than auditory; and from the numerous researches which have now been instituted by Erichson, Lespés, and myself, I think we may safely say that their existence is very general if not universal throughout the insect tribes.

M. Lespés has also pointed out the peculiar hairs which I had noticed some time since, and which I have figured in the Plate as they exist on the antenna of *Dyticus marginalis*.

Note.—The bleaching process which I now adopt is a slight modification of that formerly recommended. I take chlorate of potash, say one drachm; water one drachm and a half; mix these in a small bottle with a wide mouth, holding about an ounce; wait five minutes, and then add about $1\frac{1}{2}$ drachm of strong hydrochloric acid: chlorine is thus slowly developed; and the mixture remains in action from one to two weeks.

EXPLANATION OF THE PLATE.

TAB. LXVII.

A. *Organs on the antenna of* Microphora Vespillo.

Fig. 1. Enlarged view of the organs, between the hairs. Diameter $\frac{1}{3500}$ of an inch.

Fig. 2. Section of antenna wall, showing the sacs behind the membrane.

B. *Organs on the antenna of* Silpha ——?.

Fig. 1. Enlarged view of organs, as seen from above, on the terminal joint: *a a.* large sort; *b b.* smaller organs.

Fig. 2. Section of larger organs. Diameter at surface $\frac{1}{1760}$ of an inch.

C. *Organs on the terminal joint of a* Creophilus.

Fig. 1. Shows the lozenge-shaped groups.

a a. Organs from 6 to 16 in each group, divided by rows of hairs. Diameter $\frac{1}{5400}$ of an inch.

b b. Large organs.

D. *Organs on antenna of* Goerius olens.

a a a a. Organs rather more frequent about the hairs.
b b. Hairs.

E. *Organs of* Carabus.

Fig. 1. *C. violaceus.* Section of antenna-wall, showing true hairs, *a a.*
b b. Sacs with covering-in membranes raised above the general level.
Fig. 2. Enlarged view of section of antenna-wall, showing the peculiar markings of the covering-in membranes. Greatest diameter of the sacs $\frac{1}{1660}$. Diameter at surface $\frac{1}{3000}$th of an inch.
Fig. 3. *C. arvensis.* The covering-in membrane seen from above, ribbed more than in *C. violaceus.*

F. *Segment of the antenna of* Elater.

Fig. 1. Shows the sacs generally in front of the hairs.
Fig. 2. Enlarged view of portion of same; *b.* still more magnified, showing four or five papillæ on each.
Fig. 3. Section of the antenna-wall: *a a.* organs; *b.* true hairs.

G. *Organs of antenna of* Hydrophilus piceus.

Fig. 1. Enlarged view of a portion of surface.
Fig. 2. Section of antenna-wall, showing the various conditions of the covering-in membrane.

H. *Portion of antenna of* Dynastes Hercules.

Fig. 1. Part of one lamella. *a a.* Normal sacs.
b b. Sacs distorted at margin.
Fig. 2. Section of antenna-wall. Diameter $\frac{1}{1700}$ of an inch.

I. *Antenna of* Geotrupes stercorarius.

Fig. 1. Enlarged view of upper surface of lamella.
a a. True hairs.
b b. Organs.
Fig. 2. Section of antenna-wall.
a a. True hairs.
b b. Organs.

K. *Antenna of* Lucanus Cervus.

Fig. 1. Surface of lamella, showing the organs and their spines.
Fig. 2. Section of antenna-wall.
a. True hair-follicles.
b b. Organs with spinous terminations.
Fig. 3. Terminal lamella with cavity. There are sometimes two.

L. *Antenna of* Dyticus marginalis.

Fig. 1. Last two segments of antenna, showing—
a a a a. Dwarf hairs (tactile).
b b b b. Peculiar structure on one aspect only (see Fig. 3).
c. Nerve passing to the structures and dwarf hairs.
Fig. 2. Enlarged view of both tactile hairs and organs.
Fig. 3. Enlarged view of organs. Diameter $\frac{1}{3000}$ of an inch.
Fig. 4. Enlarged view of tactile hairs.

M. *Antenna of larva of* Colymbetes striatus.

Fig. 1. Terminal joints.
  a. Spine or hair.
  b. Apex with three hairs.
Fig. 2. Enlarged view of *b* (fig. 1), showing the nerve.
Fig. 3. Enlarged view of *a* (fig. 1).

N. *Antenna of* Myrmica rubra.

Fig. 1. The terminal and next segment, showing—
  a a a a. Organs as in other insects;
  b b b. Smaller, communicating with the tubes, as in fig. 2.
Fig. 2. Shows the elongated tubes with expanded extremities, proceeding from *b b b* (fig. 1).
Fig. 3. Section of antenna-wall.
  a a. The larger and more usual form. Diameter $\frac{1}{2700}$ of an inch; length from $\frac{1}{1900}$ to $\frac{1}{1700}$ o an inch.
  b b. Diameter $\frac{1}{4000}$ of an inch.
Fig. 4. Another form of *a a* (fig. 3).

O. *Antenna of* Pronœus inetabilis.

Fig. 1. Portion of antenna.
Fig. 2. Section of antenna-wall, showing structure of *a a a* (fig. 1). Diameter $\frac{1}{1900}$ of an inch.
Fig. 3. Section of antenna-wall.
  c c. Shows section of fig. 1 *c c.* }
  b b. Shows section of fig. 1 *b b.* } Diameter $\frac{1}{2300}$ of an inch.
  d d. Shows section of fig. 1 *d d.* Diameter $\frac{1}{4300}$ of an inch.

P. *Antenna of* Sirex gigas.

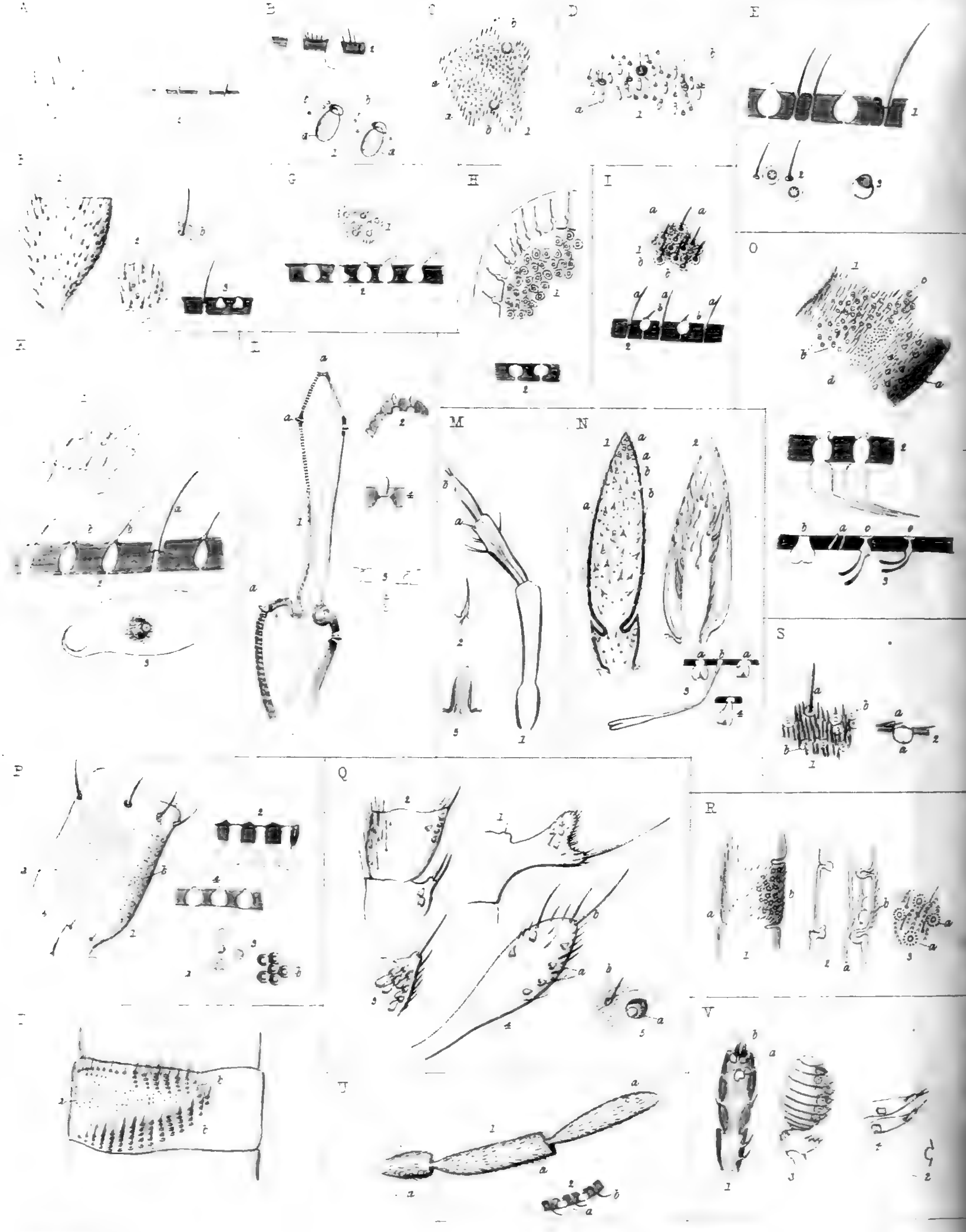
Fig. 1. One segment, showing two kinds of organs:—
  a. With elevated closing-in membrane (see P. fig. 4). Diameter $\frac{1}{3000}$ of an inch.
  b. Cup-shaped membrane (see fig. 2 and fig. 3 *b*). Diameter $\frac{1}{900}$ of an inch.
Fig. 2. Section showing the cup-shaped organs.
Fig. 3. Superficial view.
Fig. 4. Section of antenna-wall through fig. 1 *a d*, fig. 3 *a*.

Q. *Antenna of* Arctia Caja.

Fig. 1. One segment of male antenna. The organs are chiefly on the extremity of the lateral pecten, scales being on the opposite aspect.
Fig. 2. Segments of female antenna. Organs on serrated aspect.
Fig. 3. Magnified apex of serræ, with organs. The dotted lines represent the interior condition.
Fig. 4. Apex of club-headed pecten of *Odonestis potatoria.*
  a a. Organs. *b b.* Hairs.
Fig. 5. Enlarged view of an organ (*a*) and hair (*b*), with the cuticular lines.

R. *Antenna of* Tryphæna Bomba.

Fig. 1. External aspect of a segment. (All are alike.)
  a. Scales on one side.
  b b. Organs on opposite side, with small hairs between.
Fig. 2. Longitudinal section of ditto, showing nerve: *a* and *b.* lobulated matter beneath organs.
Fig. 3. Enlarged view of organs. *a a.* Organs. Between are hairs and cuticular markings.



T. P. Hicks M.D. del.

G. Jarman. sc.

S. *Organs on antenna of* Anthocera loti.

Fig. 1. Enlarged view of surface.
  a. True hair.
  b b b. Organs. Diameter $\frac{1}{2300}$ of an inch.
  c c. Cuticular projections.
Fig. 2. Section of antenna-wall and sacs.
  a. Section with papilla at back.
  b. Covering-in membrane, with papilla in centre.
  c. Cuticular projections.

T. *Antenna of* Macroglossa stellatorum.

Fig. 1. One segment of antenna.
  a. Organs, large and small.
  b b b. Rows of hairs with large follicles.

U.

Fig. 1. Last two segments of antenna, showing organs, *a a a a*.
Fig. 2. Section of antenna-wall, showing the organs at *a a.*; diameter $\frac{1}{2300}$th of an inch; and true hairs at *b b*.

V.

Fig. 1. Antenna of Pediculus of Crow.
  a a. Organs as in other antennæ.
  b b. Hairs (tactile) at apex.
Fig. 2. Section of organs.
Fig. 3. Antenna of Pulex of Mouse, showing an organ on each segment.
Fig. 4. Organs on antenna of Pulex of Mouse.

XXXIII. *On the Embryos of* Endogens *and their Germination.*
By BENJAMIN CLARKE, *Esq., F.L.S.*

Read June 16th, 1859.

IT is now some years since L. C. Richard, in his original and very accurate work, the 'Analyse du Fruit *,' divided phanerogamous plants, with reference to their germination, into Endorhizæ and Exorhizæ; but notwithstanding that exceptions to the exorhizal character as regards the secondary radicles have been repeatedly observed in exogenous plants, and its universality in the primary radicle doubted, yet in general works in which germination is referred to, this division is considered practicable, and the Endogens also are still regarded as being constantly endorhizal.

In examining the germination of the Endogens, however, for the purpose of ascertaining the position of the first leaf of the plumule relatively to the cotyledon, the primary radicle proved, contrary to my expectation, to be perfectly exorhizal in the greater number of instances, and so obviously without any trace of a sheath (coleorhiza) in *Iris*, *Alströmeria*, *Smilacina*, *Butomus*, *Tamus*, and *Arum*, as to place the fact beyond question. The secondary radicles in the Endogens, it is true, are usually, if not always, endorhizal, inasmuch as they protrude from beneath the cellular integument common to the primary radicle and young stem, although no sheath may be present; but this is a character also common to certain Exogens, as *Menyanthes trifoliata*, in which the secondary radicles and their branches not only protrude from beneath the surface, but have small sheaths at their bases; and some of the more remarkable instances of this kind have been described as occurring in the germination of *Ranunculaceæ*, *Compositæ*, and other families. The germination of *Nuphar lutea* also presents another remarkable instance in which the primary radicle is perfectly exorhizal †, but the secondary radicles above it are endorhizal, the elongated sheaths remaining attached during the early stages of growth. (Pl. LXVIII. figs. 1, 2, & 3.)

Finding, therefore, the Endogens to be frequently exorhizal, as many of them as opportunity afforded were germinated, and the probability appears to be that the primary or true radicle is known to be endorhizal (with two additions afterwards noticed) only in *Marantaceæ*, *Commelynaceæ*, *Cyperaceæ*, and *Graminaceæ*. To these families should perhaps be added *Naiadeæ*, since Richard has figured *Zannichellia palustris* as having all the appearance of an endorhizal germination; but whether they are endorhizal may be a question, because the embryos of some genera in their radicular portion do not differ materially from those in which the germination is exorhizal; and also in the embryo of *Zannichellia* no trace of a sheath is perceptible in a longitudinal section, while in *Zostera*

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* Démonstrations, ou Analyse du Fruit, 1808; H. A. Duval, Ed.

† The germination of *Nymphæa alba* has been referred to as being endorhizal, but as I have not had an opportunity of seeing it, this observation on *Nuphar lutea* was made with the greatest care; a fringe of minute radicles gives it in some degree the appearance of being endorhizal, but on examination it proves to be entirely an appearance.

marina the radicle is readily discernible lying in a canal directed obliquely towards the apex of the seed.

Although the germination of the Endogens is as yet known only in part, the subjoined instances of the exorhizal character occurring among them will, I believe, lead to the anticipation that the endorhizal is the exception rather than the rule, as most of those families in which the germination is unknown scarcely differ from one or other of the following, in which the primary radicle, as far as my observations have extended, is strictly exorhizal :—*Liliaceæ, Dioscoreaceæ, Juncagineæ, Alismaceæ, Butomaceæ, Irideæ, Amaryllideæ, Orchideæ, Palmaceæ, Araceæ, Typhaceæ*, and *Eriocauloneæ* *.

The inquiry relating to the position of the first leaf of the plumule originated in having observed that in the *Graminaceæ* the first leaf of the plumule is next the cotyledon, whilst in all other Endogens I had seen germinating it was directly away from the cotyledon, so as to be alternate with it, as in the ordinary genera of Liliaceous plants. For some years this phenomenon had appeared inexplicable, but further comparisons have led to the conclusion that the suggestion of L. C. Richard, as regards the embryo of the *Graminaceæ*, viz. that the apparent cotyledon is in reality an enlarged radicle, is the only practicable explanation of this departure from the regularly alternate position of the leaves of the embryos of the Endogens. But as objections exist to regarding the apparent cotyledon of the *Graminaceæ* as the radicle or a part of it, it may with equal propriety be compared to the enlarged cauliculus occurring in exogenous plants, or to the cormus as occurring in endogenous plants, and then the first leaf of the plumule will be the cotyledon, containing within it the leaves of the plumule occupying their usual alternate position. For the purpose, however, of being more readily understood, I shall, with Richard, still call it a radicle, though at first sight this view does not appear at all probable ; but yet the position of the first leaf of the plumule next the apparent cotyledon in *Graminaceæ* and *Cyperaceæ* (fig. 20 *c*) appears otherwise an anomaly not to be accounted for. But admitting that the cotyledon, as at present generally understood, is either an enlarged radicle or a cormus, the steps by which such an inference may be arrived at form an almost unbroken chain.

Beginning, for example, with *Caulinia, Naias,* and *Potamogeton,* we find that the first leaf of the plumule alternates with the cotyledon, being directly away from it ; and the embryo does not otherwise differ materially from those of *Orontiaceæ, Araceæ,* and *Liliaceæ,* excepting that the plumule is situated higher up, in consequence of its radicular portion having become elongated. But in *Zannichellia* we find a commencing alteration in structure ; the radicle has become more enlarged, and a partial ridge is formed on its upper part round the base of the cotyledon (figs. 4 & 5) ; but no further difference is observable, as the first leaf of the plumule is directly away from the cotyledon, as in *Naias* and *Potamogeton.*

Passing on to *Ruppia*, we find the cotyledon depressed and lying almost horizontally on the now enlarged radicle, which forms a shallow ridge surrounding it, so that it appears to lie in a furrow on its upper surface. This ridge is found to be divided into two parts ;

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* The primary radicle, as afterwards described, becomes suddenly arrested in its growth, but, as far as it developes, it is not endorhizal.

and this, I believe, offers a practical explanation of the nature of the two portions of the cotyledon (as at present understood) of *Triticum*, *Oryza* (fig. 20 *a*, *b*), and other *Graminaceæ*, in which traces of a stipule-like process exist, regarded by some botanists as a second cotyledon. The two portions of the ridge of the embryo of *Ruppia* consist of, 1, the larger portion, which forms nearly the whole of the ridge; and 2, a small process, which fills up a notch in it, and which is always in apposition with the membrane which conceals the plumule, and is therefore always next the fissured or marginal side of the cotyledon * (fig. 6). There is, however, no further difference between *Zannichellia* and *Ruppia*, the first leaf of the plumule being directly away from the cotyledon, as in that genus †.

Again, passing on to *Zostera*, we find in *Z. marina* (figs. 7, 8, 9, & 10) all the parts of the embryo of *Ruppia* much enlarged; thus the ridge, which is there but feebly marked, has become an enlarged two-lobed body, appearing when artificially opened almost like a two-lobed cotyledon, and the second portion of the ridge before alluded to, which in *Ruppia* is only a minute body, has become sufficiently prominent to look like a second cotyledon (figs. 8 & 9 *a*). The cotyledon has become elevated on a cauliculus, which is curved (fig. 8); but this is the only difference between it and the embryo of *Ruppia*, as the smaller lobe or process of the radicle is opposite the membrane concealing the plumule, as in that genus (fig. 9 *a*). The cotyledon becoming elevated on a cauliculus is not uncommon, as it occurs in the *Irideæ*, *Juncaceæ*, *Alismaceæ*, &c., and is afterwards further noticed.

If this is admitted as the only practical explanation of the structure of the embryo of *Zostera marina*, it appears to follow that the same explanation is the only mode of accounting for the relative position of the parts of the embryo of the *Graminaceæ*; for the cotyledon, both in *Ruppia* and *Zostera*, being next the larger lobe of the radicle, we should expect to find it so in the *Graminaceæ*, if the apparent cotyledon is in reality a radicle, and this I have found to be the case in both British and exotic genera (fig. 20). All the parts of the embryo have precisely the same relation to each other; and in *Zea Mays* the cotyledon (plumule as at present understood) in germination becomes elevated on a cauliculus (fig. 21 *a*), making the embryo in all respects like that of *Zostera marina*, except that it wants the minute secondary lobe, which is, however, present in *Triticum*, *Avèna*, and *Oryza* (fig. 20 *b*). *Zostera* also further agrees with the *Graminaceæ* in being endorhizal in a remarkable degree, as afterwards noticed; from which it might almost be anticipated that the structure of their embryos would prove to be the same.

Most of the *Graminaceæ* I have seen also agree with *Ruppia* and *Cymodocea* in the cotyledon (plumule as now understood) not being enclosed by the radicle, but lying in a

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* This small process is distinctly figured by Richard in *Ruppia maritima*, and his figures correctly show also its position relatively with the marginal side of the cotyledon. (*Vide* Ann. du Muséum d'Hist. Nat. tom. xvii. pl. 9. figs. 43, 58.)

† *Cymodocea Webbiana* and *Posidonia Caulini*, as figured by Ad. de Jussieu, form a connecting link between *Ruppia* and *Zostera*: in *Posidonia* the cotyledon is more than half enclosed in the upper part of the radicle, and the position of the cotyledon is distinctly shown in both of them by the plumule being exposed; and they cannot be supposed to differ in this character from *Ruppia* and *Zostera*. (*Vide* Ann. des Sciences Nat. 2^{me} série, xi. Bot. pl. 17. figs. 15, 16.)

furrow on its surface, as in *Avena* and *Hordeum*. The embryo of *Hordeum vulgare* is in this character much like that of *Cymodocea Webbiana*, as figured by Ad. de Jussieu*, the position of its leaves being precisely the same; so that the evidence of the identity of the embryo of *Zostera* with those of the *Graminaceæ* appears to be complete, and the comparatively large radicle of this genus and its allies may be regarded as supplying the place of the deficient albumen.

As a further argument that the apparent cotyledon of the *Graminaceæ* is a radicle, it deserves remark, that in germination it scarcely enlarges, and its smaller lobe, by some botanists regarded as a second cotyledon †, also remains almost stationary; whereas the stipulary process of the cotyledon, which occupies the same position in *Smilacina*, *Tamus*, *Iris*, and *Canna*, grows in favourable circumstances so as to be as long or longer than the cotyledon, or even as long as the seed, and sometimes forms a sheath for the young stem.

In this view of the structure of the embryo of the *Graminaceæ*, the second or rudimentary cotyledon, which is a minute body, usually referred to as being alternate with, and rather lower down than the larger (fig. 20 *b*), is the smaller lobe or process of a two-lobed radicle, as in *Zostera* (fig. 8 *a*); so that the division of flowering plants by Ray into Monocotyledonous and Dicotyledonous is quite correct, and the Endogens are separated from the Exogens more completely by this character than by any other.

For the purpose of further explanation as regards the germination, the position of the first leaf of the plumule, and a proposed division of the Endogens, particular notices of the embryos of the families examined are added.

Cyperaceæ.—I have seen germinating the seeds of *Cladium Mariscus*, of a *Cyperus*, and of a *Carex* from Japan, and find that they agree with the *Graminaceæ* in having the first leaf of the plumule always next the cotyledon, as at present understood, from which, as this family is so nearly allied, it may be inferred that the embryo has the same structure, and therefore consists of a radicle partially enclosing a cotyledon. There is nothing in the germination to contradict this supposition, unless it is that the radicle is endorhizal in the lowest degree, as no coleorhiza forms, and the nascent spongiole emerges from beneath the surface without a distinct appearance of a rupture of tissue taking place. This is the only family I have observed to agree with the *Graminaceæ* in the altered position of the first leaf of the plumule, but it not improbably occurs in other glumaceous Endogens, as *Restiaceæ* and *Desvauxiaceæ*.

Zosteraceæ.—The embryo of *Zostera marina* has been accurately figured by Richard ‡: the cotyledon is seen elevated on a cauliculus, and the position of the plumule is distinctly shown, and even the smaller lobe or process of the radicle is faintly indicated, but it is imperfectly seen in consequence of the embryo being closed; but its endorhizal character does not appear to have attracted notice. This, however, is quite obvious, as the

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* Ann. des Sciences Nat. 2^{me} série, xi. Bot. pl. 17. fig. 16.

† Dr. Schleiden states that this is not a second cotyledon, but a part of the cotyledon itself, which he terms the "ligula," and regards it as being of the same nature as stipules, to which it certainly has a close resemblance; but, as it does not enlarge in germination, it wants one of the characters of stipulary processes, as far as my observation has extended. (*Vide* Schleiden's Principles of Scientific Botany, translated by Dr. E. Lankester, p. 272.)

‡ Ann. du Muséum d'Hist. Nat. tom. xvii. pl. 9. figs. 47, 48.

radicle lies in a canal directed obliquely towards the base of the embryo (fig. 9), and is so unattached that it may easily be taken out entire. But in *Z. nana* the radicle is short, less oblique in its direction, and the orifice of the canal is not closed, as in *Z. marina*, being covered only by a delicate semitransparent membrane (fig. 22). In *Triticum*, *Avena*, and *Hordeum*, there is a tubercle immediately under the radicle, which looks not unlike a closed orifice.

As thus described, therefore, the embryo of *Zostera marina* differs from those of *Oryza sativa*, *Zea Mays*, &c., only in the cotyledon and its cauliculus being curved by becoming bent downwards, and in the smaller lobe of the radicle being removed from the base of the cauliculus (fig. 8 *a*), which may be the effect of the pressure of the bent cauliculus, as it makes a depression in the substance of the radicle.

Eriocauloneæ.—The germination of *Eriocaulon septangulare* is very singular, differing from that of any other plant I have seen. The embryo first protrudes a horizontal process, having a small speck on its outer part, consisting of a circular portion of the testa, in the same way apparently as Mr. Wilson has described to occur in the germination of *Lemna gibba* (Bot. Misc. i. 145. t. 42); but in its after stages it differs in sending up a leaf, which is directly away from the cotyledon, as in *Juncaceæ* and *Liliaceæ*, and it cannot, therefore, be compared in this character to either *Graminaceæ* or *Cyperaceæ*. Subsequently to the appearance of the first leaf, the horizontal process protrudes a root from its under surface, which has no coleorhiza, although it most probably escapes through a fissure in the tissue, as the subsequent radicles do. As growth proceeds, the horizontal process becomes fissured by the enlargement of the root, which soon breaks through it, and its remains are finally left as a root-like process on the root itself. (Figs. 11, 12, 13, 14, & 15.)

On referring to Klotzsch's figures of the germination of *Pistia texensis* *, I was agreeably surprised to find a satisfactory explanation of the germination of *Eriocaulon*; and no doubt it will also serve to explain that of *Lemna*, as figured by Mr. Wilson (*loc. cit.*), which is admitted to be very obscure. In Klotzsch's figures the horizontal process is no doubt the primary radicle, as it has so entirely the appearance of the primary radicle of *Araceæ* and their allies, and the same therefore must be the conclusion with regard to the horizontal process of *Eriocaulon septangulare* (fig. 11) and the analogous process of *Lemna gibba*. But whether this kind of germination is endorhizal or exorhizal remains a question, because the growth of the radicle is arrested about the time the coleorhiza first appears; and possibly such a germination may be common to both endorhizal and exorhizal plants, so that *Pistiaceæ* and *Lemnaceæ* may be, like *Araceæ*, exorhizal. I am obliged, however, to differ from Klotzsch in his description of the plumule of *Pistia texensis*: what he calls the first leaf, I should undoubtedly regard as a stipulary process, or perhaps only as the lips of the fissure in the cotyledon; and what he calls the second leaf must, of course, be the first leaf, which is figured as being directly away from the cotyledon, as in *Arum*.

Commelynaceæ.—The endorhizal character is here well marked; the coleorhiza is, however, very thin, and soon disappears. The first leaf of the plumule is directly away from

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* Ueber Pistia (Abhandl. der K. Akademie zu Berlin, aus dem J. 1852). Berlin, 1853. Taf. ii. figs. Q, R, S.

the cotyledon. On the face of the germinated cotyledon in *Commelyna tuberosa*, and another species, there is always present a small process looking like a bud, which is not, however, present on any of the succeeding leaves; possibly it may be analogous to the buds that occur on the ribs of the inferior paleæ of the Grasses.

Juncaceæ.—As this family is intermediate between *Liliaceæ* and *Cyperaceæ* and their allies, and its limits are not well defined, its germination presented a more than usually interesting subject of inquiry, and was rather expected to prove like that of the *Liliaceæ. Luzula campestris* is, however, distinctly endorhizal, being more so than the *Cyperaceæ*, and, I believe, strictly agrees with the *Commelynaceæ* in this character; it may therefore serve to show that *Juncaceæ* have no near affinity with either *Liliaceæ* or *Palmaceæ*, from which they further differ in the cotyledon, as growth advances, becoming elevated on a cauliculus. The coleorhiza is of delicate texture, and disappears within a day or two from the enlargement of the root *. The cotyledon has a well-defined opening for the plumule, the first leaf of which is directly away from it. (Fig. 23.)

Hydrocharideæ.—This family has the embryo (the plumule only being rather larger) as well as the habit of *Naiadeæ* and their allies, and so may, perhaps, supply a connecting link between the hypogynous and epigynous Endorhizæ. It also agrees with them in having the first leaf of the plumule directly away from the cotyledon.

Marantaceæ.—The germination of *Canna indica* has been figured by Richard with his usual accuracy †, with the exception of the primary radicle, which, from his figures, might be supposed to possess a coleorhiza of the same kind as the secondary, which is not at all the case. The coleorhiza of the primary radicle is of comparatively delicate texture, and unless the germination is daily examined from its commencement, may escape observation, as it very soon disappears entirely; whereas the secondary radicles break through the epidermis from a considerable depth, and the torn fissures through which they escape remain for a much longer time. At the last stage figured, the coleorhiza of the primary radicle has almost or entirely disappeared, so that the appearance of it there represented is, I believe, only that of the lateral radicle on either side reflected down upon it. The first leaf of the plumule alternates with the cotyledon, and as germination advances, the cotyledon sends up a stipulary process, forming a short sheath for the growing plumule.

Alismaceæ and *Butomaceæ.*—In the germination of *Actinocarpus Damasonium* the plumule becomes elevated on a cauliculus, which elongates, while the radicle has scarcely begun to protrude; the first two leaves of the plumule are lateral, *i. e.* neither directly towards the cotyledon nor directly away from it, but yet, as growth advances, the external of the two shows a tendency to turn more directly away from it. *Butomus umbellatus* germinates in the same way, the cotyledon having a very distinct fissure for the emission of the plumule, but its first leaf is directly away from the cotyledon. The germination was repeatedly observed, and no trace of a coleorhiza was perceptible. (Figs. 24 & 25.)

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* The coleorhiza cannot be seen unless the seed is first completely deprived of its mucilaginous coat by placing it in water for two or three days, when it swells, and is easily removed. If this is not done, the radicle becomes covered with mucus, so as entirely to prevent observation.

† Ann. du Muséum d'Hist. Nat. tom. xvii. pl. 5. figs. 3, 4, 5, 6.

Juncagineæ.—The germination of *Triglochin palustre* agrees with that of *Arum*, showing no trace of the endorhizal character; but after the radicle has protruded, a slight ridge forms, which marks its junction with the cotyledon, and is produced by the base of the cotyledon; and this gives the radicle in some degree the appearance of having been endorhizal.

Typhaceæ.—Repeated examination failed in showing any traces of the endorhizal character in *Typha latifolia*, the germination of which is much like that of *Butomus*, in the cotyledon becoming elevated on a short cauliculus, which is distinctly separated from the radicle by a slight ridge, and it agrees with it also in the position of the first leaf of the plumule. A fringe of minute radicles gives it the appearance of being endorhizal, and renders the examination difficult unless made in water. Richard's figures do not represent it as endorhizal *.

Araceæ.—It was after repeated unsuccessful attempts that the seeds of *Arum maculatum* and *Dracunculus* germinated, and neither of them proved endorhizal. At first there is no distinction between cotyledon and radicle (fig. 16), and subsequently only a faintly marked ridge shows the junction between them (figs. 17 & 18); this consists of the base of the cotyledon, and is seen at the bases of the succeeding leaves (fig. 19). In *A. Dracunculus* the first leaf of the plumule is alternate with the cotyledon, being directly away from it; but *A. maculatum* does not produce its first leaf till after it has formed a small cormus, and in the meantime its cotyledon has withered. Supposing therefore the cormus in the latter to develope rather earlier than the cotyledon, so as partially to envelope it on its dorsal side, or only to form a concave tuberosity beneath it, then it might be compared with the embryo of *Zosteraceæ.*

Palmaceæ.—The germination of *Phœnix dactylifera* agrees with that of the *Araceæ* and *Liliaceæ*, except that it protrudes its radicle like a *Commelyna*, forcing the embryotega away in much the same manner †; a shallow furrow, extending the whole length of the cotyledon, shows its marginal side, and at its base, close to the radicle, is the opening for the plumule, looking like a small scar. It is, however, if pervious, so minute, that the plumule escapes by an artificial opening, sometimes through the back of the cotyledon, but often through the furrow, in consequence of the tissue being thinner. Taking this furrow as a guide, the first leaf of the plumule is directly away from the cotyledon.

Liliaceæ.—*Smilacina, Funkia* ‡, *Asparagus*, and *Allium*, all agree in having the primary radicle exorhizal, and the first leaf of the plumule directly away from the cotyledon. *Asparagus* has the plumule sheathed by a stipulary process of the cotyledon, as in *Iris* and *Canna*; it is found on the inner side of the plumule, and becomes, in favourable cir-

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* Ann. du Muséum d'Hist. Nat. tom. xvii. pl. 5. figs. 8, 9.

† About ten days after germination has commenced, the cuticle at the apex of the radicle sometimes exfoliates in minute irregular scales, having in some degree the appearance of a commencing coleorhiza; but the same kind of exfoliation soon takes place from the whole surface of the elongated cotyledon, which becomes an inch or more in length, and therefore, I believe, is not at all analogous to a coleorhiza.

‡ One of the species of this genus is remarkable for a triple plumule, the parts of which, growing during germination, produce a singular appearance. It is in cultivation in the Botanic Gardens, Chelsea. Before germination the plumules are enclosed within the fissure, and all spring from one point.

cumstances, as long as the cotyledon, but no trace of it is present before germination. It cannot be a rudimentary leaf, because it has no connexion with the base of the plumule, but only with the margins of the opening in the cotyledon.

Irideæ.—The embryos of several species of *Iris* agree in their germination with those of *Araceæ* and *Liliaceæ*; they are, however, remarkable for the cotyledon sending up a sheath surrounding the plumule, which sometimes becomes longer than the cotyledon itself, and terminates by elongating internally between the plumule and cotyledon (fig. 26). In other species of the same genus, this sheath exists only as membranous margins of the elongated opening in the cotyledon, which proves beyond doubt it is of the nature of stipules.

Amaryllideæ.—The germination of *Alströmeria aurantiaca* agrees precisely with the species of *Iris* in the primary radicle being exorhizal, and the secondary endorhizal, or at least breaking through the cellular surface; but the stipulary process, as I have termed it, is wanting, which is a further proof of its real nature in *Iris*.

Dioscoreaceæ.—The germination of *Tamus communis* agrees most with that of the *Liliaceæ*. The first leaf of the plumule alternates with the cotyledon, and not only is it exorhizal, but it is some time before any distinction between the cotyledon and radicle is apparent. The opening for the emission of the plumule is horizontal, and a sheath, like that which forms in *Asparagus*, rises round the nascent plumule, and, as growth advances, becomes external to it instead of next the cotyledon, which gives it in some degree the appearance of a second cotyledon; it is, however, often bifid, and the young leaves, as well as those which are mature, have lateral stipules, which alone might be sufficient to explain its true character *.

With reference to the value of the characters, it may be observed that they will probably prove of some practical use in subdividing the Endogens; *Graminaceæ, Zosteraceæ, Naiadeæ*, and their allies forming a natural section, and containing, it may be anticipated, all the truly endorhizal and macropodal hypogynous families; and, on the other hand, *Araceæ, Liliaceæ, Dioscoreaceæ, Irideæ*, and their allies, in which these characters are wanting, are all otherwise in near affinity to each other.

Such a subdivision, however, would involve the placing of the *Marantaceæ, Musaceæ* and *Amomeæ*, and also the *Orchideæ* and *Burmanniaceæ* on account of their large radicle, in the endorhizal section, with which they have scarcely any connexion except the affinity between *Orchideæ* and *Triurideæ*; but yet their epigynous character should not perhaps be regarded as excluding them, because of the truly epigynous character of the *Hydrocharideæ*. If, however, Von Martius is right in his comparison of *Burmanniaceæ* with *Hydrocharideæ*, to which he refers them, another link of connexion between *Orchideæ* and the hypogynous endorhizal families may be traced; and it may also deserve notice, that the embryo of *Orchis Morio* in germination becomes in shape much like that of a *Ruppia*, the young plumule also springing from the same part. The ovules of *Burmanniaceæ* are orthotropal, and the distichous inflorescence of *Burmannia dasyantha* †

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* This stipulary process occurs in the ungerminated embryo of *Dioscorea cordifolia*, as figured by Ad. de Jussieu, and is represented as bifid. (Ann. des Sciences Nat. 2^{me} série, xi. Bot. pl. 17. fig. 13.)

† Nov. Gen. et Sp. Plant. Brasil. tom. i. tab. 5. fig. '

occurs in *Alismaceæ*, a near ally of the *Hydrocharideæ*; besides which, they may not improbably prove to have the embryo of *Triurideæ*, which would lend some further support to such a comparison. And if the *Bromeliaceæ* should prove endorhizal, such a subdivision of the epigynous families would not be unnatural, as they connect *Hydrocharideæ* and *Marantaceæ*.

The following is added as a provisional arrangement of the Endorhizæ and their allies, including especially all those families in which the radicle is enlarged; and the remainder of the class Endogens thus separated will, I believe, be found to form by themselves a very natural section. But it must be confessed that no entirely natural arrangement can be expected to be made until the structure of the embryo and its germination in all the families is definitely ascertained.

Epigynous.		All. 1. Orchideæ. Apostasiaceæ. Burmanniaceæ.	All. 2. Hydrocharideæ.	All. 3. Musaceæ. Amomeæ. Marantaceæ. All. 4. ? Bromeliaceæ. ? Taccaceæ.
Hypogynous.	All. 5. Commelynaceæ. Mayaceæ. Xyrideæ. Eriocauloneæ. All. 6. Restiaceæ. Desvauxiaceæ. Cyperaceæ. Graminaceæ.	All. 7. Philydraceæ. Juncaceæ.	All. 8. Triurideæ. Alismaceæ. Butomaceæ. All. 9. Potamogetoneæ. Naiadeæ.	
Primordial form.	Zosteraceæ.			

EXPLANATION OF THE PLATE.

Tab. LXVIII.

Fig. 1. *Nuphar lutea*. The radicle at the time of its first protrusion, before the first leaf appears.

Fig. 2. The seed of the same after the first leaf has appeared. This leaf is rudimentary, having no lamina.

Fig. 3. The same, after the second leaf has formed, and a secondary radicle protruded, which has a coleorhiza. The same coleorhiza appears on the secondary radicles, which succeed.

Fig. 4. An embryo of a *Zannichellia*, the membranous sheath containing the plumule having been laid open to show the position of its first and second leaves.

Fig. 5. A longitudinal section of the same, showing that the radicle is perfectly adherent to the surrounding tissue, and that in the ungerminated embryo no trace of a canal is formed for it.

Fig. 6. The embryo of *Ruppia maritima,* the membranous sheath containing the plumule having been laid open to show the position of its first and second leaves: *a.* the smaller lobe of the radicle.

Fig. 7. The embryo of *Zostera marina,* showing the smaller lobe of the radicle coiled over the cotyledon in its cavity.

Fig. 8. The same, opened, and the cotyledon raised out of its cavity: *a.* the smaller lobe of the radicle.

Fig. 9. The same, in longitudinal section, showing the radicle lying in a narrow canal at its base. The membranous sheath containing the plumule is opened to show that it is situated on that side of the cotyledon which is next the smaller lobe of the radicle, *a.*

Fig. 10. The plumule more magnified, showing that it consists of two leaves: the first leaf, *a,* is directly away from the cotyledon.

Fig. 11. A germinating seed of *Eriocaulon septangulare,* showing the primary radicle protruding, with a small circular portion of testa on its apex.

Figs. 12 & 13. The same more advanced, fig. 13 showing the position of the first leaf of the plumule.

Fig. 14. The same, showing the commencement of the formation of the first secondary radicle.

Fig. 15. The same more advanced, showing that the secondary radicle has broken through the primary, and the first leaf of the plumule become elevated on a cauliculus. From the cauliculus another secondary radicle has protruded; it has no coleorhiza, but the surface of the cellular tissue divides to allow its escape.

Fig. 16. A seed of *Arum Dracunculus* commencing to germinate, showing that it has no trace of a coleorhiza.

Fig. 17. The same more advanced, showing a slightly elevated line marking the base of the cotyledon.

Fig. 18. The same more advanced, showing the position of the first leaf of the plumule.

Fig. 19. The same more advanced, the cotyledon having been removed to show a circular line at the base of the first leaf, similar to that at the base of the cotyledon in fig. 17.

Fig. 20. A germinating embryo of *Oryza sativa*: *a.* the upper part of the radicle as understood by Richard; *b.* the smaller lobe of the radicle (the epiblastus of Richard), which has been regarded as a second cotyledon; *c.* the cotyledon, showing its relation to the upper part of the radicle.

Fig. 21. A germinating embryo of *Zea Mays*: *a.* the cauliculus; *b.* the cotyledon as understood by Richard, the plumule having been partly drawn out of the fissure to show its position.

Fig. 22. The embryo of *Zostera nana,* showing the aperture for the emission of the radicle, covered by a semitransparent membrane.

Fig. 23. A germinating embryo of *Luzula campestris* extracted from the albumen. The stricture in the cotyledon is produced by the pressure of the testa after the radicle has protruded.

Fig. 24. A germinating embryo of *Butomus umbellatus.*

Fig. 25. The same more advanced: *a.* part of the cauliculus (not cotyledon) is seen above the radicle.

Fig. 26. A germinating embryo of an *Iris,* extracted from the albumen: *a.* the sheath of the plumule in its earliest stage.

XXXIV. *Notes on the Structure and Affinities of* Batideæ, Callitrichaceæ, Vochysiaceæ, *and* Cassytheæ. *By* B. Clarke, *Esq., F.L.S.*

Read June 16th, 1859.

1. *On the Structure and Affinities of* Batideæ *and* Callitrichaceæ.

THE principal points in the structure of the genus *Batis*, P. Br., have become well known, but its affinities have not been decided, while those which have been suggested for it are proved to be, for the most part, if not entirely, impracticable; further analysis therefore seems required before its affinities can be brought to light; and the following additional particulars, as regards its structure, and especially the relative position of the ovules to the axis of the ovary, will, I believe, make it evident that it must be a near ally of the *Verbenaceæ*.

The male flowers are arranged in 4-rowed spikes, giving them a habit like that of the *Verbenaceæ* with 4-rowed spikes of flowers; but in one species the inflorescence becomes compound, which gives it in some degree the habit of a *Globularia*, as of *G. orientalis*. The calyx is reduced to one sepal, posterior; but, since in the *Acanthaceæ* also the calyx is sometimes very nearly obsolete, this negative character is of little value. The corolla is attached by a very slender basis to the calyx, and consists of four petals with long claws and oval or almost circular laminæ, and of four stamens alternate with them, two of which are placed anterior and posterior, and two right and left of the axis *,—the two lateral stamens having the rudiment of an ovary slightly adhering to them, which is sometimes bifid, the segments being lateral.

The female flowers are in shorter spikes, which are 4-rowed, as in the male. The floral envelopes are deficient; but each ovary has at its base a quickly deciduous bractea (Tab. LXVIII. fig. 27), so that in the early stage the spike is completely enveloped in scales, and is also terminated with three or four pairs of minute flowerless scales. The stigmas are two, right and left of the axis, and the cells of the ovary four, so placed that two of them stand right, and two left of the axis, so as to correspond in their position with the two stigmas, each pair having no bundle of vessels between them, but being separated by very distinct bundles from the opposite pair (fig. 27 *a*). Each cell contains an erect anatropal ovule, the raphe and foramen of which are very distinct. The raphe is lateral in relation to the inner angle of each cell; but in each pair of cells the raphes are always turned towards each other (fig. 27 *a*), as in the *Verbenaceæ* and *Labiatæ*, proving beyond doubt that the structure of the ovary is the same, consisting of only two carpels.

According to this view of its structure, *Batis* differs from the *Verbenaceæ* only in being diclinous and polypetalous, unless it is in the position of the stamens; for in the female

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* This, at least, is their position in *B. maritima*, but whether it is always so may be a question.

flower no positive difference is apparent except in the carpels being right and left of the axis, instead of anterior and posterior: and in its deficiency of floral envelopes, it may, as far as relates to the corolla, be compared to the *Stilbaceæ*, near allies of *Verbenaceæ*, the female flowers of which are apetalous.

The position of the *Batideæ*, therefore, appears undoubtedly to be with the monopetalous families; and however contrary to the rules of affinity it would have appeared only a few years since, this makes it in some degree probable that *Callitrichaceæ* should also be stationed there, and near *Batideæ*, as the ovary has precisely the same structure, being 4-celled, and consisting of two carpels, right and left of the axis. In *Callitriche*, however, the ovules are suspended, amphitropal, with the raphe next the placenta, in which it corresponds with *Boragineæ*, or very nearly so *; the seed is albuminous, and the cotyledons are very short, as in *Stilbaceæ*, with which it further agrees in its anther, which closely resembles that of *Campylostachys* in shape, and in the peculiarity of the two cells being confluent at the apex, so that at the time of dehiscence it appears as if it had but one cell.

Callitriche may be compared with *Elatineæ*, especially if the structure of the ovary of *Tetradiclis* can be considered as analogous to that of *Callitriche*; but *Batis* does not appear to have any affinity with the polypetalous families, except that the long claws of its petals are like those which occur in *Caryophyllaceæ*. *Callitriche* differs from *Euphorbiaceæ* in its amphitropal ovules; besides which, hermaphrodite flowers are not uncommon.

2. *Note on the Structure and Affinities of* Vochysiaceæ.

One of the most remarkable characters in this family is that the carpel when single is posterior, as in *Erisma*; the single cell of the ovary is on the opposite side of the flower to the stamen, which is anterior, and in direct relation with the spur of the calyx, which belongs to the posterior sepal (fig. 28). This character I believe completely separates the *Vochysiaceæ* from the epigynous families, and especially from the *Onagraceæ*, with which they have been compared, as in that family the carpel when single is anterior; nor is it known to be always posterior in any of the epigynous families.

If the position of the single carpel is in the present instance taken as a guide to affinity, this family should be associated with one in which the flower is in some degree irregular, with the single carpel posterior; and these characters occur in *Daphnaceæ*, of which the *Vochysiaceæ* may be a polypetalous form †, standing in the same relation to the *Chrysobalaneæ* and *Leguminosæ*, and especially to the former, as *Daphnaceæ* to *Proteaceæ*.

The relation, however, between *Vochysiaceæ* and *Daphnaceæ* is rather one of analogy than affinity, although perhaps there is no character to separate them except the absence

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* In *Boragineæ* the ovule is scarcely suspended, being attached near or at the base of the cell, at the inner angle; but the raphe of the amphitropal ovule is on its under surface—which is, doubtless, equivalent to the ovule being suspended with the raphe next the placenta.

† In *Pimelea* and other genera of *Daphnaceæ* there is a decided tendency to irregularity of the flower of the same kind as in *Grevillea* among *Proteaceæ*, with the exception that the carpel is always posterior instead of anterior, and it is not uncommon for flowers of *Pimelea* to have but one stamen anterior, as in *Erisma* (*vide* Ann. Nat. Hist. 2nd ser. vol. xi.).

of petals in *Daphnaceæ*; and it is doubtless among the polypetalous families that the more immediate relations of *Vochysiaceæ* are to be sought for,—the vicinity of *Rosaceæ*, *Leguminosæ*, and their allies (which are regarded as polypetalous forms of *Daphnaceæ* and *Proteaceæ*) appearing to be the true station of this family.

The relation of the *Vochysiaceæ* to *Chrysobalaneæ* confirms this view of their affinities, as they may be regarded as differing from *Chrysobalaneæ* only in the carpel when single being posterior instead of anterior; for it is on the posterior side of the flower that the stamens are deficient in both families, and the calyx in *Vochysiaceæ* is sometimes so nearly regular that the spur is scarcely apparent.

To the *Amygdaleæ* they are doubtless equally allied, agreeing with them in the ovules when suspended having the raphe next the placenta *; but as the flowers in this family are always regular, the approach between them is less obvious.

To the *Rosaceæ* they may be compared in the remarkably convolute æstivation of the corolla; to *Pomaceæ* in the occasionally inferior ovary, the ovules when erect having the raphe next the placenta, and in the cotyledons being either flat or convolute; and to *Calycanthaceæ* in the imbrication of the calyx, which occasions the flower-buds to look like leaf-buds; and in their large anthers.

3. *Note on* Cassytheæ.

The affinity of this family having been for some time well known to be with the *Lauraceæ*, I have only to add that it agrees with them in the ovary consisting of a single carpel †, as is shown by a furrow on one side of the style, which is also of a paler colour (fig. 29), and by the ovule being attached to the same side of the ovary, so as to be in relation with the furrow in the style, the ovule being pendulous, not from the apex of the cell, but from one side near the apex, as in *Lauraceæ* (*vide* Ann. Nat. Hist. ser. 2. vol. xi.).

The carpel is also variable in its position in nearly the same degree as in the *Lauraceæ*, being occasionally posterior, and otherwise variable from anterior to lateral; and it agrees also with them in the ovule having the raphe dorsal (fig. 29), so that there does not appear to be any distinction between them except in parasitism.

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* In those genera where the ovules are numerous, they are suspended, amphitropal, with the raphe next the placenta, and therefore the foramen is uppermost.

† The ovary of *Sassafras officinale* consists of a single carpel (*vide* Ann. Nat. Hist. 2nd ser. vol. xi.), but occasionally, although very rarely, it becomes dicarpous, with an imperfectly bifid style and parietal placentæ, consisting of two ribs on the opposite sides of the ovary, which are alternate with the styles. The ovaries of *Laurus*, *Cinnamomum*, and *Tetranthera* have also decidedly the appearance of consisting of but one carpel; but *Sassafras* being occasionally dicarpous, makes it probable that Nees v. Esenbeck is right in describing *Lauraceæ* as tricarpous, as when the ovules are two, and attached separately, the ovary would most likely be compound.

EXPLANATION OF THE PLATE.

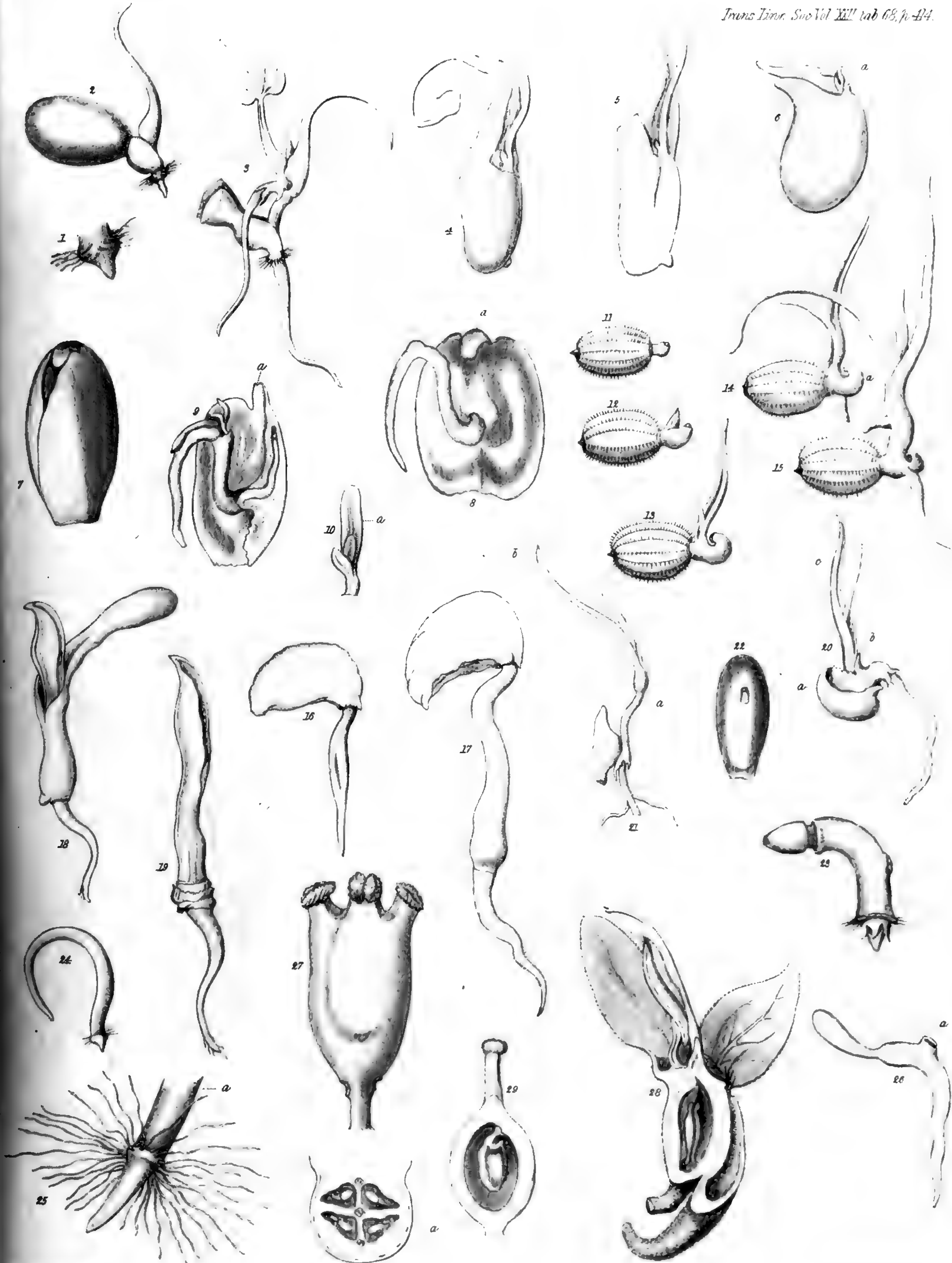
TAB. LXVIII.

Fig. 27. A portion of a spike of female flowers of *Batis maritima*, showing the scars left by the bracteæ: *a*. a transverse section of the front ovary, showing the relation of the cells to its two stigmas, and bundles of vessels interposed between them, anteriorly and posteriorly, so that they form pairs right and left of the axis. The ovules are also seen to be in pairs right and left of the axis, indicated by the position of their raphes.

Fig. 28. A longitudinal section of the ovary of *Erisma violacea*, showing the relative position of the spurred sepal and stamen, and that the ovules are attached on the anterior side of the ovary.

Fig. 29. A longitudinal section of the ovary of *Cassytha filiformis*, showing the attachment of the ovule, and that the raphe is dorsal; also a furrow in the style on the same side as the attachment of the ovule.

Trans Linn. Soc. Vol. XXII tab 68, p. 414.



B. Clarke, del.

G. Jarman, sc.

XXXV. *On the Origin and Development of the Pitchers of* Nepenthes, *with an Account of some new Bornean Plants of that Genus. By* J. D. Hooker, *M.D., F.R.S. & L.S. &c.*

Read June 16th, 1859.

In a paper read before the Linnean Society on the 16th June, 1857, and published in this volume of the 'Transactions' (p. 137), I mentioned, in a note, that I had examined and prepared drawings of the development of the pitchers of *Nepenthes*, from plants in the Royal Gardens at Kew, and that these confirmed Griffith's observation * that the pitchers are modifications of the excurrent midrib of the leaf. I have now the honour of laying before the Society the principal facts observed during the examination in question, which have further led me to the conclusion that the pitchers are modifications of a gland situated at the apex of the midrib of the leaf; and I have added the necessary illustrations. I shall also append to this paper an account of the most singular and gigantic plants of the Order, which have lately been discovered by H. Low, Esq., on the lofty mountain of Kina Balou in Borneo.

Part I.—*On the Development of the Pitchers of* Nepenthes.

At the earliest period at which I have examined the undeveloped leaf of the full-grown plant of *Nepenthes lævis* of our gardens †, I find it to consist of a minute, blunt, conical body, about $\frac{1}{100}$th of an inch long (Tab. LXXIV. fig. 1 *b*), with a slight longitudinal depression on the anterior surface, leading to a shallow oval cavity, which is placed immediately below the apex. At this period the cuticle is scarcely distinguishable, but the oval depression has a more shining appearance and less defined superficial layer of cells than any other part of the cone. On a vertical section carried down and through the groove and oval depression (fig. 2), the whole substance is found to be formed of a rather dense parenchyma, becoming looser, and as it were deliquescent at the oval cavity. This oval cavity is all that represents the future pitcher, and it is simply a subterminal gland.

The next period (as defined by a marked progress in specialization) is that at which there is an evident differentiation of the conical body into the lamina of the leaf and a superimposed body. At this stage (fig. 3) the cone is found to be prolonged upwards, and about $\frac{1}{30}$th of an inch long. The frontal groove is rather deeper, and has defined margins. There is an evident contraction about halfway between the base and apex, most marked on the edges of the groove. The apex of the cone projects forward and rather arches over the oval cavity, which has deepened, and is directed inwards and downwards. There is a

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* In 'Calcutta Journal of Natural History,' vol. iv. no. xiv. July 1843, p. 231.

† It is the *N. gracilis*, Korth. I have to record my obligations to the Messrs. Low, of Clapton Nurseries, and Messrs. Veitch and Son, of the Exotic Nurseries, Chelsea and Exeter, for the liberal manner in which they have aided me by specimens of rare species in their establishments, for examination.

more evident cuticle to the whole surface of the cone, except over the gland, which now appears to be a secreting surface, and is rather pulpy or viscid.

At the next succeeding period, when the whole body is about $\frac{1}{10}$–$\frac{1}{20}$th of an inch long, a considerable further change has taken place (fig. 4). The contraction towards the middle has greatly lengthened and forms a neck, which separates an elongated conical base (the future lamina) from an oblong terminal body (the future pitcher). The groove is still shallow on the intermediate portion (the excurrent midrib) and on the pitcher above it, but is deepened into a canal with incurved edges on the lamina below it. The gland is now a deep cavity, with a large quadrangular orifice, over which hangs the incurved apex (the lid of the future pitcher) of the original conical body. A vertical section (fig. 5) through the centre shows a narrow pale line ascending close to the dorsal margin, curving over the apex and terminating in the incurved apex; this line indicates the position of the future vascular bundles. At fig. 4 a minute conical body is seen at the base of the groove, and is a nascent second leaf.

At the next following marked stage, the lamina, excurrent midrib, and pitcher are externally very well defined, and the lid of the pitcher differentiated. The lamina is still a cone, but much elongated, and presents a cylindrical groove with the edges slightly turned in, representing the earliest appearance of that organ in its involute condition of vernation. The contracted portion above it (the excurrent midrib) has elongated more in proportion than the lamina or pitcher, and its frontal groove is less marked. The apex of the pitcher has grown upwards and backwards; the incurved portion, again, has so grown downwards as to close the orifice of the cavity. On a vertical section (fig. 7) the cavity is seen to be prolonged downwards as a sac parallel to the walls of the pitcher, whilst the incurved portion or lid has both grown downwards over the mouth of the cavity, and inwards towards its dorsal face; its protuberant inner surface is more papillose than any part of the sac. As the pitcher enlarges, the apex, which points upwards and backwards, elongates, at first considerably more than the lid itself, and becomes the styliform process at the junction of the lid and pitcher. On a vertical section (fig. 8) the vascular bundle is seen to run up to the apex of this process, which thus continues to be the true organic apex of the whole foliar organ.

The succeeding stages of growth were examined in *N. Rafflesiana* and *phyllamphora*?, and present few external characters but what have been previously observed. In the former species the terminal process often spreads and divides, and, together with the whole pitcher, is covered with appressed hairs. These hairs point upwards everywhere except on the young lid, where they either project or point in the opposite direction. On a vertical section at this time, the lid is found to have reached the lower portion of the orifice, and it afterwards closes the mouth of the pitcher (fig. 10); and one or two recurrent fascicles of vessels are found to originate in the principal vascular bundle in its course towards the apex of the young styliform process, which bundles enter the substance of the lid, and ramify in it.

The vernation of the leaf in *Nepenthes* is well known to be involute, the opposite margins being each rolled in towards the midrib. This curious arrangement, which is not peculiar to the genus, appears to me to be a secondary one, or rather an induced condition; for in some very young leaves of *N. Rafflesiana* I observed, that as the frontal groove which represents the anterior (or upper) surface of the leaf deepened and its margins expanded, these margins decidedly overlapped (fig. 11), thus forming a convolute vernation; but that, owing to a more rapid growth of the overlapping hemiphyll, which still retained its initial tendency to curve inwards towards the midrib, it eventually formed a cylindrical roll parallel to, and in contiguity with, the originally overlapped hemiphyll.

If these observations should receive confirmation, they will tend to prove that the *involute* vernation of leaves may be, in some cases at any rate, a modification of the more frequent *convolute* condition of these organs.

In the above description I have used the term adopted by Griffith, of "excurrent midrib;" but I need hardly say that the intermediate organ, or stalk of the pitcher, is no more an excurrent portion of the lamina, than is the petiole in those species where that organ is developed: it is a body more or less strictly analogous to the terminal cirrhus of the leaf of *Gloriosa*, *Flagellaria*, various species of *Convallaria*, &c.; and though the development of a gland at its apex into a pitcher is very anomalous, and possibly unique*, the existence of terminal glands in the leaves of plants, which is physiologically the most important feature, is by no means so unusual a fact as may at first sight appear. They are very conspicuous at the apex of the leaf of *Limnocharis*, *Caladium*, and other genera, both of monocotyledonous and dicotyledonous plants. In young *Limnocharis Plumieri*, especially, a gland is placed at the apex of the midrib, and being hollow, resembles the early condition of the *Nepenthes* pitcher.

Since the above observations were made, I have had the opportunity of examining some seedling *Nepenthes*, for which I am indebted to Hugh Low, Esq., of the Nursery, Clapton, and which are both extremely singular in themselves, and throw much light on the whole subject. One of these (species unknown) is figured of the natural size in Tab. LXXIV. fig. 19, and magnified at fig. 20. The first pair of leaves (fig. 20 *a* & 21), the cotyledonary, are opposite, lanceolate and acute; the following at once bear ascidia at their apices, of a size, form, and in a position that cause the whole leaf strikingly to resemble that of *Sarracènia*. The youngest leaves I have examined, namely those immediately succeeding the cotyledonary, have a more or less dilated lamina, and a hollowed-out upper half of the midrib, partially closed with a small ciliated lid; as the leaf grows, the lamina dilates upwards on each side, so as to become cuneate, and finally obcordate and bilobed at the apex, with the pitcher in the sinus. When fully developed, these leaves are about $\frac{1}{4}$–$\frac{3}{4}$ inch long; they present on the upper surface a shallow mesial groove, leading up to a triangular, slightly tumid area towards the apex, which area answers to the anterior face of the pitcher; beyond the apex the neck of the pitcher protrudes, with its lid; the margins of the leaf are carried up as wings along the sides of the neck of the pitcher to near its orifice, where they meet, and form a transverse, reflexed, ciliate membrane.

Looking at the under surface of the leaf, the midrib appears very stout below, and gradually bulges as it advances towards the apex of the leaf, forming the belly of the pitcher.

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* I have not yet satisfied myself as to the origin of the pitcher in *Cephalotus* and *Sarraceniaceæ*.

The examination of these remarkable seedling plants suggests the following observations :—

1. The difference in the development of the leaf and pitcher in these seedling plants, and in the full-grown ones previously described, is very great, and at first sight anomalous. In the full-grown plant, the lamina, petiole, excurrent midrib, and pitcher are very independently differentiated, and the pitcher itself is first developed in the most rudimentary conceivable condition, that of a simple naked gland. In the seedling plant, on the other hand, the pitcher and lid appear to be developed in the earliest discernible condition of the leaf, which is that of a hollow midrib open at the apex and there closed with a lid, along each side of which midrib the lamina becomes developed in one plane (not with a convolute or involute vernation). As the plant grows, the upper part of the hollowed midrib of each succeeding leaf becomes more and more inflated, its apex protrudes beyond the lamina, as the neck of the pitcher, and the orifice and lid of the latter assume the usual highly organized condition of these parts in the genus.

2. The position of the pitcher, occupying chiefly the underside of the leaf, is very remarkable, the appearance of the whole being not that of a pitcher with foliaceous margins, but of a leaf with a pitcher partly adnate to its under surface; and the larger the leaf is, the more independent does the pitcher appear to be, and the more confined to the apex of the leaf; so that I expect that in more advanced states of the seedlings of this species, the pitcher will be found to be wholly free from the lamina of the leaf, though continuous at its base with the midrib *. When the plant arrives at such a stage of growth that the lamina of the leaf becomes a larger and more important organ than the pitcher, then the vernation of the leaf will assume the normal condition which obtains in the old plant.

3. The horizontal development of the lamina on the sides of the pitcher, and the prolongation of the margins of the lamina on the neck of the pitcher, at first sight seem to suggest the view that in the old plant the lamina of the leaf is represented by the wings of the pitcher, and that the apparent lamina is only a winged petiole. But in the seedlings the produced margins of the lamina do not reach the mouth of the pitcher; on the contrary, they converge, and form a transverse membranous wing below its orifice; and the older the leaf is, the longer is the neck of the pitcher produced beyond this transverse lamina: and if the oldest of these seedling leaves be compared with that of a full-grown *Nepenthes*, it would appear possible that the transverse lamina is the true apex of the leaf, which in the old plant forms an elevated ridge on the anterior face of the base of the stalk of the pitcher †. This ridge, though generally small in most full-grown leaves, is often very prominent, so much so in *N. Rajah* (Tab. LXXII.) that the stalk of the pitcher is there peltately attached to the back of the leaf.

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* Since the above observations were made, I have received from Messrs. Veitch more advanced seedlings, which confirm this—the pitchers being wholly free from the lamina, but continuous at their base with the midrib. (October, 1859.)

† These more advanced seedlings do not confirm this idea: it appears that the anterior wings of the old pitcher do answer to the produced edges of the lamina in the seedling pitcher, and that the transverse process becomes evanescent. The annulus of the young pitchers is not developed in the youngest leaves of the seedling plants, and in the more advanced it occupies the whole space between the mouth of the pitcher and the transverse lamina.

4. In my description of the development of the leaves in full-grown plants of *Nepenthes,* I have stated that the gland which is developed into a pitcher occupies a position towards the apex of the nascent leaf; the examination of the seedling plants would tend to show that the position of the gland indicates the organic apex of the future midrib, and no doubt it does so (as may be seen in *Limnocharis Plumieri*). Such glands often occur on the margins, midribs, veins or petioles of leaves, and are most frequent at the anastomoses of the veins, as at the base of the lamina (*Cucurbitaceæ, Leguminosæ,* &c.), or at the serratures where the lateral nerves meet the marginal (*Aurantiaceæ, Myrsineæ,* &c.), or where the lateral veins finally converge at the apex of the midrib (as in *Nepenthes, Limnocharis,* &c.).

5. The sudden transition from the simple cotyledonary leaves of a seedling *Nepenthes,* to the pitcher-bearing leaves immediately contiguous to them, is extremely remarkable. There is, in the species I have examined, no transitionary stage of development whatever. This renders the formation of the pitchers of *Sarracenia* and *Cephalotus* (which, so far as I have observed, never present the appearance of ordinary leaves) less anomalous, than if a seedling *Nepenthes* presented a graduated series of more and more highly organized leaves connecting the simple cotyledonary with the fully developed pitcher-bearing ones.

The resemblance between the pitcher of a seedling *Nepenthes* and that of *Sarracenia purpurea* is very close, and leaves little doubt in my mind that that organ is strictly homologous in the two genera. I have never seen seedlings of *Sarracenia,* nor of *Cephalotus,* but a comparison of young leaves of the latter with those of *Nepenthes* presents several curious similarities. In *Cephalotus* the ordinary leaves are perfectly simple, and similar to the cotyledonary leaves of *Nepenthes*; and the pitcher-bearing leaves are at once developed as such, having the cavity and ciliated lid in their earliest discernible condition: though these occur both above and below the ordinary leaves, and in immediate contiguity with them, there are no intermediate stages whatever, the transition from cauline leaf to pitcher being as sudden and abrupt as from cotyledonary leaf to pitcher in seedling *Nepenthes.* The appearance, too, of the young *Cephalotus* pitcher and stalk is that of a stout petiole, with a hollowed-out terminal head obliquely adnate to its lower surface. If the analogy with *Nepenthes* holds good, the stipes of the *Cephalotus* pitcher represents the midrib of a leaf on whose sides no lamina is developed.

PART II.—*Notes on the Bornean Species of* Nepenthes, *with descriptions of the new ones.*

The want of any important characters in the flowers and fruit of *Nepenthes* is a very remarkable feature of these plants. The leaves differ considerably in insertion, and in being more or less petioled. The pitchers of most, when young, are shorter, and provided with two ciliated wings in front; more mature plants bear longer pitchers, with the wings reduced to thickened lines. The glandular portion of the pitcher remains more constant than any other, and the difference between the form of old and young pitchers is often chiefly confined to the further development of the superior eglandular portion into a neck or tube.

NEPENTHES.

§ I. *Ascidia magna, ore lamellis latis disciformibus annularibus remotis instructo.*

1. NEPENTHES VILLOSA, H. f. (Hook. Ic. Pl. t. 888). Ascidia magna turgida late pyriformia coriacea 5″ longa 3½″ lata, alis anticis mediocribus grosse dentatis, ore aperto annulo maximo! lamellis annularibus distantibus disciformibus rigidis 1″ diam., cristatis posticis in spinas rigidas ½″ longas fundum ascidii spectantibus productis, collo elongato erecto, operculo orbiculato intus densissime glanduloso dorso basi longe cornuto. (TAB. LXIX.)

Hab. Borneo (*Lobb*). Kini Balou, alt. 8000–9000 feet (*Low*).

This most remarkable pitcher resembles that of *N. Edwardsiana* in so many respects, especially in the size, form, and disposition of the distant lamellæ of the mouth, that I am inclined to suspect that it may be produced by young plants of that species, before it arrives at a stage when the pitchers have elongated necks.

The whole inner surface of the pitcher is glandular, except a very narrow area beneath the mouth at the back.

2. NEPENTHES EDWARDSIANA, Low, MSS. Foliis (6″ longis) crasse coriaceis longe petiolatis ellipticis, ascidiis magnis crasse pedunculatis cylindraceis basi ventricosis 8–18″ longis, ore lamellis annularibus distantibus rigidis magnis cristato, collo elongato erecto, operculo cordato-rotundato, racemo simplici, rachi pedicellisque ferrugineo-tomentosis. (TAB. LXX.)

Hab. Kina Balou, north side, alt. 6000–8000 feet (*Low*).

Mr. Low desires that this magnificent plant should bear the name of the Honourable George Edwardes, Governor of Labuan, who has materially assisted him in his expeditions. Under *N. villosa*, I have stated my suspicions that this may be the more mature form of that plant with elongated pitchers. The leaves, ascidia, and pitchers sent by Mr. Low are all old, and nearly glabrous; but the young parts—rachis, peduncles of the panicle, and the calyx—are covered with ferruginous tomentum. One of the pitchers sent is 18 inches long from the base to the apex of the erect operculum; it is 2½ inches in diameter below the mouth, 1½ at the narrowest part (about one-third distant from the base), and the swollen part above the base is about 2 inches in diameter. The beautiful annular discs which surround the mouth are ¾ inch in diameter.

§ II. *Ascidia magna, curva, basi inflata, medio constricta, dein ampliata, infundibuliformia; ore maximo, latissimo, annulo 0.*

3. NEPENTHES LOWII, H. f. Caule robusto tereti, foliis crasse coriaceis longe crasse petiolatis lineari-oblongis, ascidiis magnis curvis basi ventricosis medio valde constrictis, ore maximo ampliato, annulo 0, operculo oblongo intus dense longe setoso. (TAB. LXXI.)

Hab. Kina Balou, alt. 6000–8000 feet (*Low*).

A noble species with very remarkable pitchers, quite unlike those of any other species. They are curved, 4–10 inches long, swollen at the base, then much constricted, and suddenly dilating to a broad, wide, open mouth with glossy shelving inner walls, and a minute row of low tubercles round the circumference; they are of a bright pea-green, mottled inside with purple. The leaves closely resemble those of *Edwardsiana* and *Boschiana* in size, form, and texture, but are more linear-oblong.

I have specimens of what are sent as the male flower and fruit, but, not being attached, I have not ventured to describe them as such. The male raceme is 8 inches long, dense-flowered. Peduncles simple. Perianth with depressed glands on the inner surface, externally rufous and pubescent. Column long and slender. *Female* inflorescence: a very dense oblong panicle; rachis, peduncles, perianth, and fruit covered with rusty tomentum. Capsules $\frac{2}{3}$ inch long, $\frac{1}{6}$ broad.

§ III. *Ascidia magna, ore mediocri, annulo latissime explanato, dense lamellato v. costato.*

4. Nepenthes Veitchii, H. f.

N. villosa, Bot. Mag. t. 5080; non Ic. Plant. t. 888.

Hab. Borneo (*Lobb*), alt. 1000 feet. Gunoong Mooloo, alt. 3000 feet (*Low*).

5. Nepenthes Rajah, H. f. (Frutex 4-pedalis, *Low.*) Foliis maximis 2 pedalibus oblongo-lanceolatis petiolo costaque crassissimis, ascidiis giganteis (cum operculo 1–2 pedalibus!) ampullaceis ore contracto, stipite folio peltatim affixo, annulo maximo lato everso crebre lamellato, operculo amplissimo ovato-cordato ascidium totum æquante! (Tab. LXXII.)

Hab. Borneo, north coast, on Kina Balou, alt. 500 feet (*Low*).

This wonderful plant is certainly one of the most striking vegetable productions hitherto discovered, and in this respect is worthy of taking place side by side with the *Rafflesia Arnoldii*; it hence bears the title of my friend Rajah Brooke, of whose services in its native place it may be commemorative amongst botanists. Mr. Low describes it as a shrub 4 feet high; and the pitchers being of that short ampullaceous form which sometimes denotes that the plant producing them is immature, it is possible that, at a different season, it may attain a greater stature and bear different pitchers.

I have only two specimens of leaves and pitchers, both quite similar, but one twice as large as the other. Of these the leaf of the larger is 18 inches long, exclusive of the petiole, which is as thick as the thumb; and 7–8 broad, very coriaceous and glabrous, with indistinct nerves. The stipes of the pitcher is given off below the apex of the leaf, is 20 inches long, and as thick as the finger. The broad ampullaceous pitcher is 6 inches in diameter and 12 long; it has two fimbriated wings in front, is covered with long rusty hairs above, is wholly studded with glands within, and the broad annulus is everted and 1–$1\frac{1}{2}$ inch in diameter. Operculum shortly stipitate, 10 inches long and 8 broad.

The inflorescence is hardly in proportion. Male raceme 30 inches long, of which 20 are occupied by the flowers; upper part and flowers clothed with short rusty pubescence. Peduncles slender, simple or bifid. Fruiting raceme stout. Peduncles $1\frac{1}{2}$ inch long, often bifid. Capsule $\frac{3}{4}$ inch long, $\frac{1}{3}$ broad, rather turgid, densely covered with rusty tomentum.

6. NEPENTHES BOSCHIANA, Korth.; Miquel, Flora Ned. Ind. i. 1074, cum syn.

Hab. Borneo (*Korthals*). Mount Mooloo, alt. 3000 feet (*Low*). Also (*var. β*) found in Sumatra.

Pitchers 15 inches long. Plant 15–20 feet high.

7. NEPENTHES RAFFLESIANA, Jack; Miquel, Flora, i. 1070, cum syn. &c.

Hab. Labuan (*Mottley*). Kina Balou, alt. 3500 feet (*Low*). Also found in Sumatra, Malacca, and Sincapore.

8. NEPENTHES PHYLLAMPHORA, Willd.; Miquel, Flora, i. 1069, cum syn.

Hab. Labuan, alt. 2500 feet; very rare (found by *Mr. T. Lobb*) (*Low*). Also found in Malacca, Sincapore, Java, New Guinea, and China.

I have no Bornean flowering or fruiting specimens of this species, which may be known by its stout terete stem, long petioled ciliated leaves (when young), and cylindrical pitchers, which are swollen at the base, and have a contracted mouth surrounded with a broad flat annulus. Its foliage resembles that of *N. fimbriata*, from which it differs chiefly in the broad annulus.

§ IV. *Ascidia cylindracea, ore mediocri, annulo angusto creberrime costato v. striato v. sublævi.*

9. NEPENTHES REINWARDTII, Miq. Flora, *l. c.*

Hab. Mount Mooloo, alt. 3000 feet (*Low*).

Apparently chiefly differs from *N. gracilis* in the pitcher bulging at the base.

10. NEPENTHES GRACILIS, Korth.; Miquel, Flora, i. 1071, cum syn. &c.

N. lævis, Hort.

Hab. Borneo (*Korthals*). Common along the N.W. coast (*Low*).

β. elongata. Borneo (*Low*). Also Malacca and Sincapore.

Varies much in size, and in the length of the decurrent part of the leaf.

11. NEPENTHES FIMBRIATA, Blume, Mus. Lugd. Bat. ii. p. 7; Miquel, Flora, i. 1072.

Hab. Borneo (*Korthals*). Also found in New Guinea and the Louisiade Archipelago.

Apparently differs from *N. gracilis* chiefly in the narrower annulus.

12. NEPENTHES ALBO-MARGINATA, Hook. MSS. Glaucescens, caule tereti apice foliis subtus et inflorescentia rufo-tomentosis, foliis anguste lanceolatis basi longe angustatis vix petiolatis coriaceis acuminatis, ascidiis cylindricis, annulo angusto minute creberrime striato margine lato albo-tomentoso circumdato, racemo tenui, pedicellis subternis filiformibus, floribus parvis. (TAB. LXXIII.)

Hab. Borneo (*Lobb*). Maritime rocks near the mouth of the Lokotan and Tanjong-poe Rivers (*Low*). Also found at Sincapore, *Lobb.*

Species pulcherrima, distinctissima, colore pallido, foliis angustis non decurrentibus, ascidiis plerumque tomentellis, annulo angusto late albo-marginato.

This very beautiful species is sent by Lobb both from Borneo and Sincapore. The pitchers are usually covered with a short white tomentum, and the broad white velvety band surrounding the narrow polished brown annulus affords a very marked character. The pitchers of the Sincapore specimen are (when dry) of a beautiful rose-colour blotched with purple.

13. NEPENTHES MELAMPHORA, Reinwardt; Miquel, Flor. i. 1072, cum syn. &c.

β. lucida, Blume, Mus. Lugd. Bat. ii. p. 8.

Hab. Southern Borneo (*Korthals, Mottley*). Also found in Eastern Bengal and Java.

I have received Bornean specimens of this plant, collected by Mottley at Banjarmassing, on the south coast of Borneo, where it was first detected by Korthals. The originally described form grows at an elevation of 3000–5000 feet in Java.

I take the East Bengal *Nepenthes* to be the same species; it was sent from that country* by Carey to Europe, and published by Graham in the 'Botanical Magazine' (t. 2798) as the Ceylon *N. distillatoria*, L. (from which it is very different). It has also been gathered by Griffith in the same place, and by Dr. Thomson and myself near Amwee, on the Jyntea Hills—the eastern continuation of the Khasia Mountains and north of Silhet, whence probably all the specimens were sent, as the plant and that particular habitat are well known to the natives of those districts. The figure in the 'Bot. Mag.' well represents the Bengal plant in every respect; but the dried raceme in Herb. Hook., from which the drawing was made, is much more tomentose than any specimens gathered by Thomson, Griffith, or myself, or by Korthals, Blume, or Reinwardt in Java. One of Griffith's Bengal specimens is in this respect intermediate between ours and those of the Edinburgh Gardens. Korthals' figure is not characteristic, except of a small half-starved-looking form.

I have a pitcher of what I take to be this species upwards of a foot long; it was grown in Mr. Rollisson's Nursery.

§ V. *Ascidia brevia, ore contracto, annulo lato creberrime sulcato, operculo parvo.*

14. NEPENTHES AMPULLARIA, Jack; Hook. Comp. Bot. Mag. i. 271; Miq. Flora, i. 1076, cum syn. &c.

Hab. Borneo (*Lobb, Low, Mottley*). Also found in Malacca and Sumatra (*Jack, Cuming, Korthals*).

EXPLANATION OF THE PLATES.

TAB. LXIX.

Nepenthes villosa, H. f.

Fig. 1. ♂ raceme; nat. size. Fig. 2. ♂ flower. Fig. 3. ♀ flower. Fig. 4. Fruit. Fig. 5. Portion of under surface of lid:—all magnified.

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* From the Circar Mountains in N.E. Bengal, Bot. Mag. *l. c.* The Khasia Mountains are those meant here—the Circars being in the Peninsula.

Tab. LXX.

Nepenthes Edwardsiana, Low.

Fig. 1. Fruit. Fig. 2. Portion of under surface of pitcher:—both magnified.

Tab. LXXI.

Nepenthes Lowii, H. f.

Fig. 1. Portion of ♂ raceme, and Fig. 2. of ♀; both nat. size. Fig. 3. ♂ flower. Fig. 4. Young fruit. Fig. 5. Portion of under surface of pitcher:—all magnified.

Tab. LXXII.

Nepenthes Rajah, H. f.

Fig. 1. ♂ flower. Fig. 2. Portion of fruiting raceme. Fig. 3. Ripe fruit. Fig. 4. Portion of under surface of pitcher:—Figs. 1, 3 and 4 magnified.

Tab. LXXIII.

Nepenthes albo-marginata, Hook.

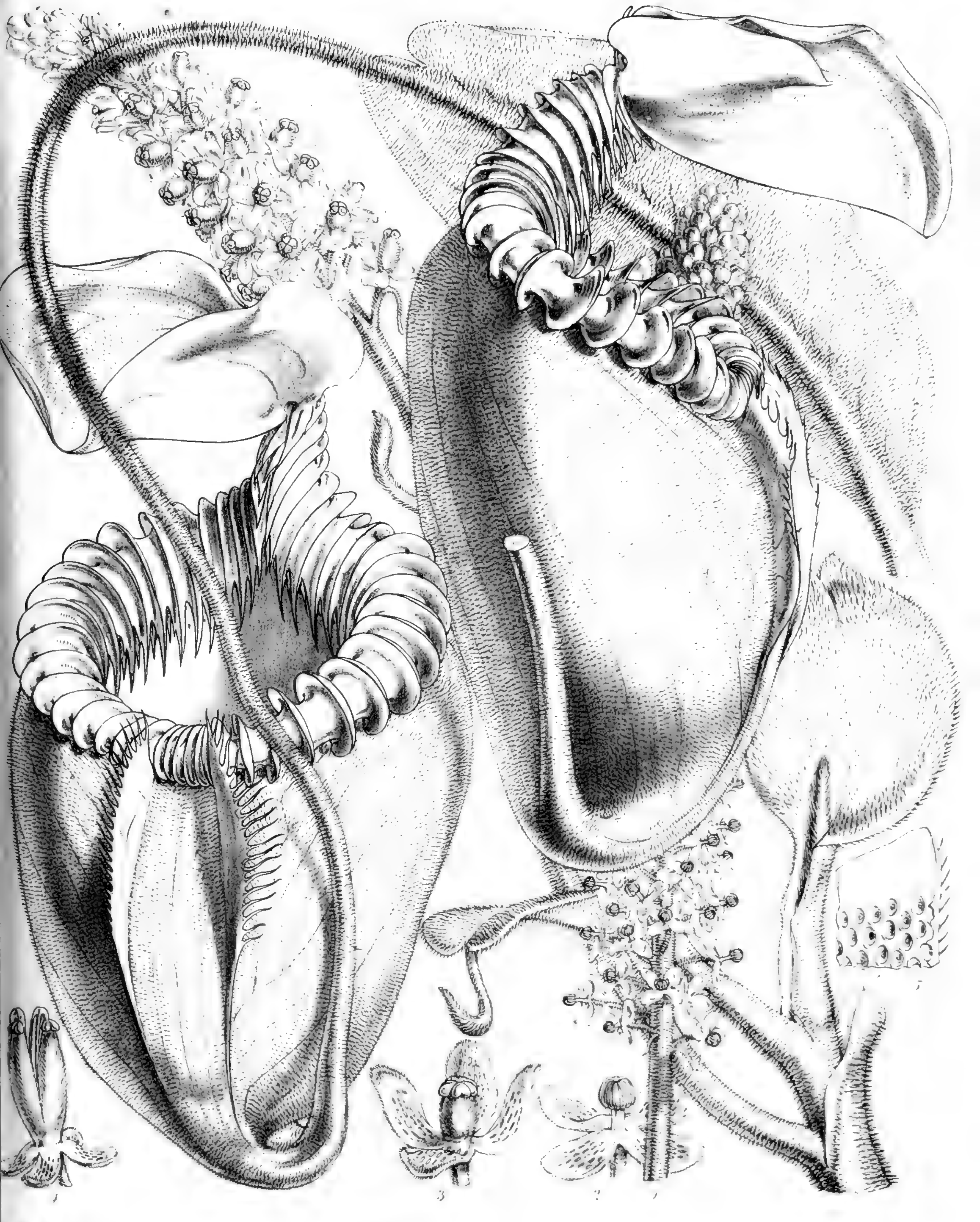
Fig. 1. ♂ flower. Fig. 2. ♀ flower. Fig. 3. Portion of under surface of pitcher:—all magnified.

Tab. LXXIV.

Illustrations of the Development of Nepenthes *pitchers.*

Fig. 1. Conical terminal bud of *N. gracilis*, Korth. (*N. lævis*, Hort.) (*a*, nat. size).
Fig. 1 *b*. Apex of the same rather more advanced, representing a leaf in its earliest state.
Fig. 2. Longitudinal section of the same.
Fig. 3. More advanced condition of ditto, showing the differentiation of the lamina below, and excurrent midrib and pitcher above.
Fig. 4. Still further advanced state of terminal bud and leaf. *a*. is a second leaf.
Fig. 5. Vertical section of apex of the same.
Fig. 6. Apex of leaf after the lamina, excurrent midrib, and pitcher are all differentiated.
Fig. 7. Apex of pitcher from the same, cut vertically.
Fig. 8. Vertical section of young pitcher of *N. Rafflesiana.*
Fig. 9. Further developed pitcher of ditto.
Fig. 10. Vertical section of pitcher of ditto.
Fig. 11. Convolute vernation of rudimentary lamina of leaf of *N. Rafflesiana.*
Fig. 12. More highly developed pitcher of ditto, cut vertically.
Fig. 13. Very young pitcher of *N. phyllamphora*?
Fig. 14. Vertical section of ditto.
Fig. 15. Further advanced pitcher of ditto.
Figs. 16 and 17. Vertical sections of still further developed pitchers of ditto.
Fig. 18. Vernation of very young leaf of *N. Rafflesiana.*
Fig. 19. Seedling *Nepenthes* from Borneo, from Mr. Low's Nursery:—nat. size.
Fig. 20. Ditto magnified. *a*, cotyledonary leaves.
Fig. 21. Cotyledonary leaf of ditto.
Figs. 22–25. Various views of leaves of ditto.

All the above figures but fig. 19 are more or less highly magnified.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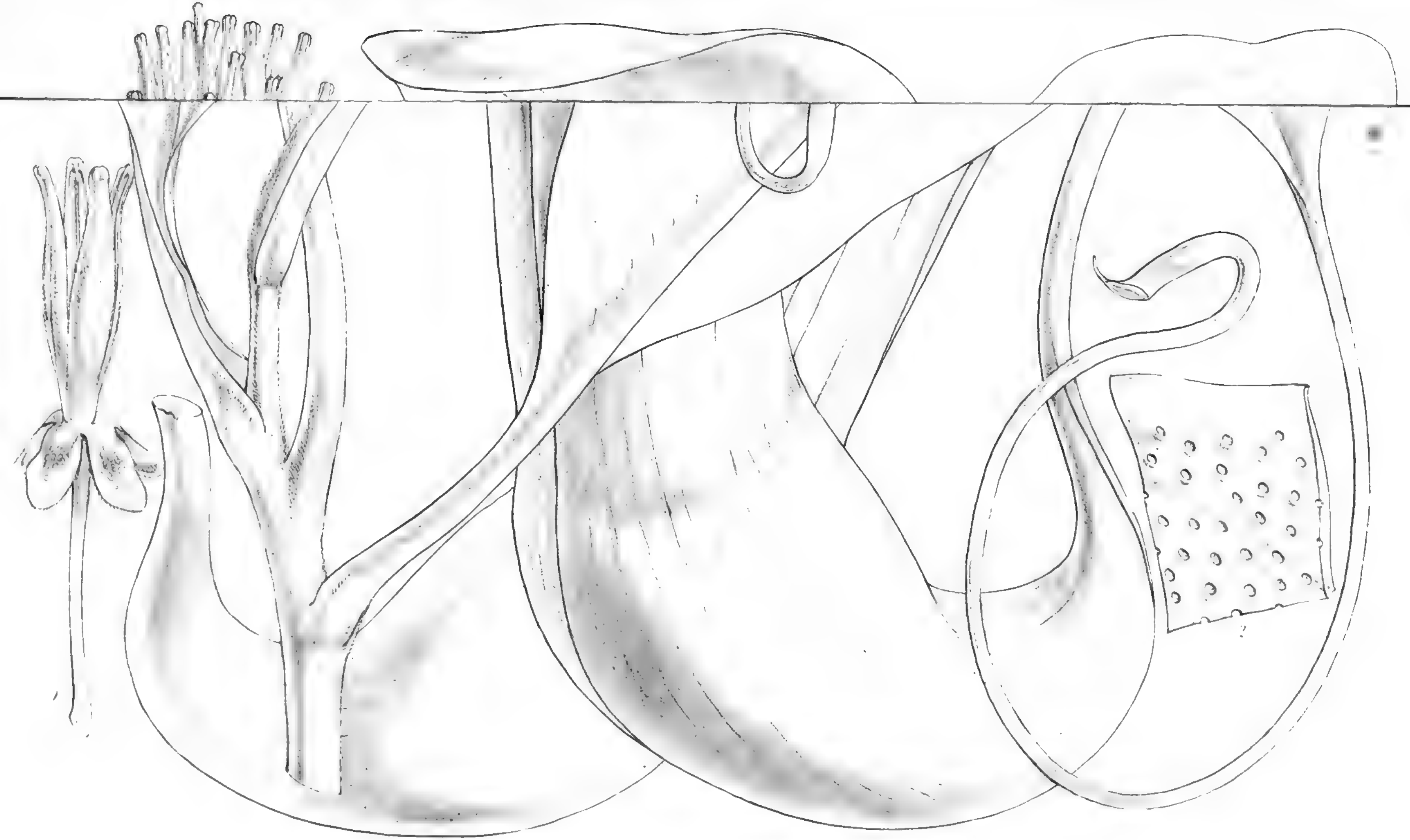
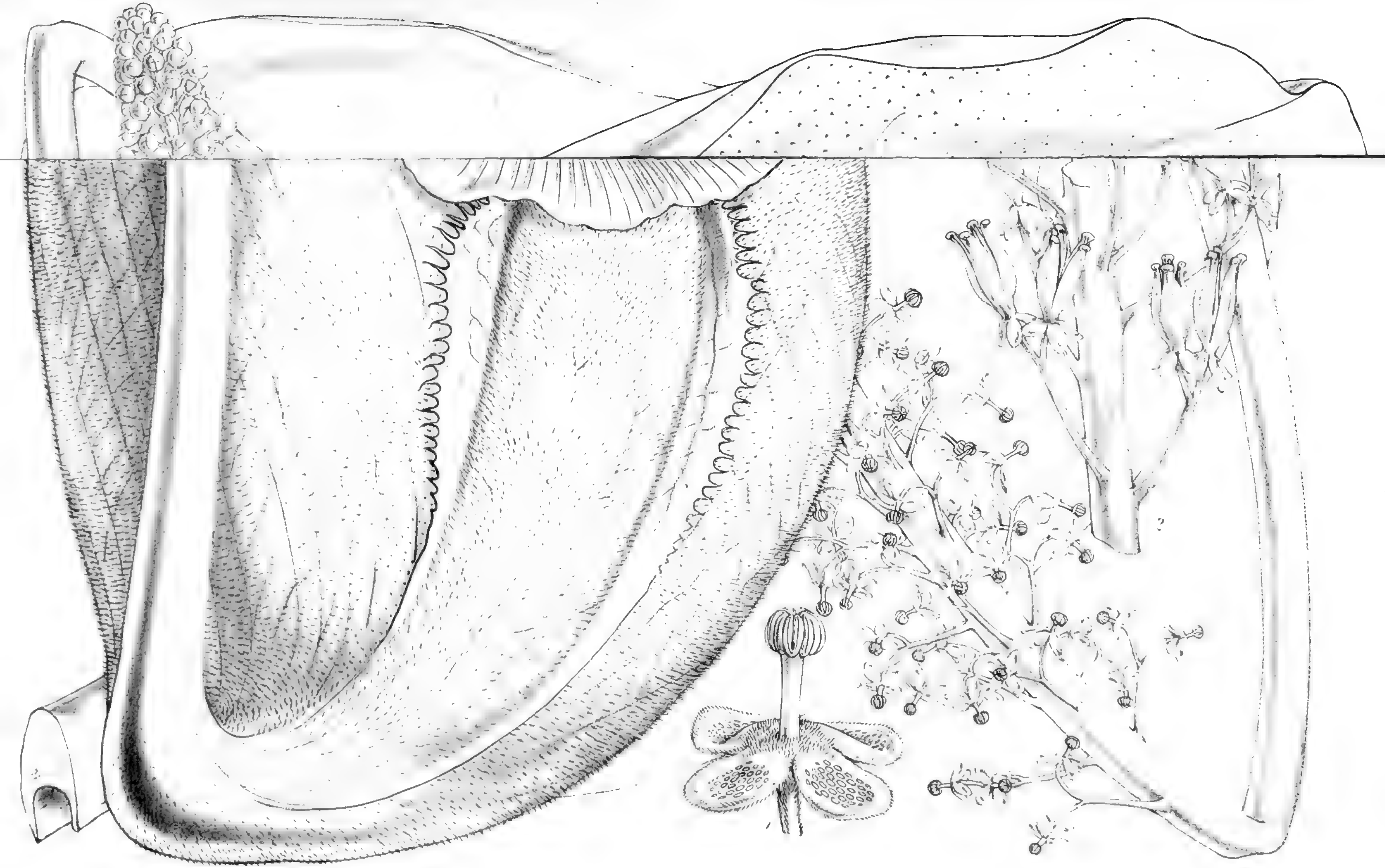
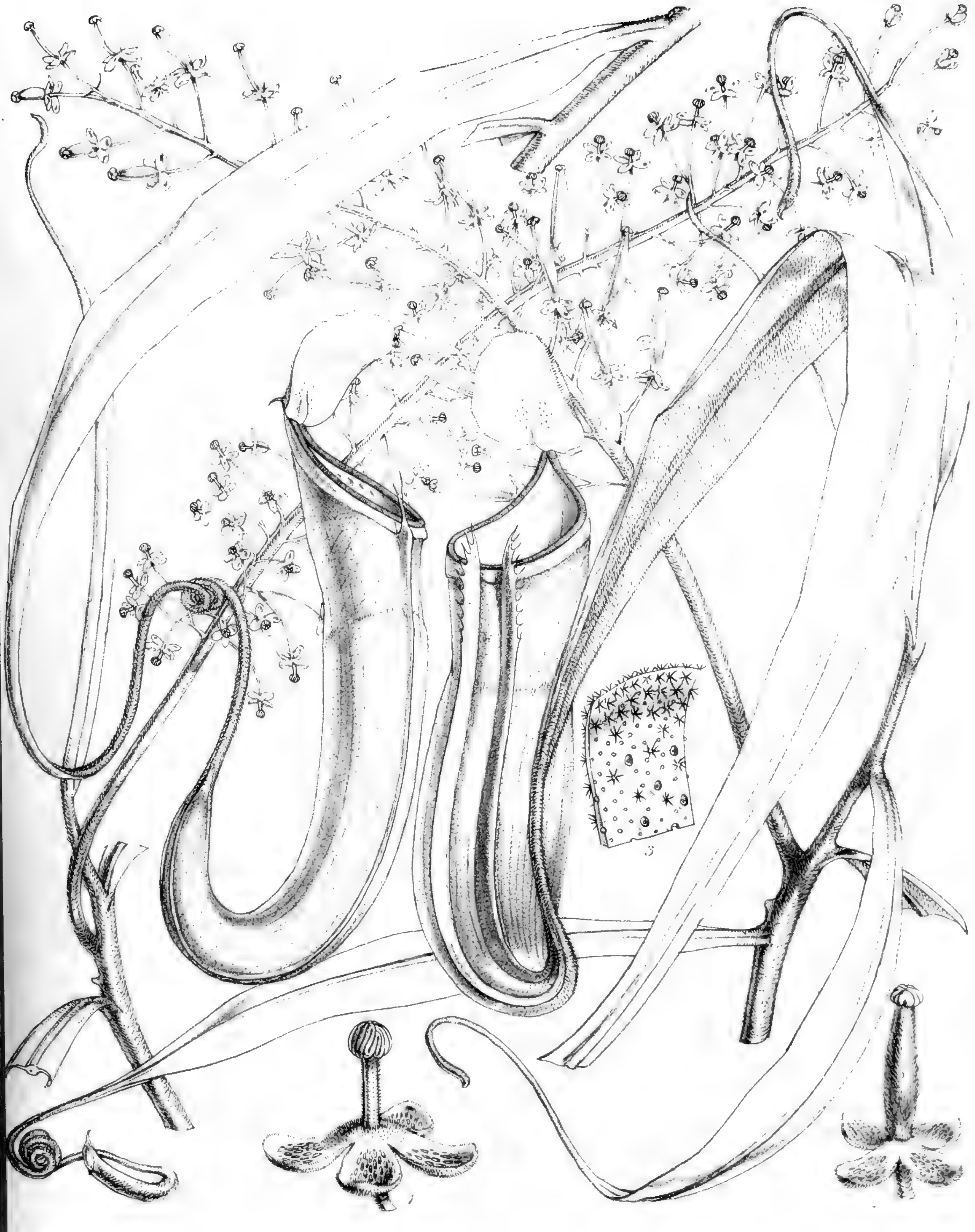


W. Fitch del. et lith.

NEPENTHES EDWARDSIANA, Low.

Day & Son lithrs.

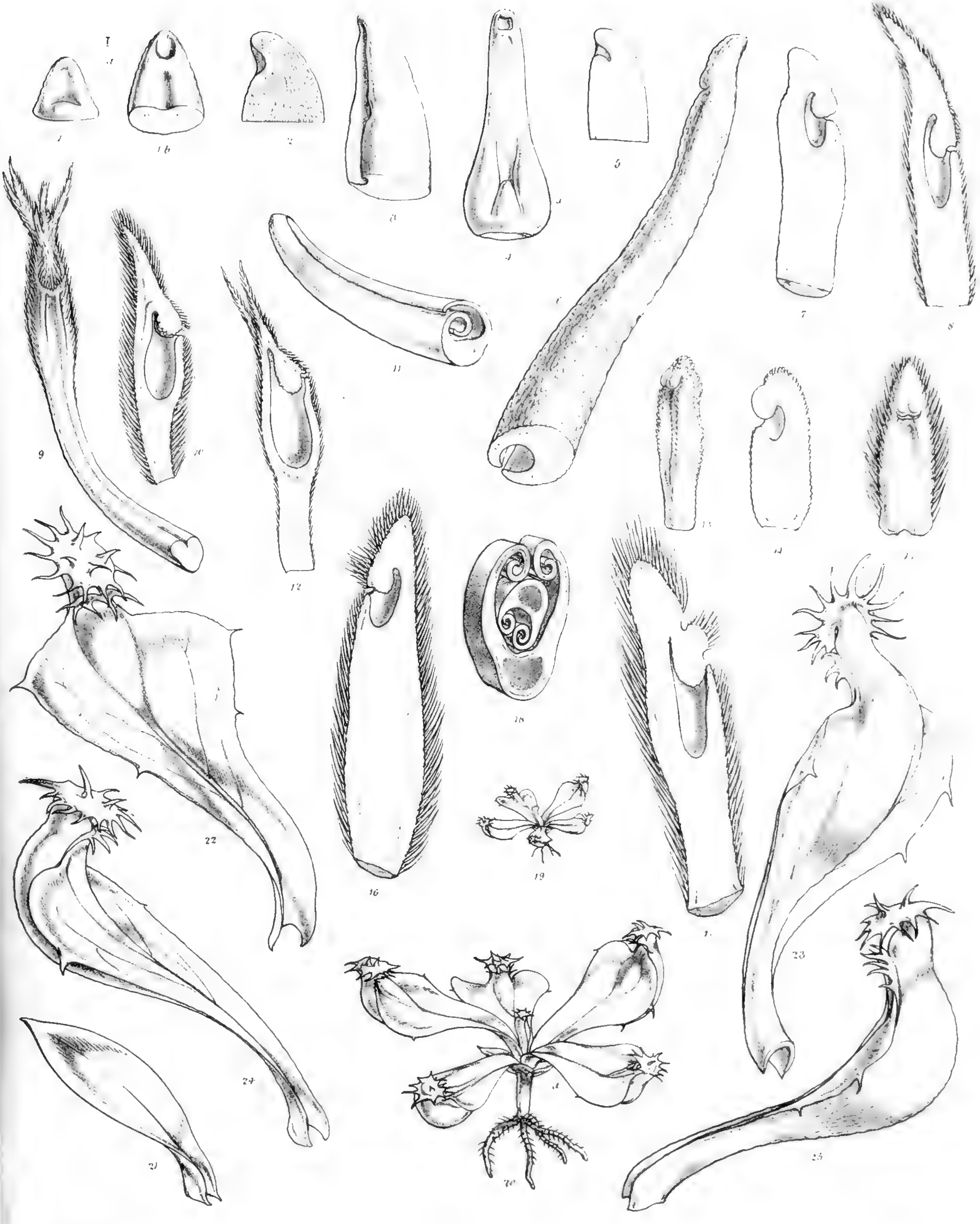




W. Fitch del. et lith.

NEPENTHES ALBO-MARGINATA. *Hook.*

Day & Son, Lithrs to the Queen.



J D H del J Fitch Lith.

Development of Nepenthes leaves

W West imp.

XXXVI. *On a New Genus of* Balanophoreæ *from New Zealand, and Two New Species of* Balanophora. *By* J. D. Hooker, *M.D., F.R.S. & L.S. &c.*

Read June 16th, 1859.

SINCE laying before the Linnean Society my observations on the structure and affinities of *Balanophoreæ**, I have received two additional species of *Balanophora*, and a remarkable new genus of the Order, which I shall now proceed to describe under the name of *Dactylanthus*.

Dactylanthus, n. g.

Dioicum. *Rhizoma* tuberosum, lobatum. *Pedunculi* plurimi, squamati, apice spadices plurimos gerentes. Flores in spadices dense conferti, inferiores dissiti. Fl. masc. *Stamen* solitarium sessile, filamento brevissimo, anthera 2-loculari. Fl. fœm. *Perianthium* ovario globoso subsessili adnatum, lobis 2–3 subulatis, stylo filiformi, stigmate simplici.

1. Dactylanthus Taylori, H. f. (Tab. LXXV. A.)

Hab. Nova Zelandia ad radices *Fagi* et *Pittospori* montibus prope Wanganui, alt. 4000 ped. (*Rev. R. Taylor, M.A.*). Nom. vern. *Pua reinga* (Flos Hades).

Rhizoma magnitudine pugilli et ultra, tuberculatum, superficie celluloso, pustulis papillisve nullis, intus sicco rubrum. *Pedunculi* numerosi, 4–6 unc. alti, sicco fragiles, rugulosi, opaci, ferruginei, intus rufescentes, squamis imbricatis laxe tecti, apice in receptaculum floriferum dilatati. *Squamæ* oblongæ, obtusæ, lata basi sessiles, inferiores dissitæ, $\frac{1}{4}$ unc. longæ, brunneæ, superiores sensim majores, supremæ inflorescentiam involucrantes, 1–2 unc. longæ, lineari-oblongæ, membranaceæ, albæ medio sordide brunneæ v. rubræ. *Spadices* (v. pedicelli floriferi) 10–30, conferti, erecti, 1–2 unc. longi, cylindracei v. fusiformes, crassitie pennæ corvinæ, stipitati, basi nudi v. floribus deformatis bracteolati. *Flores* dense conferti. Masc. *Stamen* solitarium nudum, sessile, filamento brevissimo crasso; anthera adnata, 2-locularis, transverse oblonga, rimis subverticalibus dehiscens, loculis crassiusculis, inferiores in spica imperfectæ dissitæ stipitatæ. *Pollen* pallidum, globosum. Fl. fœm. sicco nigri, sub $\frac{1}{10}$ unc. longi. *Ovarium* stipitatum, subglobosum. *Perianthium* supra ovarium paulo angustatum, dein bi-, rarius 3-partitum, a dorso compressum, cum stylo connatum; segmentis respectu axeos lateralibus, subulatis, inæqualibus. *Stylus* cylindricus, teres, superne paulo incrassatus, apice obtusus.—“Planta viva odorem subgratum Melonis, sed demum ingratum humi spirat.”—*Taylor.*

For a specimen of this singular plant I am indebted to my friend the Rev. R. Taylor, of New Zealand, who brought a fragment of it to England in 1856, and on my pointing out its probable interest, promised to procure more on his return to New Zealand. This he did; and early in the present year I had the pleasure of receiving from him a dried specimen of the female plant, a perfect male inflorescence in a letter, and a pen and ink sketch of the peduncle and flowers, with notes on the same. Owing to the great contraction of the cellular tissue, and blackening and fragility of the only entire specimen, which was unfortunately loosely packed in a box and much damaged, I have had considerable difficulty in so restoring the parts as to enable Mr. Fitch to complete the accompanying Plate, and myself to make the necessary analyses.

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* Page 1 of this volume.

The most remarkable character of *Dactylanthus* is its inflorescence, which, instead of presenting the solitary capitulum or spadix of most of its allies, or the branched character of *Sarcophyte*, consists of numerous erect spadices, densely covered with flowers. Of these the males consist of a solitary stamen, not articulate with the spadix, and without any trace of perianth, and hence present by far the most reduced form of male flower in the Order. The female spadices present a crinite appearance from the long flexuose styles of the flowers. The ovary appears to be compressed, furnished with a short thick stipes, and its upper part is contracted into a short thick neck, apparently consisting of the tube of the perianth connate with the base of the style: this contracted part varies much in width and breadth, and sometimes appears as if reduced to the adnate bases of the subulate lobes of the perianth.

I have not been able to ascertain the nature either of the contents of the ovary, which is extremely minute, and crumbles into black powder on being touched, or of the tissues of the rhizome and peduncle, which do not seem to differ materially from those of other *Balanophoreæ*.

The position of *Dactylanthus* is amongst my first group of *Balanophoreæ*, the *Monostyli*; but in many respects it partakes of the structure of various genera of *Distyli*, and is not very nearly related to any described genus. In habit it presents the rhizome of *Balanophora*. In the male flowers reduced to a solitary stamen, it agrees with *Lophophytum* and *Thonningia*, and in the subulate perianth-lobes of the female flower with *Cynomorium*. Upon the whole it may perhaps rank nearest to *Thonningia*, with which it agrees in habit, in some points of structure of the female flower, especially in the tube of the perianth being connate with the style above the ovary, in the absence of imperfect flowers amongst the females, of bracts, and of a perianth to the male flower.

The natives of New Zealand call this plant "Flower of Hades," because it grows almost buried in the soil; they further consider it allied to *Freycinetia*, which it strikingly resembles in the inflorescence.

Mr. Taylor informs me that he has heard vaguely of the existence of another species with blue flowers in the forests of Mount Egmont.

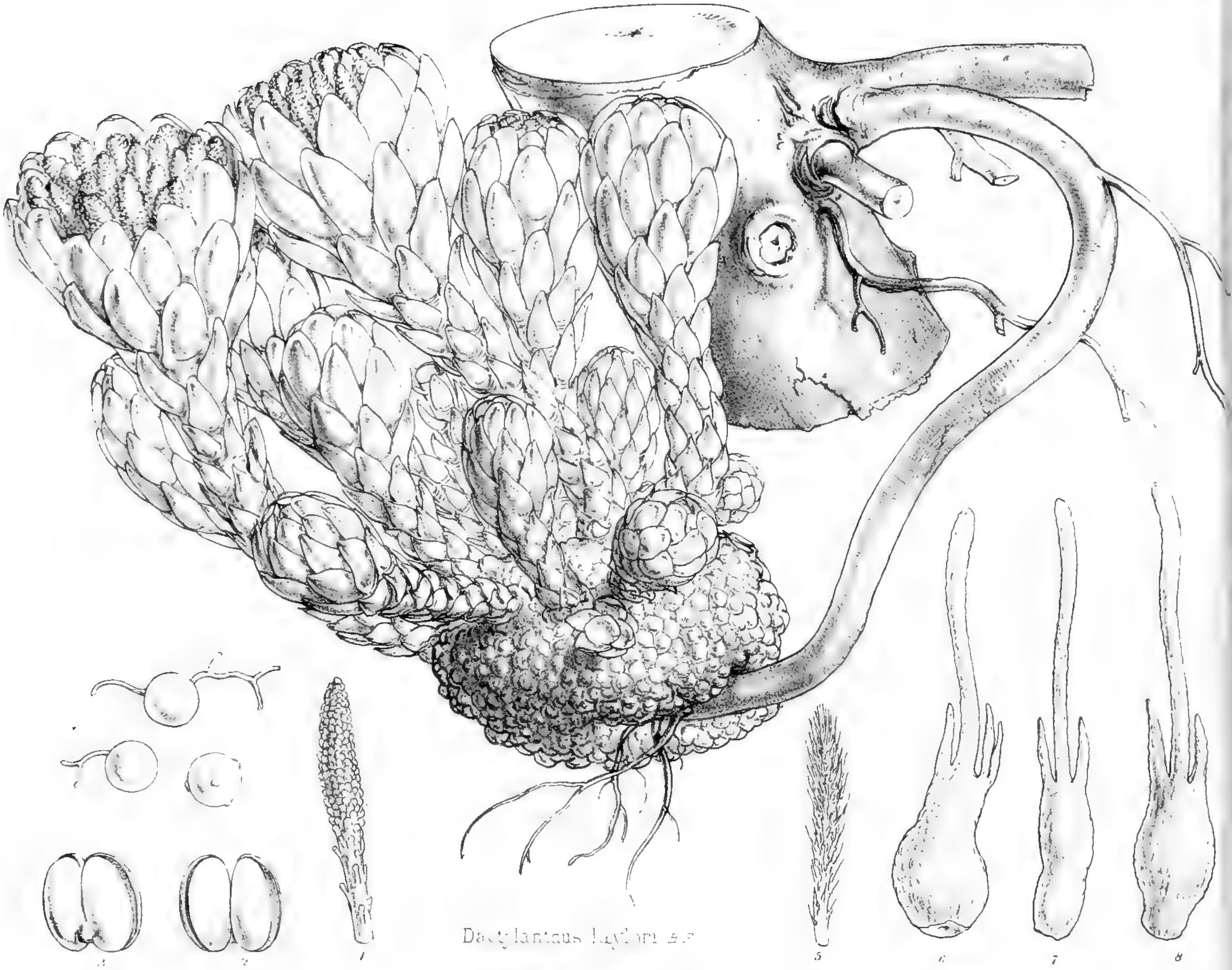
2. BALANOPHORA HARLANDI, H. f. Dioica, rhizomate parvo lobato epustulato, pedunculo ima basi bracteis subfoliaceis involucrato, capitulo globoso, floribus fœmineis capitulo sessilibus. (TAB. LXXV. B.)

Hab. Sylvis insulæ Hongkong (*Harland*); in convalle Mont. Gough (*C. Wilford*, Dec. 1858).

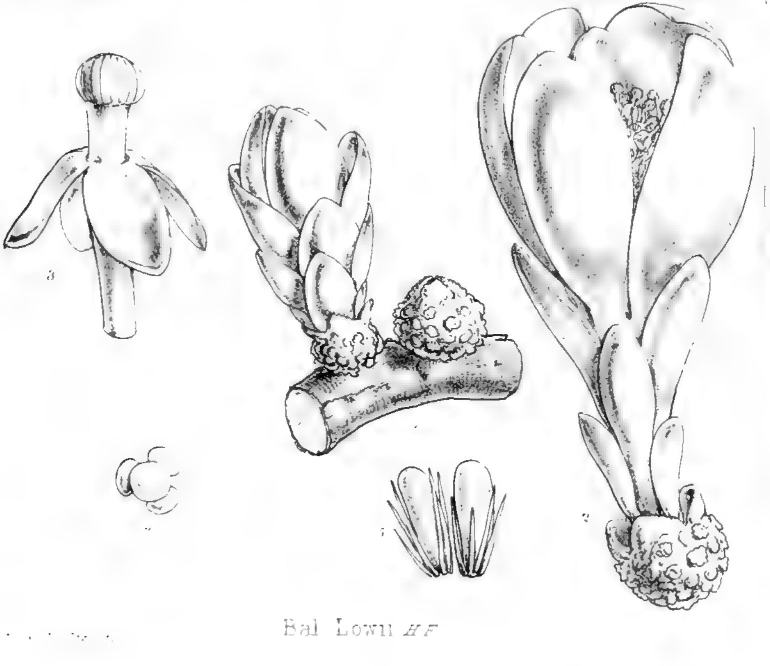
Species pusilla, 1–3 pollicaris, ab omnibus differt pedunculo basi tantum squamato; et præterea a *B. dioica*, capitulo globoso, et rhizomate epustulato; a *B. fungosa* capitulo unisexuali globoso, floribus fœmineis capitulo (non pedicello bracteolæ) sessilibus.

3. BALANOPHORA LOWII, H. f. Dioica, rhizomate parvo papilloso et pustulato, pedunculo brevi, squamis inferioribus parvis, superioribus magnis numerosis imbricatis concavis capitulum velantibus, capitulo fl. ♂ oblongo, receptaculo columnari, perianthio 4-fido, lobis lateralibus angustioribus. (TAB. LXXV. C.)

Hab. Sylvis umbrosis montis Kina Balou, insulæ Borneo (*H. Low*).



Dactylanthus Taylori H.F.



Bal. Lowii H.F.

Bal. Harlandi H.F.

Rhizoma pallidum, intus laxe cellulosum, in exemplaribus meis parvum, simplex, magnitudine nucis *Avellanæ*, superficie cellulis hyalinis papillosum, pustulisque conglobatis conspersum. *Pedunculus* solitarius, 2–3 unc. longus, ob squamas superiores amplas obpyriformis, basi volva brevi rhizomatis 3–4-lobi cinctus. *Squamæ* sicco atro-rubræ v. piceæ, nervis subparallelis, inferiores laxe imbricatæ, $\frac{1}{4}$–$\frac{1}{3}$ unc. longæ, oblongæ, obtusæ; superiores sensim majores; supremæ maximæ, $1\frac{1}{2}$ unc. longæ, valde concavæ, subcymbiformes, vix coriaceæ, imbricatæ. *Capitulum* ♂ pollicare. *Flores* erecto-patentes, pedicellis receptaculo non immersis? cum pedicello sub $\frac{1}{3}$ unc. longi. *Perianthii* lobi antici et postici oblongi, obtusi, laterales lineari-oblongi. *Capitulum* antheriferum oblate sphæricum, apice depressum, loculis polliniferis sub 20–30, parallelis, supra verticem capituli continuis. *Pollen* trilobum, minutissimum. *Capitulum ♀ valde immaturum* globosum, bracteolæ clavatæ; floribus stipitibus bracteolarum sitis.

The exogenous root on which this species grows appears soft, and swells out into deformed, spongy, lobed branches when attacked by the parasite. In all my three specimens the rhizome is simple and small, but probably only small specimens were gathered; their surface is covered with a layer of lax, transparent, empty, prominent cells, giving the whole a minutely papillose appearance. Prominent pustules or lenticels also occur in the rhizome, formed of 4–6 rounded radiating lobes. There is a considerable quantity of *balanophorine* in the cells of the rhizome; not enough, however, to give it a very waxy texture.

The most remarkable character of the species are the very large concave scales of the peduncle, which greatly exceed the capitulum, and, imbricating, arch over and entirely conceal the flowers.

Balanophora globosa has also been found on Kina Balou in Borneo by Mr. Low; his specimens, which are male, have the flowers almost an inch long and half an inch broad. The lateral lobes of the perianth are much narrower than the others, and the anthers are many-celled.

EXPLANATION OF THE PLATE.

Tab. LXXV.

A. *Dactylanthus Taylori*, H. f.

Fig. 1. ♂ spike, nat. size. Figs. 2 and 3. Stamens. Fig. 4. Pollen:—all magnified. Fig. 5. ♀ spike, nat. size. Figs. 6, 7 and 8. ♀ flowers, magnified.

B. *Balanophora Harlandi*, H. f.

Fig. 1. ♂, and Fig. 2. ♀ plant:—both nat. size. Figs. 3 and 4. ♂ flower. Fig. 5. Pollen. Fig. 6. Young ♀ flowers and bracts:—all magnified.

C. *Balanophora Lowii*, H. f.

Fig. 1. Young ♀ plant. Fig. 2. Full-grown ♂:—both of nat. size. Fig. 3. ♂ flower. Fig. 4. Pollen. Fig. 5. Very young ♀ flower and bracts:—all magnified.

DIRECTIONS
FOR
PLACING THE PLATES
OF
THE TWENTY-SECOND VOLUME.

55

END OF THE TWENTY-SECOND VOLUME.

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